SECTION-VII

MATERIAL REQUISITION

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MATERIAL REQUISITION (TOP SHEET)

ITEM DESCRIPTION: GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE

GROUP ITEM CODE:	**DESTINATION:** As per Commercial Documents
MR CATEGORY: II	**DELIVERY PERIOD:** As per Commercial Documents

DOCUMENT NUMBER

(Always quote the Document Number given below as reference)

B240	910	KA	MR	5010	B	18/09/2019	80	42
JOB NO.	UNIT/ AREA	MAIN COST CENTRE	DOC. CODE	SR. NO.	REV.	DATE	DIVN.	DEPT.
							ORIGINATOR	

NOTES :

1 This page is a record of all the Revisions of this Requisition.
2 The nature of the Revision is briefly stated in the "Details" column below, the Requisition in its entirety shall be considered for contractual purposes.
3 Vendor shall note the MR category and shall submit his offer in line with the requirements included in attached 'Instructions to Bidders'.

REV.	DATE	BY	CHK.	APPD.	DETAILS
A	11/07/2019	AS	NK	NK	ISSUED FOR BIDS
B	18/09/2019	AS	JSD	N K	REVISED AND REISSUED FOR BIDS

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SR. NO.	TAG NO/ ITEM CODE/ [ID. NO.]	DESCRIPTION	QUANTITY
01.00		Design, engineering, manufacture, procurement of materials and bought out components, assembly at shop, inspection, testing at manufacturer's works, Performance Guarantee test run at site, packing, delivery of the following, including supply of commissioning spares (Note-2) & special tools and tackles, documentation as per the enclosed EIL standard specifications, job specification, data sheets etc. and other codes and standards attached or referred.	
01.01	**910-K-901**	**NATURAL GAS COMPRESSOR**	**1 Nos**
02.00		**<< DELETED >>**	
03.00		**<< DELETED >>**	
04.00		Supply of Mandatory Spares as per enclosed list	
04.01	**{04}910-K-901**	**For Sr. No. 01.01 (Note-1)**	**1 Lot**
05.00		Quotation for Two Years Operation and Maintenance Spares	Lot
06.00		**<< DELETED >>**	
07.00		**<< DELETED >>**	
08.00		Supervision of erection and commissioning of items specified at item 1.00 above	
08.01	**{08}910-K-901**	**For Sr. No. 01.01 (Note-3)**	**1 /diem rate**
09.00		Drawings and documents as per attached Vendor Data requirement for all supplies and services covered above in Sr.Nos.1.00 to Sr.No.8.00	Lot
10.00		Training Charges at Vendor Works	
10.01	**{10}910-K-901**	**For Sr. No. 01.01 (Note-4)**	**1 Nos**
11.00		**<< DELETED >>**	
12.00		**<< DELETED >>**	
13.00		**<< DELETED >>**	
14.00		**<< DELETED >>**	
15.00		**<< DELETED >>**	
16.00		**<< DELETED >>**	
17.00		Per-diem rates for participation in Hazop Study of the GTC package	
17.01	**{17}910-K-901**	**For Sr. No. 01.01 (Note-5)**	**1 /diem rate**
18.00		**<< DELETED >>**	

Vendors shall quote prices in EIL Price Schedule except for Sr.No.9.00. Price for documentation is implied to be included in the prices quoted against Sr.No.1.00 to Sr.No.8.00

Vendor to note that the numbers given in square '[]' and curly '{}' brackets are not for their use and meant for store purpose only. Items shall be tagged as per main equipment Tag No. only.

LIST OF ATTACHMENTS

SL. No.	DOCUMENT TITLE	DOCUMENT NO.	REVISION			
			REV. DATE	REV. DATE	REV. DATE	REV. DATE
1	REFER LIST OF ATTACHMENTS					

In case of any subsequent revision of MR or PR, only revised sheets of the attachments listed above shall be issued alongwith the revision.

GENERAL NOTES:

(1):Bidder shall supply Mandatory spares as listed in Doc. No. B240-910-80-42-SL-5010 Rev. B.

(2).Any Commissioning spare consumed during commissioning phase over and above the quoted commissioning spares shall be supplied without any time/cost implication to the Purchaser. Any left-over spare shall be Purchaser's property.

(3). The GTC package vendor shall provide his services for supervision during erection and commissioning of the GTC package. Electrical & Instrumentation engineers (as required) shall also be present along with vendor's erection and commissioning engineers. For supervision of erection and commissioning of the GTC package, a total of 200 mandays (maximum limit) and pre-defined per diem rates (as defined in commercial document) have been envisaged. Bidder shall categorically confirm compliance to the figure of 200 mandays and the pre-defined per diem rates (as defined in commercial documents) for supervision of erection and commissioning. Bidder may decide between days for Indian/Foreign supervisors and also discipline wise i.e. Mechanical, Electrical & Instrumentation etc., if required for supervision of erection and commissioning of GTC package but total of 200 mandays (maximum) as indicated above. The cost for supervision of erection and commissioning shall not be considered for commercial comparison of bids.

(4). Training of client's operating and maintenance personnel (at vendor's works) shall be for 15 personsx2 weeks = 30 manweeks. Bidder shall quote accordingly.

(5). The successful bidder shall participate in HAZOP study of the GTC package. Bidder shall indicate the cost of providing the above services on per diem basis. For the purpose of commercial comparison 3 mandays shall be considered for participation in the HAZOP study of the GTC package. Per-diem rates as quoted by bidder shall be the basis of payment against participation in HAZOP study. However, the actual payment shall be baased on actual mandays participated by bidder.

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SPECIAL INSTRUCTIONS TO BIDDERS (GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE)

PROJECT : **Installation of New GTC Compressor at Gandhar, Gujarat,**

OWNER : **Gas Authority of India Limited**

PMC : **Engineers India Limited**

JOB NO. : **B240**

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
A	25.03.19	ISSUED WITH MR	AS	NK	NK

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1.0 For bid evaluation philosophy, refer bidder qualification criteria in commercial section (RFQ) of inquiry.

2.0 **Pre-Bid stage:**

i). Following shall be discussed / finalized during the pre-bid meeting (if applicable as per RFQ):-
- Bidder's deviations to data sheets/specifications/referred codes and standards.
- Bidder's deviations/clarifications (if any) w.r.t. scope of supply as specified.

ii). Bidder to note that the evaluation of BIDS shall be done on **"ZERO DEVIATION"** basis. Hence, Bidder shall strictly make all possible efforts to comply strictly with the requirements specified in the inquiry document.

iii). In case deviations are necessary, bidder shall note that only those deviations to codes & standards, which are either equipment specific or are technically infeasible to be complied with, may be considered and discussed during **PRE-BID MEETING**, provided a suitable justification for the same is furnished. Deviations, which can be complied either with extra cost and/or with time implications, shall not be permitted.

iv). Deviations, if any, shall be consolidated in a single Deviation List ***(Doc. No. B240-910-80-42-BF-5010)*** as enclosed in the MR to be discussed during pre-bid stage. It is in Bidder's interest to ensure that all technical deviations are sorted out in the pre-bid stage only. Bidder to categorically note that no new deviations *(except as agreed and discussed during pre-bid stage)* shall be allowed with the BID or after submission of BID/placement of order.

v). In case, any of the bidder is not attending the PRE- BID meeting, it shall be understood that the bidder does not have any comments / deviations to MR/RFQ requirements. In case any deviations/ clarifications are furnished in his bid, those deviations shall be deemed to have been withdrawn by the bidder.

vi). Conflicts/ambiguity, if any, between various documents attached in the material requisition/inquiry document shall be highlighted by the bidder during pre-bid meeting. In case of any conflict among the documents attached in the inquiry document, the following preferential order shall govern, except as specifically indicated otherwise (in any document forming part of MR). However, Purchaser's decision/clarification shall be FINAL and BINDING in this regard.

(a). Process Datasheets/P&IDs.

(b). Mechanical Datasheets.

(c). Job Specifications (if any).

(d). Other Specifications.

(e). International Standards/Codes/recommended practices as applicable.

In case of any other conflict /ambiguity is brought to purchaser's notice in the Bidder's bid/proposal & during post bid submission stage, the same shall also be subject to purchaser's review/approval and purchaser's decision shall be FINAL and BINDING in this regard. Purchaser's decision shall be complied by the bidder without any cost/ time implications.

3.0 **In-Bid requirement:-**

Bidder shall necessarily furnish the following along with the bid without which the bid/offer shall be considered incomplete and is likely to be rejected.

(a). Completely filled-in Centrifugal Compressor and Gas Turbine Datasheets.

(b). Performance curves for Centrifugal Compressor.

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(c). Correction Curves/Charts for Gas Turbine.

(d). Duly filled & signed/stamped Letter of Wavier format **(Doc. No. B240-910-80-42-DF-5010)**.

(e). Duly filled-in Proven track record proforma format along with back up supportive documents as specified elsewhere.

(f). Equipment layout/GAD/Foundation details for the GTC package.

(g). Preliminary utility requirements for the GTC package.

(h). Other documents required with bid as per vendor data requirements.

(i). Filled in Un-Priced EIL priced schedule format without any alteration/comments/clarifications.

(j). Un-Priced list of Mandatory Spares, Erection & Commissioning spares and Special Tools & Tackles.

(k). Un-priced list of vendor recommended two year spares with quotations.

(l). Documents required with bid as per Bidder Qualification Criteria/Bidder Proven Track Record proforma.

(m). Any other supporting document/drawing required with bid as per BQC/Bidder Proven Track record proforma and Vendor Data Requirement.

(n). Clarifications/deviations will be finalised during Pre bid meeting. No new technical deviations other than what has been discussed and agreed upon in pre bid stage shall be considered or taken cognizance of.

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DEVIATION FORMAT
(GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE)

PROJECT : Installation of New GTC Compressor at Gandhar, Gujarat,

OWNER : Gas Authority of India Limited

PMC : Engineers India Limited

JOB NO. : B240

NOTES:

1. Bidder shall note that only those deviations to specified standards & codes (if any), shall be permitted which are technically infeasible to be met, provided suitable justification for the same is furnished. Deviations, which can be complied with extra cost and or time implication, shall not be permitted.

2. Any deviations/deletions/corrections made elsewhere in the body of the bidder's proposal will not be taken cognisance of and all such deviations shall be deemed to have been withdrawn by the bidder.

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TITLEOF THE DOCUMENT:_____

DOCUMENT NO.:_____

Sl. No.	Document No.	Clause No.	Technical requirements specified as per inquiry document	Vendor Deviation	Reason for Technical Deviation / Technical Justification	Remarks

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Sl. No.	Document No.	Clause No.	Technical requirements specified as per inquiry document	Vendor Deviation	Reason for Technical Deviation / Technical Justification	Remarks

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FORMAT FOR LETER OF WAIVER

(TO BE SUBMITTED ON THE LETTERHEAD OF BIDDER)

TITLE OF WORKS/SUPPLY :

BIDDING DOCUMENT NO.

We …….(*) hereby agree to fully comply with, abide by and accept without variations, deviation or reservation all technical, commercial and other conditions of the Bidding Document and its Technical Amendments, issued by EIL.

We confirm that during detailed engineering, we will review and recommend the required Special tools & tackles and Commissioning spares, wherever specified in the enquiry document and supply the same without any additional cost and time implication to Purchaser.

We further hereby waive, withdraw and abandon any and all assumptions, deviations, variations, objections or reservations whatsoever hereto set out, give or indicated in our offer, clarifications, correspondence, communications, or otherwise with a view that the price bid and price implication (if any) submitted may be treated to conform to, in all respects, with the terms and conditions of the said Bidding Document including all Technical Amendments.

**

For and on behalf of

Authorised Signatory

Date :

*Here fill in the name of bidder

** The Letter of Waiver must be signed by the person(s) authorized to sign.

SCOPE OF SUPPLY
(GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE)

PROJECT : **Installation of New GTC Compressor at Gandhar, Gujarat,**

OWNER : **Gas Authority of India Limited**

PMC : **Engineers India Limited**

JOB NO. : **B240**

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
B	16.09.2019	REVISED AND RE-ISSUED WITH MR	AS	JSD	NK
A	14.06.2019	ISSUED WITH MR	AS	NK	NK

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SCOPE OF SUPPLY FOR GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE

Notes:

(i) Bidder shall furnish all equipment, drivers, auxiliary systems, instruments and controls and safety devices as per the enquiry document. Anything required over and above what is specified, for safe and satisfactory operation of the equipment package shall be included by the vendor in his scope.

(ii) Bidder's offer shall be completely inline with scope indicated. No deviation w.r.t. scope shall be accepted.

(iii) Bidder's scope of supply shall include but not be limited to the following for the Gas turbine driven Centrifuigal compressor package:

SECTION-A: ROTATING EQUIPMENT
SECTION-B: ELECTRICAL
SECTION-C: INSTRUMENTATION
SECTION-D: PIPING

SECTION-A: ROTATING EQUIPMENT

Sl. No.	Description	Required (Yes/No)	Remarks
1.0	**Compressor** ***(Refer equipment data sheets and job specification for full details)***		
1.1	Centrifugal Compressor as per Chapter-1 & 2 of API Standard 617, 7th edn. & EIL Std. Specification 6-42-0005 Rev. 2 along with matching companion flanges, gaskets, fasteners etc. at all terminating points requiring owner's interface.	**Yes**	
1.2	Dry Gas Seals (Bi-directional Tandem Type with internal labyrinth)	**Yes**	
1.3	Gear Unit as per API Standard 613	**Yes**	If Required
1.4	Couplings (non-lubricated type) as per API 671 with spacers and non-spark guards	**Yes**	
1.5	All associated auxiliary piping/tubing etc. prefabricated and duly mounted on the equipment/base-plate.	**Yes**	
1.6	Fabricated Steel Base Plate: Compressor and Gear unit & Gas Turbine Driver.	**Yes**	Bolted & dowelled at site (if reqd.)
2.0	**Gas Turbine and Associated System** ***(Refer equipment data sheets and job specification for full details)***		
2.1	Gas Turbine (GG & PT) as per API 616, 5th edn. & EIL Std. Specification 6-43-0041 Rev. 2 complete with all necessary auxiliary equipments and control systems as per inquiry document	**Yes**	With DLE/DLN combustors (w/o water or steam injection)
2.2	Acoustic Enclosure to limit noise level within 85 dBA @ 1m alongwith ventilation system for Enclosure including ventilation fans (1W+1S), air inlet filter, inlet and exhaust ducting, silencers, Expansion joints, flanged connections and transition pieces with all supports and fixing arrangement etc. as required along with necessary instrumentation.	**Yes**	
2.3	Air intake system complete with suction weather-hood, bird screen, louvers, silencers, inlet air filter as per Job spec., filter housing, Pre-fabricated air inlet ducting, Expansion joints, flanged connections and transition pieces etc. as required along with necessary instrumentation.	**Yes**	

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SECTION-A: ROTATING EQUIPMENT			
Sl. No.	**Description**	**Required (Yes/No)**	**Remarks**
2.4	Turbine exhaust system including min. 30 meter high Stack/Chimney and complete with exhaust collector, exhaust silencer, expansion joints, flanged connections, transition pieces etc. as required along with necessary instrumentation.	**Yes**	
2.5	CO_2 Fire suppression system for GT enclosure as per Job specification for fire suppression system	**Yes**	
2.6	Portable trolley mounted Gas Turbine washing and cleaning system complete with reservoir, driver, interconnecting flexible hose piping (10 m each at each port), hose-storage-wheel, valves, motor cable of approximately 30 m length & plug to suit the area classification & necessary instrumentation & controls.	**Yes**	If required for the quoted Gas Turbine model
3.0	**Fuel Gas system** ***(Refer equipment data sheets and job specification for full details)***		
3.1	Fuel Gas system as per Clause no. 5.8 of 6-43-0041 Rev. 2 and Job Specification B240-910-80-42-SP-5010 attached with the inquiry document complete with the following:	**Yes**	
	- Twin Knock-out Pots with Demister pads.	**Yes**	
	- Twin strainers.	**Yes**	
	- Twin filters	**Yes**	
	- Continuous flow transfer valves.	**Yes**	
	- Twin fuel gas super heater(s), (one working & one standby).	**Yes**	
	- All Instrument and Controls duly mounted including all necessary control valves, safety valves, Gas & heater skin temperature controls, temperature and pressure gauges, fuel piping upto skid etc.	**Yes**	
	- All Stainless steel interconnecting, Pre-fabricated piping/tubing for fuel gas line duly installed.	**Yes**	
	- Fuel Gas Booster system	**Yes**	If required
3.2	All Stainless Steel supply piping/tubing between Fuel Gas conditioning skid and GT duly fabricated.	**Yes**	
3.3	All Stainless Steel Vent/Flare piping/tubing from Fuel Gas conditioning skid to safe height or flare header.	**Yes**	
3.4	Matching companion flanges, gaskets, fastners etc. at all terminating points requiring Owner's interface.	**Yes**	
4.0	**Lube Oil System for Compressor, Gear Box and Gas Turbine (GT)** ***(Refer equipment data sheets and job specification for full details)***		
4.1	Lube oil Console complete with the following:		
	- Stainless Steel Oil reservoir	**Yes**	
	- Shaft Driven/Electric motor (AC) driven Main oil pump with external pressure relief valve.	**Yes**	
	- Electric motor (AC) driven Standby oil pump with external pressure relief valve.	**Yes**	
	- Shaft Driven/Electric motor (AC) driven main Hydraulic Oil Pump with external pressure relief valve.	**Yes**	as applicable

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SECTION-A: ROTATING EQUIPMENT			
Sl. No.	**Description**	**Required (Yes/No)**	**Remarks**
	- Electric motor (AC) driven Standby Hydraulic Oil Pump with external pressure relief valve.	**Yes**	as applicable
	- Electric motor (DC) driven Emergency-oil pump for equipment cool-off.	**Yes**	
	- Twin Oil-filters.	**Yes**	
	- Continuous flow transfer valves.	**Yes**	
	- All instruments & controls duly mounted.	**Yes**	
	- Skid mounted Local Gauge Board with all instruments mounted on it.	**Yes**	
	- All Stainless Steel interconnecting, pre-fabricated piping/tubing duly installed	**Yes**	
4.2	Oil cooler (Air-cooled type) with adequate number of fans with 100% spare capacity, complete with interconnecting piping between Oil Cooler and the Oil Console.	**Yes**	
4.3	Emergency overhead Lube oil run down tank (sized for equipment coast down) along with all necessary piping, instrumentation and controls.	**Yes**	
4.4	All Stainless Steel supply/return piping/tubing between lube oil console and Compressor/Gear Unit/GT.	**Yes**	
4.5	Matching companion flanges, gaskets, fastners etc at all terminating points requiring Owner's interface/tie-in points.	**Yes**	
4.6	Necessary Instrumentation and Controls.	**Yes**	
4.7	Gas generator Lube Oil system as recommended by GT manufacturer.	**Yes**	If separate system is recommended by Gas Turbine manufacturer
4.8	One no. Portable trolley mounted emptying/Fill oil Pump for Lube Oil reservoir complete with Driver, flexible hose piping (10 m each at suction & discharge), hose-storage-wheel, valves, motor cable of approximately 30 m length & plug to suit the area classification.	**Yes**	
4.9	One no. Portable trolley mounted oil purifier complete with automatic self cleaning centrifuge separator, flexible hose piping (10 m each at suction & discharge), hose-storage-wheel, valves, motor cable of approximately 30 m length & plug to suit the area classification & necessary instrumentation and controls.	**Yes**	
5.0	**Buffer Gas Supply System for Dry Gas Seals** ***(Refer equipment data sheets and job specification for full details)***		
5.1	Buffer/Seal Gas Skid complete with the following:	**Yes**	
	- All instruments & controls duly mounted	**Yes**	
	- All Stainless Steel interconnecting, pre-fabricated piping duly installed	**Yes**	
5.2	Seal Gas Booster	**Yes**	If required for the seal gas conditions
5.3	Seal Gas heater	**Yes**	
5.4	All Stainless Steel supply piping/tubing between buffer gas skid & compressor	**Yes**	
5.5	All Stainless Steel vent/flare piping/tubing from compressor to safe height/flare header.	**Yes**	

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SECTION-A: ROTATING EQUIPMENT			
Sl. No.	**Description**	**Required (Yes/No)**	**Remarks**
5.6	Matching companion flanges, gaskets, fastners etc. at all terminating points requiring Owner's interface.	**Yes**	
5.7	Provision of automatic change-over from normal to emergency Seal gas supply along with all the necessary instrumentation and controls. *Note:During start-up/Emergency external Seal Gas shall be made available by the Purchaser at the Vendor's battery limit for further distribution by vendor. Start-up/Emergency Seal gas Details are as given in Compressor datasheet.*	**Yes**	
6.0	**Pressure Vessels and associated systems** ***(Refer equipment data sheets and job specification for full details)***		
6.1	Process Vessels	**No**	
6.2	Other vessels forming part of Auxilliary systems	**Yes**	
7.0	**Heat Exchangers and Associated systems** ***(Refer equipment data sheets and job specification for full details)***		
7.1	Heat Exchangers forming part of Auxilliary systems (i.e. Air-Cooled Oil cooler same as Sl. No. 4.2 above). ***Note: All coolers forming part of GTC package shall be air-cooled only***	**Yes**	Air-cooled heat exchangers
8.0	**Piping** ***(Refer piping specification, PMS for details)***		
8.1	Permanent type Process Gas Suction Strainers at inlet of compressor along with spool piece(s).	**Yes**	
8.2	Temporary Process Gas Suction strainer for the commissioning of the Compressor package.	**Yes**	
8.3	Complete interconnecting piping within and between various skids (i.e. main equipment skid and various auxiliary skids such as L.O. Console Skid, Buffer Gas Skid and Fuel Gas conditioning Skid etc.)	**Yes**	
8.4	Complete inter-connecting piping from and/or to Purchaser's battery limit including Vent, Flare, Drain, Utility piping (i.e. Inst. Air, Plant Air, Inert Gas etc.)	**Yes**	
8.5	All other items as per Piping scope of supply in Section-D	**Yes**	
9.0	**Electrical Equipment** ***(Refer electrical data sheet & specs. for full details)***		
9.1	All items as per Electrical scope of supply in Section-B & Electrical specifications	**Yes**	
10.0	**Instrumentation and controls** ***(Refer instrumentation datasheets, related to specifications & P&IDs for full details)***		
10.1	All items as per Instrumentation scope of supply in Section-C & Instrumentation specifications	**Yes**	
11.0	**Spares and Special Tools & Tackles** ***(Spares for the GTC package including Mechanical, Electrical, Instrumentation etc.)***		
11.1	Mandatory spares, as specified in Doc. No. B240-910-80-42-SL-5010	**Yes**	
12.1	Commissioning spares as recommended by the equipment manufacturer	**Yes**	

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SECTION-A: ROTATING EQUIPMENT			
Sl. No.	**Description**	**Required (Yes/No)**	**Remarks**
11.2	Quotation for vendor recommended spares for 2 year normal operation.	**Yes**	Including Mech./Elect./inst. Spares
11.3	Special tools and tackles required, if any, for erection, site assembly and maintenance of each equipment of compressor package as recommended by the equipment manufacturer including Hydraulic tightening device with low pressure and high pressure Pumps if required & GT manufacturer's recommended special tools including also Boroscope & Alignment tools. Also, refer Clause no. 13.3 of Job Specification for Centrifugal Compressor (Doc. No. B240-910-80-42-SP-5010) for Special tools and tackles to be mandatorily supplied.	**Yes**	
11.4	Spreader Bars/Slings/Shackles for lift of GTC skid for transportation/erection	**Yes**	
11.5	Torque Wrenches/Bolt Tensioners	**Yes**	
12.0	**Inspection & testing:**		
12.1	Shop inspection and Testing:		
	• Mechanical Run Test for Compressor with Main Rotor as per API Std. 617 & EIL Standard Spec. 6-42-0005 at Compressor manufacturer's works.	**Yes**	
	• Mechanical Run Test for Compressor with Spare Rotor as per API Std. 617 & EIL Standard Spec. 6-42-0005 at Compressor manufacturer's works.	**Yes**	
	• Performance Test for Compressor (with main rotor) as per Type 2 ASME Code PTC-10 at Compressor Manufacturer's works.	**Yes**	
	• Mechanical run test for the Gas Turbine with main rotor / main Gas generator as per API Std. 616 & EIL Standard Spec. 6-43-0041 at Gas Turbine Manufacturer's works.	**Yes**	Rotor or Gas Generator as per offered GT type
	• Performance Test for Gas Turbine main rotor / main Gas generator as per API Std. 616, ASME Code PTC 1 & 22 and EIL Standard Spec. 6-43-0041 at Gas Turbine Manufacturer's works.	**Yes**	Rotor or Gas Generator as per offered GT type
12.2	Performance Guarantee Test run (PGTR) of the GTC package at site	**Yes**	Refer Job specification
12.3	Other Shop inspection and Testing for all items under vendor's scope of supply, as specified in the datasheets, specifications etc. forming part of the inquiry document.	**Yes**	
13.0	**Vendor Data & Drawings**		
13.1	The Proposed layout(s) enclosed with the inquiry document indicates tentative equipment layout. Bidder	**Yes**	

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SECTION-A: ROTATING EQUIPMENT			
Sl. No.	**Description**	**Required (Yes/No)**	**Remarks**
	shall confirm that the Proposed equipment package is accommodated within the space allocated for the specified units. Bidder in his proposal shall include in his proposal suggested detailed equipment layout indicating main equipment as well as auxiliary equipment various consoles, local panels/local gauge board etc. along with their dimensions and levels at which the same are to be placed. The Bidder shall also indicate weights of equipment, maintenance space required, crane capacity (recommended) and crane hook approach from the grade level etc. The data/information shall be adequate for designing of the Compressor house (Shelter). General Arrangement Drawing(GAD)/Equipment layout of all equipment located inside compressor house including main equipment, auxiliaries heat exchangers and routing of piping etc. *(based on the indicative layout drawing provided in the inquiry)* shall be provided by the vendor along with the proposal.		
13.2	Detailed manufacturing, installation drawings & bill of material for self supporting exhaust steel stack with suitable ladder/ staircase for maintenance of the same & with connections/tappings for measuring emission levels.	**Yes**	Exhaust stack supply by Bidder. Assembly &, Installation by others under supervision of bidder
13.3	Detailed fabrication, installation drawings & bill of materials for structural supports, access/maintenance platforms, ladders for the Gas-Turbine Compressor skid and all the auxiliary systems forming part of GTC package like: - Inlet Air filters & Inlet Air Ducting - Ventilation Fans & Ventilation Air Ducting - Lube Oil Run Down Tanks - Exhaust Stack/Chimney/Exhaust ducting etc.	**Yes**	Fabrication, Supply, Installation of platform and ladders by others. Note: All foundation bolts of the complete GTC package and auxiliaries are in bidder's scope
13.4	All data & drawings as required per Vendor data requirements, data sheets, specifications and referenced codes and standards.	**Yes**	
14.0	**Erection & Commissioning**		
14.1	Supervision of Erection for Compressor package	**Yes**	Per diem rates as defined in commercial documents
14.2	Supervision of Commissioning for Compressor package	**Yes**	
15.0	**Miscellaneous**		
15.1	All Foundation/Anchor Bolts for the complete scope of supply of GTC package	**Yes**	To be supplied for all skids/chimney/supports
15.2	Chemical Cleaning, Pickling, Passivation etc. of vendor Supplied piping	**Yes**	
15.3	Surface Cleaning, environment primer etc. of all Pressure vessels & Heat Exchangers.	**Yes**	
15.4	Painting, Preparation of Shipment and export quality packaging	**Yes**	

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SECTION-A: ROTATING EQUIPMENT			
Sl. No.	**Description**	**Required (Yes/No)**	**Remarks**
15.5	Customer Training (15 no. of persons x 02 Weeks=30 man weeks) at Bidder's/Sub-vendors's Works.	**Yes**	
15.6	Participation of Purchaser's personnel during assembly and other important activities	**Yes**	
15.7	Participation in HAZOP study of the GTC package	**Yes**	Per diem rates to be quoted
15.8	Train Torsional study	**Yes**	
15.9	Compressor Lateral study	**Yes**	
15.10	All other items not mentioned in this document but required as per P&IDs, datasheets, specifications etc. attached in the inquiry document .	**Yes**	
15.11	Additional items (including mechanical, electrical and instrumentation and controls) not specified by Purchaser but recommended by vendor for safe, smooth and efficient operation of complete Compressor Train.(Vendor to include separate list of such items in his proposal along with their unit prices)	**Yes**	

SECTION-B: ELECTRICAL

1.	**Electrical Equipment**			
1.1.	All MV motors IE2 efficiency class minimum (AC/DC Ex-de)/ heaters (Ex-de) as required for the auxiliary drives.	**Yes**		
1.2.	415V GTMCCs for feeding all the loads of package equipment envisaged at substation1.	**Yes**		
1.3.	MV induction Motors for the Electro-Hydraulic Starting system of GT.	**Yes**		
1.4.	VFD system if required (including input and output transformers, as applicable)	**Yes**		
1.5.	Flameproof Local control station/ local control panel for local operation of motors with Start, Stop push buttons, ammeter etc. It shall also contain other devices like selector switches, indications, etc as per operational/ process requirements. (Separate local control station (LCS) shall be provided for motors/ heaters located away from LCP)	**Yes**		
1.6.	Earthing for bidder supplied equipments within the skid and Earthing terminals for connection to main plant earth grid to be provided on Motor/Skid.	**Yes**		
1.7.	Cabling for skid mounted equipment including supply and termination within the skid.	**Yes**		
1.8.	Cable trays withing the skid (Refer Note-7)	**Yes**		
1.9.	Cable accessories / installation materials such as flameproof double compression cable glands, cable lugs etc., and all other associated accessories and hardware for all bidder	**Yes**		

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	supplied equipment.			
1.10.	Lighting of turbine enclosure and other skid mounted equipment.	**Yes**		
1.11.	Testing and commissioning of VFDs at site is included in vendor's scope & this work shall be executed/ carried out by VFD manufacturer, i.e. OEM only. Vendor shall certify readiness of system fit for commissioning. Vendor's scope shall also include supply of all specialised tools & tackles/ instruments and commissioning spares required for above service.	**Yes**		
1.12.	Heat tracing as required.	**Yes**		
1.13.	UPS (Refer Note-5)	**No**		Existing UPS 110V shall be utilised. Refer Instt part of MR.
1.14.	UPS Distribution Board	**Yes**		
1.15.	Battery, Battery Charger, DCDB, DC Motor starter panel and cell booster to cater load of Emergency Lube oil pump (As required and Emergency lighting of Turbine enclosure.	**Yes**		
1.16.	Electrics for any other equipment / items as specified elsewhere in the MR.	**Yes**		
1.17.	Special cables as applicable	**Yes**		
1.18.	All other electrical equipment, materials and work not explicitly mentioned but nevertheless required to fulfil the requirements shall be deemed to be included in the scope of the contractor with no additional cost and time implication to the owner/ EIL.	**Yes**		
1.19.	FLP Junction box (Ex-d) suitable for Gas group IIA/IIB, Temperature class: T3. If required in case of problem in termination of power cables	**Yes**		
1.20.	CCoE/PESO approval, Type test certificates, BIS Licence (applicable only for all Indigenous FLP items) for all bidder supplied equipment.	**Yes**		
1.21.	All data & drawings as required per Vendor data requirements, data sheets, specifications and referenced codes and standards.	**Yes**		
1.22.	Incoming 415V feeders for GTMCC	**No**		
1.23.	General Lighting within the compressor shed.	**No**		
1.24.	All power and control cables (other than cables within the skid).	**No**		
1.25.	Cable trays and accessories outside the skid	**No**		

Notes:

1. Commissioning spares shall be included in the Vendor's scope of supply. A list shall be attached with offer giving quantity of such spares.
2. The vendor shall supply special tools for operation and maintenance. A list shall be attached with offer giving quantity of such tools.
3. Vendor shall quote unit rates for 2 years operation and maintenance spares over and above mandatory spares already listed in this MR.
4. Cables glands shall be flameproof type, nickel plated brass, double compression for use in hazardous area shall conform to the requirements of lates IS/IEC 60079-0. Indigenous flameproof cable glands shall have valid BIS license as per the requirements of statuttory authorities. Size of cables will be informed during detailed engineering and cable glands selected shall be appropriate to the size of cable
5. Bidder shall furnish number and rating of UPS feeders (110V AC) required alongwith offer.

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6. For portable trolley mounted lube oil transfer pump and portable lube oil purifier, vendor shall supply and install 63A, TPN, 415V flameproof receptacles (socket) with plug within the skid. Purchaser shall feed 415V, 50Hz power to each socket.
7. For Power and Control cabling which are excluded from vendor's scope, cable laying provision including supply and installation of cable trays within the skid battery limit shall be provided by the vendor.

SECTION-C: INSTRUMENTATION

S.No.	DESCRIPTION	Bidder	Purchaser
1.0	**Scope of Design & Engineering**		
1.1	Design and detailed engineering including residual engineering (note-1) of instrumentation & controls of Gas turbine driven Centrifugal Compressor based on P&ID's and other technical requirements described in various documents attached with this MR. This shall include detailed engineering including preparation of engineering drawings/ documents, specification data sheets, sizing, selection of materials, review of vendor drawings / documents for all supply items and preparation of engineering drawings/ documents for UCP and PLC.	Yes	
1.1.1	All type of field instruments identified and marked as "*" on P&ID's on process gas suction & discharge, starting gas, fuel gas, seal gas, gas recycle and vent gas lines such as pressure, Flow(DP), temperature, differential pressure, temperature transmitters, pressure & temperature gauges, temperature elements and thermowells, all types of control valves & shutdown valves with accessories, pressure relief valves, anti surge control valves, suction flow elements, gas detectors etc. and any other instruments including skid mounted instruments, local gauge board mounted instruments, control panel mounted Instruments required to complete the job in all respect.	Yes	
1.1.2	Unit control panel with Programmable Logic Controller based control system to be located **existing** control room, for entire Gas turbine driven centrifugal compressor and associated auxiliaries and station control system as per P&ID's.	Yes	
1.1.3	All skid mounted instruments related to compressor package including Turbine, compressor, seal gas system, fuel gas system, starting gas systems, air intake system, gas after coolers, lube oil system and auxiliaries etc.	Yes	
1.1.4	All controls for entire gas turbine compressor train including process gas suction & discharge, starting gas, **fuel gas conditioning skid with metering system**, seal gas, gas recycle and vent gas lines instruments to be executed in dedicated PLC based control system of the compressor .	Yes	
1.1.5	Local Gauge boards	Yes	
1.1.6	Antisurge controllers, Performance/Master controller and load sharing controller (if required)	Yes	
1.1.7	Vibration, temperature and Displacement monitoring system including monitors.	Yes	
1.1.8	**Integration of Compressor control systems with**	Yes	

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S.No.	DESCRIPTION	Bidder	Purchaser
	existing DCS/PLC systems.		
2.0	**Scope of procurement/ supply**		
2.1	Supply of all items related to instrumentation & control system of Gas turbine driven centrifugal compressor and other station facilities as indicated in P&IDs and technical documents attached elsewhere in MR. The scope of supply shall include but not limited to following:	Yes	
2.1.1	All field mounted instruments including pressure, Flow(DP), temperature, differential pressure, temperature transmitters, temperature elements & thermowells, pressure & temperature gauges, all types of control valves & shutdown valves with accessories, pressure relief valves, anti surge control valves, suction flow elements, gas detectors etc. as marked "*" Gas turbine driven centrifugal compressor vendor scope and other station facilities as per P&ID's and compressor data sheets attached elsewhere in this MR and any other instruments required to complete the job in all respect.	Yes	
2.1.2	All controls system instruments for entire Gas turbine driven centrifugal compressor including process gas suction & discharge, starting gas, fuel gas, seal gas, gas recycle and associated other facilities. All instruments to be executed in dedicated PLC based control system	Yes	
2.1.3	Supply of Unit Control Panels for compressor and gas turbine controls and monitoring, including anti-surge, performance / master controllers, load sharing controller (if required) and panel mounted operator console (HMI) etc. These shall be located in control room.	Yes	
2.1.4	One no. HMI (Desk top PC with 21" TFT monitors) mounted in control room for control, monitoring and configuration of Integrated gas turbine compressor control system including all subsystems such as vibration, temperature, displacement, anti surge, performance / master controls. The HMI shall have operator cum engineering functionality with engineering facility password protected.	Yes	
2.1.5	One no Laptop computer with all necessary hardware and software and anti virus software for programming configuration of bidder supplied control system.	Yes	
2.1.6	Supply of AC and DC power supply distribution cabinets as required for as required for Centrifugal Compressor control systems, PLC, vibration monitoring system etc. in the control room and field instruments in the field.	Yes	
2.1.7	Local gauge boards with all instruments and accessories, duly mounted on them, if any.	Yes	
2.1.8	Any other skid mounted (Lube Oil System, dry gas seal system etc.) or panel mounted instruments required to complete the job in all respect for satisfactory operation of Compressor and Ancillary systems.	Yes	
2.1.9	Vibration, Temperature & Displacement Monitoring system including monitors.		
2.1.9.1	Vibration, axial displacement, key phaser and temperature probes etc as per compressor data sheets	Yes	

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S.No.	DESCRIPTION	Bidder	Purchaser
	attached elsewhere in this MR.		
2.1.9.2	UCP mounted Monitors/ racks located in control Room. Vibration and temperature points shall also be configured in HMI including direct and GAP voltages and temperature indications.	Yes	
2.1.9.3	Panel/ cabinet for monitors/ rack in control room including terminals, barriers, I/O cards, and dual redundant power supplies etc., duly mounted on panel / cabinet.	Yes	
2.1.10	Antisurge controllers for compressor along with a dedicated Performance / master Controller, load sharing controller (if required) including terminals, barriers, I/O cards, and dual redundant power supplies etc., duly mounted & prewired in a Unit control panel located in control Room.	Yes	
2.1.11	Programmable Logic Controller (PLC) with dual redundant processor, communication and power supply and single I/O as per PLC data sheet no B240-910-YE-DS-5010 attached with this MR.	Yes	
2.1.12	Supply of Fire and Gas detectors including Detectors & Transmitters for Gas turbine enclosure. Fire and gas detection system shall be configured in the Centrifugal Compressor system PLC. On line data shall be displayed on HMI showing approximate locations of sensors	Yes	
2.1.13	Alarms, signals & power Junction boxes for following:		
2.1.13.1	For interconnection between skid mounted instruments in field and UCP in control room	Yes	
2.1.13.2	For interconnection between instruments supplied loose in field to be located on process gas compressor suction & discharge piping, Knock out drums, fuel gas /startup gas lines, gas vent lines, recycle gas lines as shown in P&ID and marked as "*" to Control Room and other associated facilities.		Yes
2.1.14	Cables (signal, alarm, thermocouple extension, RTD, power supply, serial communication) for following: (Note - 2)	Yes	
2.1.14.1	Between field instruments and skid mounted junction boxes	Yes	
2.1.14.2	Multi-pair cables between junction boxes and UCP in control room [6P or 12P 1.5mm2, For RTD and Gas detectors 8T(1.5mm2) cable to be used].Distance between field and control room to be considered as 500m approximately.	Yes	
2.1.14.3	Between field mounted sensors of vibration & temperature, displacement, key phasor monitoring system and monitors/ racks located in control room	Yes	
2.1.14.4	All system cables between various systems such as vibration & temperature monitoring system, antisurge controllers, performance/master controllers and UCP PLC and HMI.	Yes	
2.1.14.5	Special cable between speed sensor in field and Turbine Speed Controller in UCP in control room	Yes	
2.1.14.6	Any other special cables from field to UCP in existing	Yes	

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S.No.	DESCRIPTION	Bidder	Purchaser
	control room for compressor control system.		
2.1.14.7	All Interconnection cables between instruments supplied loose in field to be located on process gas compressor suction & discharge piping, fuel gas /startup gas lines, gas vent lines, recycle gas lines as shown in P&ID and marked as "*" to Control Room		Yes
2.1.15	Installation & Erection Materials:		
2.1.15.1	All installation and erection materials such as impulse tubes, pipes, valves, fittings, manifolds etc. for installation of all bidder supplied instruments and junction boxes (on skid instruments and other off skid instruments) as per approved installation standards.	Yes	
2.1.15.2	Instrument stanchions, supports and all types of consumables and accessories for mounting all bidder supplied instruments and accessories, gauge boards etc.	Yes	
2.1.15.3	Cable glands, and PVC sleeves (cable shrouds) for different types of cables	Yes	
2.1.15.4	Cable trays along with supports from instruments to junction box for skid mounted instruments	Yes	
2.1.15.5	GI/ copper earthing strip & earthing cables for earthing of all instrumentation items including junction boxes, field instruments, etc.	Yes	
2.1.15.6	Supply & installation of all cable trays and accessories for routing the cables with the GTC skid.	Yes	
2.1.15.7	All piping and pipe fittings, tubes and tube fittings for instrument air supply distribution for instruments supplied by Bidder.	Yes	
2.1.15.8	Insulation and painting of instruments and impulse lines, as applicable, in line with insulation and painting specifications attached elsewhere in MR.	Yes	
2.1.15.9	Installation material for junction boxes and power distribution boards.	Yes	
2.1.15.10	Any other installation material required for installation and commissioning of various instruments and systems supplied by Bidder.	Yes	
2.1.16	Start-up and Commissioning spares	Yes	
2.1.17	Mandatory spares	Yes	
2.1.18	Supply of drawings and documents as listed in Vendor Data Requirement	Yes	
2.1.19	Any special tools or tackles for instrumentation	Yes	
2.1.20	Any additional instrument required in the opinion of bidder for meeting functional requirements, safe and efficient operation, which are not listed specifically in this document.	Yes	
2.1.21	One heavy-duty dot matrix type printer as per PLC data sheets as alarm cum log printer shall be supplied. And one no. laser jet colour printer A3 size shall be supplied.	Yes	
3.0	**Factory testing & calibration**		
3.1	Carrying out/ witnessing shop testing and calibration of all instruments and system oriented items as per approved Inspection Test Plan / FAT procedure.	Yes	Yes
4.0	**Installation, field calibration/ testing and commissioning**		

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S.No.	DESCRIPTION	Bidder	Purchaser
4.1	Installation of all instruments, junction boxes, and accessories and auxiliary systems (e.g. lube oil) on equipment skid.	Yes	
4.2	Installation of loose supply instruments on gas compressor process lines.		Yes
4.3	UCP in control room		Yes
4.4	HMI's in control room		Yes
4.5	Installation of local gauge board (mounted on bidder supplied skid)	Yes	
4.6	Laying & termination of all cables from bidder supplied instruments& junction boxes on skids to Bidder supplied UCP in control room.		Yes
4.7	Instrument air distribution for all bidder supplied instruments on skids	Yes	
4.8	Installation of all junction boxes and power distribution boards on skids.	Yes	
4.9	Supervision of installation, hookup, testing and commissioning of various instruments, local gauge board, antisurge controllers, performance controller, turbine speed controller, vibration and temperature monitoring system etc. supplied by Bidder.	Yes	
5.0	**Coordination**		
5.1	Coordination with • Purchaser, • Purchaser's Plant Control Station • Purchaser's station PLC contractor for loop checking, field testing of all items, calibration of all instruments for successful commissioning of the compressor package.	Yes	
6.0	Insulation and painting of instruments and impulse lines, as applicable, in line with insulation and painting specifications.	Yes	

Notes:

1. Residual engineering includes instrument sizing, Thermowell Wake frequency calculation, utility consumption, specifying derived data in process data sheets, type and material selection of instruments wherever required. Residual engineering shall also include actual transfer/ implementation of the information provided in the form of notes in P&ID and instrument data sheets/ equipment data sheets and other documents provided in MR. Bidder to note that turbine control systems indicated in P&ID attached is indicative. Bidder shall develop the P&ID considering monitoring and controls from UCP PLC and its HMI and interface with Purchaser's Plant Control Station .

2. Approximate cable routing distance between skid in field and Unit control panel located in existing Control room shall be considered as 500 meters for all interconnecting cable estimate as part of base quote of the Package. However bidder shall calculate the exact cable laying distance as per indicative

3. Instruments not mounted on skid but to be located on process gas compressor suction & discharge piping, fuel gas /startup gas lines, gas vent lines, recycle gas lines shall be supplied loose along with all required installation materials as per approved installation standards finalized during detailed engineering.

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4. Installation & cabling between bidders supplied off skid loose instruments including supply of cables, junction boxes, cable glands, trays etc shall be by purchaser.

5. EIL/Owner shall witness testing of any or all items at various stages during manufacture and/or final stage before shipment as per approved Inspection Test Plan. All system oriented items like Integrated Compressor & Turbine Control system, Anti Surge controllers, Vibration and Temperature Monitoring System, F&G system, performance/master controllers etc. shall undergo factory testing and integrated factory acceptance test. Testing shall be carried out as per approved procedure. No such item shall leave manufacturer's works without factory acceptance test.

6. For instruments and accessories outside skid, supervision of installation, erection & commissioning shall be in bidder's scope, on per diem basis.

7. All bidder supplied instruments and junction boxes on various skids of package shall be pre-installed including cabling & termination within the machine skid.

8. Bidder shall provide required assistance to Purchaser's instrumentation contractor during loop checking of all Compressor instruments (mounted within skid or outside skid).

9. Any activity specifically not listed in this document, does not absolve the vendor of their responsibility to include such activities in their scope of work, which otherwise is necessary, to complete instrumentation work for compressor.

10. All such activities shall be carried out by the vendor without any implication. Instrument Job Specification shall be read in conjunction with scope of work.

11. Any items not covered in this section, which form part of the vendor's standard package and are required for ease of operation, control safety and interlock requirement shall be supplied by Bidder without any implication.

12. In case compressor and turbine vendors are two different vendors then also all the engineering and engineering drawings/documents shall be prepared by the sole bidder for entire control system of turbine and compressor and also other system as per this requisition.

13. All indications, recording of instruments, status, control and alarms of Instruments **(which are NOT marked as * in attached P&IDs)** shall also be in common facility PLC supplied by GTC Package vendor. Vendor to size the PLC accordingly. B

14. Following are excluded from bidder scope of work:

- Installation of bidder supplied off skid loose instruments & junction boxes.
- Laying & termination of single pair cables supplied by the bidder, from bidder supplied loose instruments to the bidder supplied junction boxes ~~(if any)~~.
- Laying & termination of the single pair., multi-pair cables & special cables, supplied by the bidder, from machine skid junction boxes to respective control room.
- Installation of all bidder supplied Unit control panels / cabinets in control rooms.
- Laying & termination of all interconnecting cables including power supply cables between bidders supplied unit control cabinets / panels with in the control room.

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- These activities will be carried out by purchaser's field erection contractor and compressor package vendor shall coordinate with purchaser's field erection contractor and provide them necessary specifications, data, documents and drawings and any other information & assistance required for the above activities to complete the job within the agreed time schedule. Further bidder shall be fully responsible for proper commissioning of the package along with all associated instruments and control systems.

SECTION-D: PIPING

BIDDER shall supply all Materials as per scope of work. The procurement and supply of all materials required shall be strictly in accordance with the requirements of P&ID's and PMS (B240-000-83-41-SP-0001) enclosed with the MR document. As a minimum, the following materials shall be supplied by BIDDER:-

(i) All Piping materials (Pipes, fittings, flanges, valves, nuts, bolts, gaskets) for allsystems mentioned in clause 2.1 & P & IDs.

(ii) All Valves as indicated in P&IDs, including Direct Gas Actuated Ball Valves with Tag Nos. 910-AV-1107, 910-AV-1108, 910-AV-1109, 910-AV-1110, 910- AV-1111, 910-AV-1112, 910-AV-1113, 910-AV-1202, 910-AV-1301.

(iii) Apart from the Valves included in (1) & (2) above, manually operated Full Bore Ball Valves to the Upstream & Downstream of PSVs with Tag Nos. 910-PSV1401A & 910-PSV-1401B.

(iv) All companion flanges (including bolts, nuts, gaskets & adequate no. of Spare gaskets) at Battery Limits for process piping at all inlet/outlet connections of GTC, Fuel Gas Booster/ Conditioning Skid and Seal Gas Skid. Companion Flanges of all Valves in Bidder's scope of supply.

(v) Strainers for Compressor & Fuel Gas Skid; including mating Flanges (with Nuts, Bolts, Gaskets & adequate no. of Spare gaskets).

(vi) All Carbon Steel Ball valves (size 2" & above) shall be supplied as per Standard Specification for Pipeline Ball Valves (6-71-0014) and data sheets. All other valves shall be supplied as per Technical Notes for Valves (6-44- 0052).

(vii) All supporting material for all Piping (including vents) in Bidder's scope of supply.

(viii) All companion flanges (including bolts, nuts, gaskets & adequate no. of Spare gaskets) at Battery Limits for process piping at all inlet/outlet connections of GTC Skids and Fuel Gas Conditioning Skid.

(ix) All other items as per Pipeline specifications attached in the inquiry document.

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MANDATORY SPARES (GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE)

PROJECT : **Installation of New GTC Compressor at Gandhar, Gujarat,**

OWNER : **Gas Authority of India Limited**

PMC : **Engineers India Limited**

JOB NO. : **B240**

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
B	16.09.2019	REVISED AND REISSUED WITH MR	AS	JSD	NK
A	14.06.2019	ISSUED WITH MR	AS	NK	NK

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GENERAL REQUIREMENTS

Bidder shall note the following and furnish the quotation for Mandatory Spares accordingly:

1. Mandatory spares shall consist of Spares as listed below. Bidder shall study the complete list below and submit a detailed list with bid. In case, if it is found that any mandatory spare has not been considered by the bidder but otherwise applicable, then the same shall be supplied by the bidder without any implication to the purchaser. Hence, it is in the bidder's own interest to carefully study the list of Mandatory spares and quote accordingly.
2. The word 'Set' means the quantity required for full and complete replacement of that part in the complete Gas Turbine driven Centrifugal Compressor package.
3. The bidder shall quote for all the mandatory spares as defined below & as applicable to the proposed design of the equipment. In case, any spare which is listed in the list but not applicable due to specific construction/design of the equipment, the same shall be highlighted as 'Not Applicable' against that spare supported with proper technical explanation.
4. Spare part shall be identical in all respects to the parts fitted on the main equipment, including dimensions, material of construction, and heat treatment.
5. The cost of these Mandatory Spares shall be added to the total cost for commercial evaluation of the offer.
6. The offers, not including the quotation for mandatory spare parts in the commercial section & the unpriced quotation for mandatory spare parts in the technical section shall be considered as incomplete offers and shall be liable for prima-facia rejection. The bidder is advised to furnish the above quotation alongwith the techno-commercial offer (i.e. both unpriced & priced copies).
7. Any other Mandatory spares if mentioned elsewhere in inquiry document shall also be included by bidder.

SECTION-A: ROTATING EQUIPMENT

Sl. No.	Part Description	Unit	Quantity	Remarks
	ROTATING EQUIPMENT			
1.0	**CENTRIFUGAL COMPRESSOR**			
1.1	Spare Rotor (Dynamically Balanced)	Set	1	(See Note 1)
1.2	Dry Gas Seal (Drive end and Non-Drive end)	Set	1	
1.3	**Bearings for Centrifugal Compressor**			
	(a). Set of Radial Bearings	Set	1	
	(b). Set of Bearing Pads for radial bearings (in addition to above, if applicable)	Set	1	Not applicable for Sleeve type Bearings
	(c). Set of Thrust Bearings	Set	1	
	(d). Set of Bearing Pads for thrust bearings (in addition to above)	Set	1	
1.4	Instrumentation (as below) for Compressor Bearings			
1.4.1	**Vibration Probes**			
	(a). Radial vibration probes (non-contacting proximity) for Radial (journal) bearings	Set	1	
	(b). Axial vibration probes (non-contacting proximity) for Tilting pad thrust bearings	Set	1	
1.4.2	**Temperature Probes**			
	(a). RTD's for Radial (journal) bearings	Set	1	
	(b). RTD's for Tilting pad thrust bearings (Active/Inactive)	Set	1	
2.0	**GAS TURBINE** **(Heavy Industrial, Light Industrial or Aero-derivative type)**			
2.1	Spark Plugs	Set	1	

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Sl. No.	Part Description	Unit	Quantity	Remarks
2.2	Fuel Nozzles for Gas Turbine	Set	1	
2.3	Fuel Control valve for Gas Turbine	Set	1	
2.4	Bleed Valves for Gas Turbine	Set	1	
2.5	Temperature probes for Combustion Chamber	%age / nos.	20% or 3 nos. (min.) whichever is higher	
2.6	Complete Gas Turbine starting system including all associated auxiliaries and accessories	Set	1	Refer Electrical Mandatory spares
3.0	**SPECIAL PURPOSE GEAR-UNIT (If applicable)**			
3.1	Set of Radial Bearings	Set	1	
3.2	Set of Bearing Pads for radial bearings (in addition to above, if applicable)	Set	1	Not applicable for Sleeve type Bearings
3.3	Set of Thrust Bearings	Set	1	
3.4	Set of Bearing Pads for thrust bearings (in addition to above)	Set	1	
3.5	Instrumentation (as below) for Bearings			
3.6	**Vibration Probes**			
	(a). Radial vibration probes (non-contacting proximity) for Radial (journal) bearings	Set	1	
	(b). Axial vibration probes (non-contacting proximity) for Tilting pad thrust bearings	Set	1	
	(c). Accelerometers for Gear-Box Casing	Set	1	
3.7	**Temperature Probes**			
	(a). RTD's for Radial (journal) bearings	Set	1	
	(b). RTD's for Tilting pad thrust bearings (Active/Inactive)	Set	1	
4.0	**COUPLING(S)**			
4.1	Complete Coupling assembly (including both driven and driver end hubs, spacer, flexible elements, nuts, bolts, bush etc.) in assembled condition with Pilot bore.	Set	1	In case of Gear-box drive, the quantity i.e. Set 1 will include both LS and HS coupling.
5.0	**LUBE OIL PUMPS (Note-2)**			
5.1	**Centrifugal Pump**			
	(a). Complete Pump assembly with drive motor in ready to install condition	Set	1	
	(b). Mechanical seals (Complete Cartridge assembly) for above	Set	1	
	(c). Set of Bearings for above	Set	1	
5.2	**Positive Displacement Pump Rotary**			
	(a). Complete Pump assembly with drive motor in ready to install condition	Set	1	
	(b). Mechanical seals (Complete Cartridge assembly) for above	Set	1	

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Sl. No.	Part Description	Unit	Quantity	Remarks
	(c). Set of Bearings for above	Set	1	

Remarks:

1. Spare Rotor shall be supplied duly dynamically balanced and Mechanical Run Tested.
2. Spares shall be quoted depending on the type of pump proposed for lube oil system. Incase of a between bearing pump, both Drive-end side and Non-drive end seals shall be considered.
3. Bidder shall Indicate unit prices for each Mandatory spare and the total cost shall be used for commercial evaluation.

SECTION-B: ELECTRICAL

1.1.	**MV induction motors 37 kW & above (one set of spare for each rating & type)**		
a)	Set of bearings (NDE+DE	Set	1
b)	Terminal/ bushing	Set	1
1.2.	**VFD (one set of spare for each VFD)**		
a)	Transistors/IGBT	Set of each rating & type	1
b)	Control cards	No. of each type	1
c)	Power supply cards	No of each rating & type	1
d)	Power fuses	Each rating &type, whichever is more	20 % or one no (min)
e)	control fuses/MCB	Each rating &type, whichever is more	10 no of each type and rating (min)
f)	Contactors	Each rating &type, whichever is more	10 % or one no (min)
g)	Indicating lamps	Each rating &type, whichever is more	20 % or one no (min)
h)	Indicating lamps covers	No. of each color	2 nos
i)	Blocker Diode	Each rating &type,	2 nos
1.3.	**All Electrics of GTC Starting System including VFD, Starting motor and other accessories**	If Electric Motor start is envisaged.	1 Lot
1.4.	**MV Switchboard (MCC)**		one set of spare for each switchboard
a)	Closing Coil	Each rating &type,	1
b)	Trip Coil	Each rating &type,	1
c)	Control Fuses/MCB	Each rating &type,	10
d)	Indicating lamps covers	Each rating &type, whichever is more	5
e)	Indicating lamps	Each rating &type, whichever is more	20% or 3 Nos. (min.), whichever is more
1.5.	**DC System**		one set of spare for each DC System
a)	Power Thyristors / Transistors / IGBT /IGCT	Set of each rating & type	1
b)	Control cards	No. of each type	1
c)	Power supply cards	No of each rating & type	1
d)	Power fuses	Each rating &type,	20 % or one no (min)

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		whichever is more	
e)	Control fuses / MCB	Each rating &type, whichever is more	10 no of each type and rating (min)
f)	Indicating lamps	No. of each color	10 % or one no (min)
g)	Indicating lamps covers	No. of each color	20 % or one no (min)
h)	Blocker Diode	Each rating &type	2 nos

SECTION-C: INSTRUMENTATION

Mandatory Spares List
(To be supplied loose)

Mandatory spares shall be quoted as per the following table:

Sl. No.	Part Description	Quantity Required
	Mandatory spares shall be quoted and included in base price as follows:	
1	**Field Instruments**	
	This includes all types of the following instruments excluding line-mounted instruments.	
I	Pressure gauges Temperature gauges	10%subject to minimum1No. of each type and size, range, rating and material wise whichever is higher.
II	Field transmitters for Pressure, Level, DP, Flow and Temperature etc.	10%subject to minimum1No. of each type and size, range, rating and material wise whichever is higher.
III	RTD/Thermocouple (with Thermowell), Thermowell etc.	10%subject to minimum1No. of each type and size, range, rating and material wise whichever is higher.
V	Gas detector, fire detector UV/IR Thermal/heat detectors with transmitter	10% subject to minimum 1 no of each type of sensor & transmitter, whichever is higher.
VI	Level gauge glasses	10% subject to minimum 1 no of glass of each size along with gasket set, whichever is higher.
VII	Instrument valve / 3-Way valve manifold / Tube fittings etc.	10% subject to minimum 1 no for each type/size, whichever is higher.
VIII	Speed transmitter probe	10% subject to minimum 1 no of each, which ever is higher.
IX	Beacons / Horns for gas detector	10% or minimum one number, whichever is higher.
2	**Line mounted instruments**	
I	Control valve, shutdown valve	a) 01No. seat plug assembly for each valve under cavitation and / or flashing and noise (for globe and angle valves). b) Grouping of balance valves with respect to size, rating, material & trim type and 10% subject to minimum 1 no. of plug & seat assembly of each group, whichever is higher (for globe & angle valves)

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Sl. No.	Part Description	Quantity Required
		c) Grouping of valves with respect to size, rating & material and 10% subject to min 1 no. ball & seat, for each group whichever is higher (for ball valves).
		d) Grouping of valves with respect to size, rating & material and 10% subject to min 1 no. of disk/rotary plug and seat of each group, whichever is higher (for rotary plug & butterfly valves).
		e) Grouping of all valves with respect to size, rating, material & trim type and 10% subject to minimum 1 no. whichever is higher of the following items group wise: - I. Gland packing II. Actuator Diaphragm. III. Valve positioner IV. Bonnet gaskets (for all type of valves) V. Quick exhaust Valve (if any) VI. Solenoid valves VII. Limit switches. VIII. Smart Positioner. IX. Air filter regulators
II	Pressure Relief valve and pilot valve of pilot operated PRV	
	a) Spring, Nozzle, Seat	5% of total quantity of identical pressure relief valves or minimum one number which ever is higher.
	b) Gasket set, O-Ring set	20% of total quantity of identical pressure relief valves or minimum one number whichever is higher.
	c) Complete Pilot of Pilot operated pressure safety valves	5% of total quantity of identical pilot operated pressure relief valves or minimum one number whichever is higher
III	Self actuated regulators	a) Grouping of valves with respect to size, rating, material & trim type and 10% subject to minimum 1 no. of the following items of each group, whichever is higher : - I. Plug & Seat Assembly II. Gland packing III. Actuator Diaphragm. IV. Bonnet gaskets (for all type of valves)
3	**PLC**	
I	Each type of modules used in PLC like I/O cards, processor cards, power supply cards, communication cards, interface cards, etc. as being offered by the system	5% of the total installed quantity subject to minimum one number, whichever is higher of each type.
II	IS isolator barriers	
	a) Analog input	5 % of total quantity
	b) Analog output	5 % of total quantity
	c) Digital input	5 % of total quantity
	d) Thermocouple / RTD	5 % of total quantity

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Sl. No.	Part Description	Quantity Required
III	Isolator/signal multiplier	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
IV	IS mV/I converter	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
V	IS RTD/I converter	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
VI	Prefabricated cable	4 set with connecting plug for each type of peripheral and I/O hardware
VII	Keyboard	1 no of each type
VIII	Interposing relay	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
IX	Push button	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
X	Lamps	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
XI	Selector switch	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
XII	Switches	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
XIII	Alarm cards (receiver switches)	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
XIV	MCBs	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
XV	System cabinet air filter	100%
XVI	Annunciator	
	- Power supply module	4 nos
	- Flasher module	4 nos
	- Tone generator card	2 nos
	- Lamps	5 dozen
	- Fuses	2 dozens
XVII	Termination panel/patch card, series resistor, isolator (for safe area signal)	5 % of total quantity
XX	Fuses (of each type)	100 %
4	**Vibration and Temperature monitoring system**	
I	Each type of module used n machine monitoring system like I/O cards, processor cards, power supply cards, communication card, interface card etc as being offered for system	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
II	Probe of each type (vibration, temp, axial displacement keyphasor, etc)	**Quantity shall be as mentioned in Rotating Equipment mandatory spares list attached elsewhere with the MR.**
III	Fuses of each type	100%
VIII	Selector switches	5% of total installed quantity subject to minimum one number, whichever is higher of each type.

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Sl. No.	Part Description	Quantity Required
5	**Compressor control system**	
I	Anti-Surge Controller(If applicable)	01 No.
II	Master /Performance Controller(If applicable)	01 No.
III	Load Sharing Controller (If applicable)	01 No.

Notes:

1. The word 'Type' means the make, model no., type, range, size/length, rating, material as applicable.
2. Whenever % is identified, contactor shall supply next rounded figure.
3. Mandatory spares shall include sub-package items also.
4. Mandatory spares shall be supplied loose for use by client in future.

Mandatory Spares for Fire Suppression system:

Mandatory Spares for Fire suppression system as per Clause No. 15 of EIL Std. Spec. STANDARD No. 6-66-0045 Rev. 3 shall be included.

Note: In Sl. No. 1.0 of table in clause no. 15, the clean agent gas may please be read as CO2 gas.

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LOADING & PENALTY CRITERIA (GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE)

PROJECT : **Installation of New GTC Compressor at Gandhar, Gujarat,**

OWNER : **Gas Authority of India Limited**

PMC : **Engineers India Limited**

JOB NO. : **B240**

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
B	17.09.2019	REVISED AND RE-ISSUED WITH MR	AS	JSD/NK	SM
A	26.06.2019	ISSUED WITH MR	AS	NK	SM

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1.0 SCOPE

This specification describes the Loading & Penalty criteria applicable for Gas Turbine driven centrifugal compressor package.

2.0 PERFORMANCE GUARANTEES

Loading and Penalty criteria shall be based on individual guaranteed performance of compressor and the gas turbine.

The parameter for loading shall be the **fuel consumption** of the Gas Turbine while generating the guaranteed compressor BKW (as per 2.1 below) with the Gas Turbine guaranteed heat rate (as per 2.3 below) at site conditions, corresponding to the process parameters of the ***RATED/GUARANTEE CASE*** as indicated in the compressor datasheet and operating with ***RLNG fuel gas*** as indicated in Gas Turbine datasheet.

Bidder shall furnish the guaranteed values for the following:

2.1 COMPRESSOR

Guaranteed BKW of compressor **(BKW_G)** including all losses (Compressor mechanical losses, Gear-box, transmission etc.) with zero per cent positive tolerance including errors in instruments and measurement, corresponding to the ***RATED/GUARANTEE CASE*** specified in the compressor datasheet which shall be verified on test bed during compressor performance test as per Type 2 ASME Code PTC-10 at Compressor manufacturer's shop.

2.2 GEAR-BOX (AS APPLICABLE)

Efficiency of Gear-Box while transmitting the guaranteed shaft power of Compressor. However, for loading purposes the maximum efficiency of Gear-Box shall be limited to 98%.

2.3 GAS TURBINE

2.3.1 Guaranteed Heat rate H_G (kcal/kw-hr) of gas turbine with zero percent positive tolerance including errors in instruments and measurement at the specified site rated temperature, Intake and Exhaust losses of 100 mm (4") of Water column, while generating at the Turbine output shaft, the guaranteed compressor BKW_G (as defined in 2.1) when operating with the ***RATED/GUARANTEE CASE*** as specified in the compressor data sheet which shall be verified on test bed during gas Turbine performance test as per PTC-22 conducted at Gas turbine manufacturer's shop.

2.3.2 Guaranteed Site Rated shaft power P_{GT} developed by the Gas Turbine with zero percent negative tolerance including errors in instruments and measurement at the specified site rated temperature, Intake and Exhaust losses of 100 mm (4") of Water column when generating the guaranteed compressor BKW_G (as defined in 2.1) at the ***RATED/GUARANTEE CASE*** as specified in the compressor data sheet.

Note: Please refer Job specification & Gas Turbine Datasheet for Gas Turbine sizing criteria.

3.0 LOADING CRITERIA

3.1 TOTAL COST

The total cost of the GTC package for evaluation purposes shall be computed as under:

TOTAL COST OF THE PACKAGE FOR EVALUATION PURPOSE
= A + B + C + D + E

Where,

A = Capital cost of GTC package including cost of commissioning spares and special tools & tackles.
B = Cost of Mandatory Spares
C = Differential operating cost as defined hereunder in Clause # 3.3.1 below
D = Cost for Training of client's personnel at vendor's works (15 persons x 2 Weeks=30 manweeks)
E = Cost for participation in HAZOP study of GTC package (3 mandays)

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3.2 FUEL COST LOADING CRITERIA

This shall be based on the compressor guaranteed **BKW_G** (as per 2.1) and guaranteed heat rate **H_G** (as per 2.3) furnished by the bidder in Annexure-1 alongwith the bid.

3.3 DIFFERENTIAL OPERATING COST

3.3.1 Differential operating cost, **C** is defined as under:

C (in Rupees) = $(F_E - F_R) \times C_F \times 8760 \times D_F$

F_E = Fuel consumption as calculated for the bidder under evaluation as defined under 3.3.2.

F_R = Lowest fuel consumption (Amongst all technically acceptable bidders) as defined under 3.3.2.

C_F = Cost of fuel, **10.73** Rupees per Sm3 of fuel.

8760 = Number of operating hours per year.

D_F = Discounting factor to arrive at Net Present Value (NPV) based on number of operating years as defined under clause 3.3.3.

3.3.2 Guaranteed Fuel consumption (F_G) is defined as:

F_G(Sm3/hr) = ($BKW_G \times H_G$) / LHV

Where,

BKW_G = Guaranteed BKW of compressor in kW as defined under 2.1.
H_G = Heat rate of gas turbine in kcal/kW-hr as defined under 2.3.
LHV = LHV value to be considered as **8445** kCal/Sm3.

3.3.3 Discounting factor (D_F) is defined as under:

$$D_F = \frac{[1 \quad \{1+ (X/100)\}^n]}{n = 2}$$
$$n = k+1$$

where,

k = Number of operating years for which loading is to be done as specified i.e. **5 Years.**
X = Percentage rate of interest. i.e. **9.5 %.**
D_F = **3.5066**.

[The above formula considers one year time for start-up of operation]

3.4 The maximum loading to be applied however shall not exceed **15 %** of the total capital cost i.e. **[A+B]** as defined in 3.1.

4.0 PENALTY CRITERIA

In case the offered Compressor and/or the offered Gas Turbine fails to meet the declared guaranteed values (in Annexure-1) during the performance test at the Compressor and Gas Turbine manufacturer's works respectively, the following procedure shall be followed for levy of performance guarantees.

4.1 COMPRESSOR

4.1.1 In case during shop performance tests, the tested **BKW_T** (as per 4.1.3.) consumed by the compressor exceeds the bidder/supplier quoted guaranteed value **BKW_G** (as defined under 2.1), by upto 4%, penalty as defined in clause no. 4.1.3 shall be applied.

4.1.2 In case during shop performance test, the tested **BKW_T** consumed by the compressor exceeds the stipulated bidder/supplier quoted guaranteed **BKW_G** (as defined under clause 2.1), beyond 4%, the following methodology shall be adopted:

(a). Equipment vendor/supplier/OEM shall carry out necessary shop performance re-tests

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after repair / rectification / modification / replacement at his own cost & time to prove bidder/supplier quoted guaranteed **BKW_G**. All such re-tests shall be conducted at the earliest, within the committed delivery dates as per contract.

(b). However, if the guaranteed **BKW_G** is still not met, equipment vendor/supplier/OEM & owner will mutually agree on the method & possibilities of further rectification.

(c). If the compressor is still not found capable of performing within the guaranteed **BKW_G**, it shall be owner/EIL's decision with respect to "rejection" (or) "acceptance with penalty upto a maximum four percent (4%) for excess power **ΔBKW** consumed over and above the bidder/supplier quoted guaranteed **BKW_G**", which shall be final & binding on the equipment vendor/supplier.

(d). In case, owner/EIL exercises the acceptance with penalty option, for excess power **ΔBKW** consumed over and above the bidder/supplier quoted guaranteed **BKW_G** upto a maximum of four percent (4%), penalty as defined in Clause no. 4.1.3 shall be applied.

4.1.3 Penalty (P_{CC}) shall be worked out as under:

$$P_{CC}\text{ (in Rupees)} = [(BKW_T - BKW_G) \times H_G \times C_F \times 8760 \times D_F] / LHV$$

Where,

P_{CC}	=	Penalty for Compressor
BKW_T	=	Compressor BKW as obtained during shop Testing.
		Note: All losses as per 2.1 shall also be considered in the shop tested value
BKW_G	=	Guaranteed Compressor BKW as per 2.1.
H_G	=	Guaranteed Heat Rate of Gas Turbine as per 2.3.
LHV	=	LHV to be considered as **8445** kCal/Sm3
C_F	=	Cost of fuel, **10.73** Rupees per Sm3 of fuel.
8760	=	Number of operating hours per year.
D_F	=	Discounting factor to arrive at Net Present Value (NPV) based on number of operating years as defined under clause 3.3.3.

4.2 GAS TURBINE

4.2.1 OUTPUT POWER

In case during shop performance test of a gas turbine, the guaranteed site rated power **P_{GT}** as defined under 2.3 is not met, the subject gas turbine gets rejected.

4.2.2 HEAT RATE

In case during shop test, the tested heat rate **H_T** of the Gas Turbine exceeds the bidder/supplier quoted guaranteed value of heat rate **H_G** (as defined under 2.3), by upto 5%, penalty as defined in clause no. 4.2.4 shall be applied.

4.2.3 In case during shop performance test, the tested heat rate **H_T** of the Gas turbine exceeds the stipulated bidder/supplier quoted guaranteed heat rate **H_G** (as defined under 2.3), beyond 5%, the following methodology shall be adopted:

(a). Equipment vendor/supplier/OEM shall carry out necessary shop re-tests after repair / rectification / modification / replacement at his own cost & time to prove bidder/supplier quoted guaranteed heat rate **H_G**. All such re-tests shall be conducted at the earliest, within the committed delivery dates as per contract.

(b). However, if the guaranteed heat rate **H_G** is still not met, equipment vendor/supplier/OEM & owner will mutually agree on the method & possibilities of further rectification.

(c). If the Gas Turbine is still not found capable of performing within the guaranteed heat

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rate H_G, it shall be owner/EIL's decision with respect to "rejection" (or) "acceptance with penalty upto a maximum five percent (5%) for excess heat rate **ΔH** above the bidder/supplier quoted guaranteed heat rate H_G", which shall be final & binding on the equipment vendor/supplier.

(d). In case, owner/EIL exercises the acceptance with penalty option, for excess heat rate **ΔH** over and above the bidder/supplier quoted heat rate H_G upto a maximum of five percent (5%), penalty as defined in Clause no. 4.2.4 shall be applied.

4.2.4 Penalty (P_{CGT}) shall be worked out as under:

$$P_{CGT} \text{ (in Rupees)} = [(H_T - H_G) \times BKW_G \times C_F \times 8760 \times D_F] / LHV$$

Where,

P_{CGT}	=	Penalty for Gas Turbine
H_T	=	Heat Rate of Gas Turbine obtained during shop Testing.
H_G	=	Guaranteed Heat Rate of Gas Turbine as per 2.3.
BKW_G	=	Guaranteed Compressor BKW as per 2.1.
LHV	=	LHV to be considered as **8445** kCal/Sm3
C_F	=	Cost of fuel, **10.73** Rupees per Sm3 of fuel.
8760	=	Number of operating hours per year.
D_F	=	Discounting factor to arrive at Net Present Value (NPV) based on number of operating years as defined under clause 3.3.3.

4.2.5 Gas Turbine Correction Curves

The bidder shall furnish alongwith the bid, gas turbine correction curves to correct power and heat rate for the following:
- Site ambient temperature
- Site ambient pressure
- Humidity & Altitude
- Power Turbine Speed
- Actual Power Turbine Loading
- Conversion of heat rate and power from liquid fuel to gas fuel and vice versa.

These curves shall be used to estimate heat rate and power indicated by the Bidder in his bid and to convert test results to site conditions and to ISO conditions. No change in this shall be accepted after award of the contract. Bidder shall also furnish a set of sample hand calculations for conversion of test data to site conditions.

4.3 The maximum penalty to be charged for non conformance to guaranteed values during the shop performance test of compressor & gas turbine put together shall not exceed **15 %** of the total capital cost i.e. **[A+B]** as defined in 3.1.

This penalty shall be independent of any other penalties specified elsewhere in the bid/inquiry documents.

5.0 GUARANTEED VALUES

Bidder shall furnish the guaranteed values (Compressor and Gas Turbine) as per ***ANNEXURE-1*** attached.

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Annexure-1 : Format for Guaranteed Compressor BKW and Gas Turbine heat rate

RFQ :

BIDDING DOCUMENT NO. :

NAME OF BIDDER :

GUARANTEED PARAMETER FOR COMPRESSOR (#)

SL. NO.	ITEM TAG NO. /EQUIPMENT	DESCRIPTION/ SERVICE	GUARANTEED PARAMETERS	REMARK
1	910-K-901	Centrifugal Compressor	**BKW_G =** _____kW	**(0% +ve Tol.)**

(#) No change in guaranteed value is permitted post submission of bid. Bidder to note and comply with the following:

- In case of suo-moto increase in guaranteed Compressor **BKW_G** (without any change in operating condition), post submission of bid, bidder's bid/offer is liable to be ***REJECTED***.
- In case of suo-moto decrease guaranteed Compressor BKW (without any change in operating condition), post submission of bid, the guaranteed figure as per original bid will be considered for the purpose of loading and reduced guaranteed figure will be considered for the penalty purpose.

In case of non-submission of guarantee values with the bid, the bid shall be summarily rejected.

GUARANTEED PARAMETER FOR GAS TURBINE (§)

SL. NO.	ITEM TAG NO./ EQUIPMENT	DESCRIPTION/ SERVICE	GUARANTEED PARAMETERS	REMARK
1	910-KT-901	Gas Turbine	**F_G=**_____Sm3/hr	**(0% +ve Tol.)**
2			**H_G =**_____kCal/kW-h	**(0% +ve Tol.)**
3			**P_{GT}=**_____kW	**(0% -ve Tol.)**

(§) No change in guaranteed value is permitted post submission of bid. Bidder to note and comply with the following:

- In case of suo-moto increase in guaranteed fuel consumption value (without any change in operating condition), post submission of bid, bidder's bid/offer is liable to be ***REJECTED***.
- In case of suo-moto increase in guaranteed heat rate value (without any change in operating condition), post submission of bid, bidder's bid/offer is liable to be ***REJECTED***.
- In case of suo-moto decrease in guaranteed gas turbine site rated power value (without any change in operating condition), post submission of bid, bidder's bid/offer is liable to be ***REJECTED***.
- In case of suo-moto decrease in guaranteed heat rate value (without any change in operating condition), post submission of bid, the guaranteed figure as per original bid will be considered for the purpose of loading and reduced guaranteed figure will be considered for the penalty purpose.

CAUTION: Technical bids without duly filled-in & signed/stamped Annexure-1 will be summarily rejected.

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SITE & UTILITY DATA

PROJECT : **Installation of New GTC Compressor at Gandhar, Gujarat,**

OWNER : **Gas Authority of India Limited**

PMC : **Engineers India Limited**

JOB NO. : **B240**

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
A	26.04.2019	ISSUED WITH MR	AS	NK	NK

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1.0 SITE DATA INFORMATION

SITE LOCATION

•	Plant Location	:	Gas Processing Unit, Gandhar
•	State	:	Gujarat
•	Nearest Important Town	:	Bharuch
•	Nearest Railway station	:	Jambusar
•	Nearest Port	:	Dahej
•	Nearest Airport	:	Bhavnagar
•	Nearest National Highway	:	NH-228
•	Source of Water	:	Narmada River (through pipeline)
•	Rainy Season	:	June to October

2.0 METEOROLOGICAL DESIGN DATA:

Sl#	Parameter	Minimum	Normal / Average	Maximum / Design
(A) METEOROLOGICAL DATA				
1	Elevation above mean sea level, m		8	
2	Barometric pressure, mBar			
3	Ambient temperature, ^{0}C	t_{min}= 6	t_{nor} =	t_{max}=47
4	Relative humidity, %	20%@ t_{min}	@ t_{nor}	90%@ t_{max}
5	Rainfall data for 24-hour period			305 mm
6	Wind data (a) wind velocity			160 km/hr
	(b) wind direction (% days per year)	N(5), NE(13.5), E(5.75), SE(10.25), S(10), SW (37.5), W(6), NW(9), Calm(3)		
(B) DATA FOR EQUIPMENT DESIGN				
1	Design dry bulb temperature, ^{0}C			42
2	Design wet bulb temperature, ^{0}C			29
3	Low ambient temperature for MDMT, ^{0}C			6
4	Design air temperature for air cooled exchangers where ***followed*** by water cooling, ^{0}C			40
5	Design air temperature for air cooled exchangers Where *not* ***followed*** by water cooling, ^{0}C			42
6	Coincident temperature and relative humidity for Air Blower / Air Compressor design.			40 ^{0}C & RH 90%

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3.0 UTILITY SPECIFICATIONS:

Sl. No.	Parameter	Minimum	Normal	Maximum	Mech. Design
1	**HIGH PRESSURE FUEL GAS**				
	Pressure, kg/cm2g	-	27.0	-	31.0
	Temperature, °C	-	40-45	-	65
2	**LOW PRESSURE FUEL GAS**				
	Pressure, kg/cm2g	-	4.0	-	15.0
	Temperature, °C	-	40-45	-	65
3	**LOW PRESSURE (LP) STEAM**				
	Pressure, kg/cm2g	4.5	5.0	6.0	8.0
	Temperature, °C	155	160	195	240
4	**SERVICE WATER**				
	Pressure, kg/cm2g	-	2.5	-	9.5
	Temperature, °C	-	AMB	-	65
5	**COOLING WATER**				
	Supply Pressure, kg/cm2g	3.5	4.0	4.5	7.5
	Return Pressure, kg/cm2g	2.5	-	-	7.5
	Supply Temperature, °C	-	33	-	65
	Return Temperature, °C (Max)	-	43	45	65
6	**PLANT AIR**				
	Pressure, kg/cm2g	4.5	6.5	7.0	9.5
	Temperature, °C	-	AMB	-	65
7	**INSTRUMENT AIR**				
	Pressure, kg/cm2g	4.5	6.0	6.5	9.5
	Temperature, °C	-	AMB	-	65
8	**NITROGEN**				
	Pressure, kg/cm2g	3.0	4.0	-	9.5
	Temperature, °C	-	40	-	65

Notes:

1. Utility conditions mentioned above are at unit battery limits.
2. All battery limit pressures are measured at grade.

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4.0 PLANT & INSTRUMENT AIR QUALITY:

Sl. No.	Parameter	Plant Air	Instrument Air
1	Dew Point at atmospheric pressure	No free moisture	(-) 40 Deg. C
2	Oil Content, ppm	Nil	Nil

5.0 NITROGEN GAS QUALITY:

Sl	Parameter	Nitrogen
1	Dew Point at atmospheric pressure	(-) 40 Deg. C
2	Oil Content, ppm	Nil
3	Nitrogen purity, vol%	99.5% vol% (min.)
4	Oxygen content, vol ppm (max)	0.5vol% (max.)

6.0 FLARE HEADER PRESSURE:

Maximum Flare Backpressure at the Pressure Relief devices shall be considered as 5.0332 kg/cm^2A.

7.0 INTERFACE POINTS

The Purchaser's interface for Process Fluid and utilities such as electrical power, instrumentation and control power, cooling water/service water, instrument and Plant air, inert gas etc. shall be as described below:

(a). All Auxiliary Piping within the skid is in equipment manufacturer's scope.

(b). Utilities shall be made available at Pressure and temperature values as per above. Any hardware for pressure reduction and flow regulation, if required, shall be in vendor's scope. Purchaser shall terminate piping at the edge of skid/base-plate as single inlet point and single outlet point. Further distribution within the skid shall be by vendor.

(c). Electrical & Instrumentation Power termination points shall be as per respective datasheets and specification.

(d). Vent & Drain Piping shall be terminated by the vendor at the edge of the skid/base-plate along with isolation valves & flanged piping.

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JOB SPECIFICATION
(GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE)

PROJECT : **Installation of New GTC Compressor at Gandhar, Gujarat,**

OWNER : **Gas Authority of India Limited**

PMC : **Engineers India Limited**

JOB NO. : **B240**

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
B	16.09.2019	REVISED AND REISSUED WITH MR	AS	JSD	NK
A	26.06.2019	ISSUED WITH MR	AS	NK	NK

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1.0 GENERAL

1.1 Scope

This specification describes the minimum requirements for design, engineering, manufacture, testing, supply & supervision of erection and commissioning of Gas Turbine Driven Centrifugal Compressor (GTC) package as described hereunder and in various attachments forming part of Inquiry document.

1.2 The intent of these requirements is to supplement, highlight and modify the requirements as given in the datasheets, specifications as listed under list of attachments forming part of the MR and other applicable standards and codes as specified therein.

1.3 Other General Requirements

1.3.1 The design, construction, manufacture, supply & testing and other general requirements of the compressor package shall be strictly in accordance with the data sheets, this job specification, Drawings, standard specifications etc. as listed under “List of Attachments” as well as other referred codes, standards and recommended practices etc. which also form a part of this specification.

1.3.2 Along with compliance with this specification, bidder shall also have responsibilities of furnishing equipment and accessories of proper design, materials and workmanship to meet the specified start-up and operating conditions.

1.3.3 Compliance with this specification shall not relieve the Vendor of the responsibility of furnishing equipment and auxiliaries of proper design, materials and workmanship to meet specified operating conditions.

2.0 SITE & UTILITY DATA

2.1 Refer Doc. No. B240-910-80-42-SU-5010 forming part of inquiry document.

3.0 LOADING & PENALTY CRITERIA

3.1 Refer Doc. No. B240-910-80-42-LP-5010 forming part of inquiry document.

4.0 QUALIFICATION CRITERIA

4.1 Refer Bidder Qualification Criteria enclosed elsewhere with the RFQ. Bidder shall submit Proven Track Record Proforma duly filled-in alongwith supporting documents for Bidder Qualification attached with the RFQ.

4.2 QUALIFYING CRITERIA (QC) FOR AUXILLIARIES:

QC for Dry Gas Seal/Dry Gas Seal skid and Gear-unit are as specified in the successive clauses.

(i) The offers submitted by the bidders shall be evaluated based on the basis of offers meeting the QC of main equipment and the information required to satisfy the QC requirements of auxiliaries/bought-out shall be submitted post-order after finalizing the details of such bought-out equipment.

(ii) Pumps coming in auxiliary systems such as Lube oil system etc. included in the package shall be of field proven design sourced from the approved vendors as listed in *ANNEXURE-A* to this job specification. The equipment sourced by the package vendor shall comply to the relevant standards indicated in the inquiry document. In case of an order, Bidder shall furnish details of all auxiliaries, as asked under vendor data requirements, during detailed engineering stage i.e. post order. Reference list for the auxiliaries shall be submitted during detailed engineering stage post-order.

5.0 SCOPE OF SUPPLY/ WORK & EXCLUSIONS

5.1 Bidder shall be the Single Point responsibility Vendor (SPRV) for the complete GTC package.

Single point responsibility vendor’s scope of supply is described in data sheets, specifications, Process P&ID’s, equipment layout and scope of supply doc. no. B240-910-80-42-SS-5010 forming part of the inquiry document.

However, it shall be the responsibility of the SPRV to furnish a safe operating unit. For this purpose, in case SPRV envisages additional equipment / instruments / control and safety

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devices, the same shall be offered by the SPRV and included in his scope of supply. Such additional items shall be separately listed with reasons for their inclusion.

5.2 During detail engineering stage (in case of an order), the GTC package shall be studied for HAZOP review with the successful bidder at Owner's/EIL's office. Any suggestions/modifications raised during HAZOP review shall be implemented by the bidder without any cost/time implication to the purchaser.

Bidder shall indicate the cost of participation in HAZOP study on per diem basis. For the purpose of commercial comparison, 3 mandays shall be considered for participation in the HAZOP study of the GTC package. Per-diem rates as quoted by bidder shall be the basis of payment against participation in HAZOP study. However, the actual payment shall be based on actual mandays participated by the bidder.

5.3 Exclusions

Following are excluded from bidder's scope of supply:

- Foundation & civil works.
- Compressor shelter, other Civil & structural work.
- Erection & Commissioning (Except supervision).

6.0 GAS TURBINE AND COMPRESSOR SIZING

6.1 The enclosed Process Datasheet specifies two cases of operation i.e. Case-1 and Case-2. Case-1 represents while GANDHAR GPU is running condition (normal & most prevelant operating case). Case-2 represents while GANDHAR GPU is stopped condition.

6.2 GTC train shall be selected to suit all the operating cases as per Process Datasheet with the Rated/Guarantee case as indicated in Compressor Datasheet (Doc. No. B240-910-80-42-SP-5010).

The continuous base rating of Gas turbine at the specified site conditions of altitude, intake & exhaust losses, site rated temperature (47°C), humidity etc. shall not be less than:

(i) **For Case-1:** 110% of maximum compressor power required among all cases/Guarantee case *(inclusive of all losses i.e. compressor mechanical losses, Gear-box losses, transmission losses etc.)*.

(ii) **For Case-2:** 100% of maximum compressor power required among all cases *(inclusive of all losses i.e. compressor mechanical losses, Gear-box losses, transmission losses etc.)*.

Site conditions as indicated in Site & Utility data (Doc. No. B240-910-80-42-SU-5010) shall be considered for arriving at Gas Turbine site rating.

7.0 Piping termination and Vendor's battery limit

7.1 Process Gas Piping

The Compressor shall be supplied flange to flange. No process gas piping (inlet/ discharge) is included in the bidder's scope of supply.

7.2 Utility Piping

(i) The purchaser shall supply single point supply connection near the compressor package battery limit for each of the utilities like:

- Nitrogen.
- Instrument Air.
- Fuel Gas.
- Starting Gas.
- Seal Gas etc.

P&IDs as attached may please be referred for further details.

(ii) Bidder shall furnish Utility consumption requirements for Nitrogen, Instrument Air, Fuel gas, Starting Gas, Seal Gas, electrical load requirements for auxiliary systems (i.e. lube oil pumps, portable lube oil purifier, portable oil filling & emptying Pump etc.) for the offered compressor package.

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(iii) All interconnecting distribution piping to various consumption points within bidder's Battery Limit, tubing, cabling, supports including isolation valves at the tie-up points of bidder's battery limit shall be engineered, designed and supplied by the bidder.

(iv) All Piping shall be supplied prefabricated with minimum field joints and as a commercial length, where prefabrication is not possible due to general erection constraints. Refer Tentative Layout for compressor package enclosed in the inquiry document.

(v) All vents pipes shall be supplied by the bidder with valves, fittings etc. and terminated to the safe elevation outside the compressor house.

(vi) Bidder shall terminate all the drains at the grade level with isolation valves for further connection to purchaser's CBD/OWS system. Also, bidder shall terminate all the compressor-casing drains manifolded to single connection at the grade level for further connection to purchaser's CBD/OWS system. Further, any device if required to match with the operating and design conditions of existing CBD/OWS system shall be in bidder's scope.

(vii) All flare lines required for the package shall be piped by the bidder up to purchaser's flare header and shall be free draining towards the flare header.

8.0 OPERATING & CONTROL PHILOSOPHY

8.1 The unit start-up shall be essentially automatic with two button operation along with "Confirm operation Button". Pressing of the first button & "Confirm operation Button" shall initiate the sequential steps leading to a purged and pressurised compression system ready for start. Pressing of the second button & "Confirm operation Button" shall cause sequential start-up of gas turbine compressor train, bringing the unit to speed and loading it.

In the event of pressing the normal stop button, the shutdown sequence shall end with compressor trains in the pressurised mode ready for start. With the pressing of the second button, the system shall be completely depressurised and after completion of all the sequential steps, 'ventilated shut down' shall be displayed on the panels.

The unit shall be brought safely to a shutdown/ventilated shutdown in the event of activation of the emergency push button or in the event of a malfunction as part of the GTC protection and sequence control system. Detailed sequence block diagrams and logic diagrams for start-up / shutdown etc. shall be approved by the Purchaser.

The complete compressor-gas turbine train shall be capable of remote starting/stopping from Unit/Compressor control panel installed in the Main Control Room (MCR). However, Start clearance from the field will be provided. Monitoring & Control of the Compressor station shall be performed at two levels viz. Station PLC and Unit Control Panel (UCP)/Common facility panel (FCP).
Bidder shall refer Instrumentation specifications attached in the inquiry document which will be governing in this case.

8.2 Emergency shutdown of the compressor train shall be possible from Unit/Compressor control panel, Master control center as well as from local gauge board on the GTC skid regardless of mode selection.

8.3 Monitoring and control of the compressor station are envisaged to be performed as under.

System	Control and Monitoring from
Gas Turbine Compressor (GTC) Train, Fuel Gas Conditioning Skid, indication and alarms etc	1. Unit/Compressor control panel/PLC 2. Master Control Center/Station PLC (only key parameters)
Station Flow Computers/Repeat Signals to and from GTC Train PLC	1. Purchaser's Common Facility Panel/PLC for common facilities 2. Purchaser's Master Control Center/Station PLC (only key parameters)

Note: Refer Instrumentation System Configuration Schematic Nos. B240-910-16-52-SK-0001 and B240-910-16-51-SK-0002 and Instrumentation specifications attached elsewhere.

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9.0 SPECIAL REQUIREMENTS

9.1 COMPRESSOR

9.1.1 The Centrifugal compressor and associated equipment shall conform to Chapter 1 & 2 of API Std. 617, 7th edition together with EIL Standard specification no. 6-42-0005 Rev. 2 and other specifications as listed in the List of Attachments forming part of MR.

9.1.2 The compressor shall be selected so as to fully meet the requirements specified in data sheets (i.e. Process data sheets and Equipment datasheets) and specifications as well as referred codes and standards forming part of the inquiry document.

9.1.3 Compressor shall be driven by Gas Turbine (GT) through a Gear Unit (as applicable).

9.2 DRY GAS SHAFT SEALING SYSTEM

9.2.1 Compressor shall be equipped with dry gas shaft sealing system. All dry gas seal piping between auxiliary skids and compressor shall be included in bidder's scope.

The Proposed Dry-Gas Seals shall be bi-directional, interchangeable between drive end and non-drive end and of Tandem (with int. Labyrinths) & cartridge type design as per Fig. 1.C-9 of API 617, 7th edition.

The dry gas seal modules shall be on separate skid from the lube oil console comprising of all the necessary instruments like pressure reducing valves, pressure & temperature and differential pressure instruments etc.

9.2.2 Seal gas skid shall be compact, easy to operate/carry out maintenance and designed to ensure that there is no condensate ingress in dry gas seals.

9.2.3 The Dry gas seal (Primary Seal gas supply and vent) and seal gas system shall be designed for the supply/ return / mechanical design conditions of the proposed seal gases OR casing MAWP, whichever is higher.

9.2.4 The primary sealing medium shall be same as the gas handled by the compressor during normal running of compressor. Conditioning of seal gas to suit dry gas seal requirement shall be done by the vendor within dry gas seal skid.

9.2.5 During start-up of the Compressor package, start-up seal gas from upstream of Compressor shall be provided as indicated in P&ID No. B240-02-42-910-1111 attached in the MR.

Normal and emergency seal gas supply shall be from the compressor discharge also as indicated in the P&ID referred above. Compressor datasheet shall be referred for the B/L conditions of seal gas(es) under various conditions.

9.2.6 The secondary sealing medium shall be Nitrogen. The provision for change over from normal to emergency seal gas supply is in bidder's scope. Bidder is advised to review the supply conditions of Nitrogen from Nitrogen Header as indicated in "Site & Utility data" and shall indicate their limitations, if any. Bidder shall furnish the quantity of Nitrogen required under various conditions. Nitrogen bottle bank with a load cell (suitable for area classification), suitable for compressor start-up (as necessary) shall be supplied by the bidder.

9.2.7 Nitrogen as separation gas shall be provided between Secondary seal and Compressor Bearing to prevent flow of lube oil to seal area.

9.2.8 The Dry Gas Seals & Sealing system shall be designed for settle-out pressure attained after the Compressor trip. Bidder shall supply Seal system complete with all necessary pressure regulators, Control valve, Pressure safety valve, electric heaters, Pressure gauges, piping from Purchaser's battery limit to Compressor Seals along with fittings, other instruments and controls, stainless steel piping, Coalescing filters and Steel bodied transfer valves with Stainless Steel trim/internals. If required, based on Seal Gas conditions, Stainless Steel piping shall be insulated and heat traced by the Vendor to

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prevent any condensation.

9.2.9 If the Battery-limit pressure(s) of seal gas/nitrogen are not adequate, bidder shall provide Seal Gas Boosting System and associated auxillaries along with necessary instrumentation & logics, as part of dry gas seal skid (&) Nitrogen Bottle Bank (as recommended by bidder) with auto-change-over valve(s) and associated axillaries along with necessary instrumentation & logics.

9.2.10 **Coalescing filters:** If required based on Seal Gas Conditions, Coalescing filters shall be equipped with stainless steel housing & shall have filtration efficiency of 98% on liquids (i.e. 1 micron or greater) & solids (i.e. 3 microns or greater). The collapse pressure of the filter elements shall be minimum 50 psi (3.5 kg/cm2) differential. Filters shall be twin filters each with an overdesign margin of 20%. The seal vents shall be routed to flare or safe disposal.

9.2.11 **QC for Dry Gas Seal:**
The offered model of Dry Gas Seal shall be field proven and similar in terms of specified process gas service, shaft diameters, speeds, sealing pressures and configuration as compared to at least TWO UNITS designed, manufactured, tested and supplied by the proposed manufacturer and at least ONE of these units shall have completed at least ONE year of satisfactory operation at site as on bid due date of main equipment. Bidder shall furnish past supply experience list of the seal manufacturer for the offered model of seal and justify meeting accepting criteria, during detailed engineering stage (post-order).

9.2.12 **QC for Dry Gas Seal Skid:**
The offered dry gas seal skid and panel shall be field proven and similar to the specified operating parameters as compared to at least TWO UNITS designed, manufactured, tested and supplied by the proposed manufacturer and at-least ONE of these units shall have completed at-least ONE year of satisfactory operation at site as on the bid due date of main equipment. Bidder shall furnish past supply experience list of the seal gas skid/panel manufacturer against the offered seal gas skid/panel and justify meeting accepting criteria, during detailed engineering stage.

9.2.13 Bidder shall indicate process gas & Nitrogen consumption requirements during normal, stand-still/settle-out & start-up conditions.

9.2.14 Bidder shall indicate the guaranteed seal leakage rate in compressor data sheet.

9.2.15 Operating and spare seals shall have the following shop tests:

(i). Cleanliness (No discoloration or hard particles found on 20 mesh screen after module blown for 5 minutes with 100 psig (7.0 kg/cm2 g) dry filtered gas).

(ii). Gas Leak at a pressure equal to settling out pressure with a mol weight gas equal or less than the seal gas

(iii). Functional run for minimum of one hour at operating pressure and speed. Following the test, the seal elements shall be examined for wear and general conditions.

(iv). Other tests as per Annexure 1D of API 617.

9.2.16 The design & drawings of dry gas seal skid and panel shall be vetted by the dry gas seal manufacturer to ensure trouble free operation.

9.2.17 Dry Gas seal(s) shall preferably be of one of the makes as listed in the vendor list attached in *ANNEXURE-A* of this document.

Note: The Dry Gas seal panels shall be sourced from the Dry Gas Seal manufacturer.

9.3 ANTI-SURGE CONTROL SYSTEM

9.3.1 Anti-surge control system furnished for the compressor shall include all Instruments viz. (Flow, Pressure, Temperature, Speed) Transmitters, Indicators, control valve, surge controller with accessories as required for completeness of the surge control loop. The design/engineering, testing, supply and supervision of erection and commissioning of the

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complete system shall be in bidder's scope of supply. Details of the proposed system shall be furnished by the bidder along with the bid.

9.3.2 The surge controller shall be installed at a location as indicated in the Instrument Specifications/P&IDs.

9.3.3 Bidder shall be totally responsible for any coordination with controller supplier in realising the anti-surge control system for safe and reliable operation of the compressors.

9.3.4 Instrumentation specifications and process P&ID's as enclosed with the inquiry documents shall be referred for further requirements.

9.4 COMPRESSOR SUCTION STRAINERS

9.4.1 Bidder shall provide a suitable permanent "T" type strainer at gas inlet with spool piece arrangement. Suction pressure indicated in the data sheet is at the Suction flange of the Compressor. A pressure drop of 0.1 Kg/cm² has been considered across the strainer, to arrive at the compressor suction pressure. In case the pressure drop is more than the above value, Vendor to indicate the pressure drop and re-calculate the value of suction pressure at compressor flange. The revised value of suction pressure shall be indicated on compressor data sheet & shall be the basis of sizing/selection of the compressor. Strainer shall be mechanically suitable to withstand a pressure drop of 5 kg/cm2. The open area shall be at-least 150%.

9.4.2 Bidder shall indicate the mesh size and the pressure drop across the strainer. A Differential pressure indicator with high differential pressure alarm & shutdown shall be provided for differential pressure across the suction strainer.

9.4.3 Bidder shall also provide a temporary strainer, which shall be housed in the same spool piece as provided for the permanent strainer. The temporary strainer in each case shall be used for commissioning of the compressor after which the same shall be removed and permanent "T" type strainer installed.

9.4.4 This strainer shall be installed as indicated in the enclosed P&ID. Strainers shall be of full line size.

9.4.5 All strainer materials shall confirm to Strainer Datasheet attached with the MR. Bidder shall furnish the details for the strainer in his bid/offer.

9.4.6 Piping specifications as attached elsewhere in tender may also be referred.

9.5 CASING DRAINS

9.5.1 All casing drains of the compressor shall be manifolded by the bidder and terminated at the package Battery-limit with double isolation valves. Drains shall be connected by the bidder to purchaser's nearest CBD/OWS point(s).

9.6 GEAR UNIT (AS APPLICABLE)

9.6.1 The Gear unit shall conform to API Std. 613, 5th edition 2003.

9.6.2 QUALIFYING CRITERIA (QC) FOR GEAR UNIT

The Gear unit shall be from a regular and established manufacturer of API 613 gear unit having requisite design, manufacturing and testing facilities.

The Gear-Unit model offered shall meet the following minimum service and manufacturing experience requirement:

Gear Unit model offered shall be identical or validly similar in terms of Power rating, Pinion speeds, Gear ratio, Mechanical Design, Materials as compared to at least ONE UNIT designed, manufactured, tested and supplied from the proposed manufacturing plant in the last TWENTY years and the same shall have operated for one year at site as on the bid due date of main equipment.

Note: Provenness of the offered Gear-unit w.r.t. the qualification criteria shall not be

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reviewed during bid-evaluation stage. The same shall be reviewed during post-order stage upon placement of order. Duly filled in experience record proforma shall be submitted post-order to establish provenness of the offered Gear Unit model. However, if it is found during post-order stage that the offered gear-unit does not satisfy the QC as above, then bidder shall provide alternate make/model of gear-unit (meeting the QC as above) without any time/cost implication to the purchaser and without any increase in the "Guarateed Compressor BKW".

9.7 GAS TURBINE

9.7.1 The Gas Turbine and associated equipment shall conform to API Std. 616, 5th edition together with EIL Standard specification no. 6-43-0041 Rev. 2 and other specifications as listed in the List of Attachments forming part of inquiry document.

9.7.2 The gas turbine shall be either of heavy-industrial, light-industrial or aero-derivative type and Single/Multiple Shaft design equipped with DLE/DLN combustors. All the components including gas generator shall be supplied with gas turbine which shall be newly manufactured against this order. *This shall be indicated from the manufacturing serial number*.

9.7.3 The Vendor shall furnish detailed time schedule of inspection/overhaul of various components. The design life of major components shall also be indicated. This information shall be indicated in the proposal.

9.7.4 Gas Turbine starting system:

(i). Gas Turbine driver can be with a gas starting (expansion turbine) system & the pipeline gas (start-up gas) as available shall be used for the purpose. The gas starter (gas based start motor) should be provided with speed monitoring system to measure the speed of the starter during startup & after the starter drop out to ensure the safety of starting system & clutch mechanism.

---OR---

Alternatively, the Gas Turbine starting system can be of soft starter based electric type i.e. VFD fed electric Motor Starter (Clutched) subject to the condition that the electric motor starting system shall be suitable for starting at full load with 500 kVA (Prime Rated Power) rating emergency DG set (in purchaser's scope) with GTC and all its auxiliaries (i.e. Air-cooled LO coolers, auxiliary motors etc.) on full load. The electric starting system shall be complete with all associated accessories, instrumentation & controls. ***A categorical confirmation w.r.t. the above shall be provided in the bid with back-up calculation.***

(ii). Complete Gas starting system includes the equipment required for making the gas suitable for expander, interconnecting SS piping along with companion flanges from source to expander & vendor pipes shall be supplied by SPRV (Applicable PMS shall be referred for flanges and gaskets etc.) are included in bidder's scope.

(iii). Starting Gas used for starting the gas turbine shall be measured by installing a meter in starting gas line for the Gas turbine. Bidder to supply the metering system with flow computer suitable for compressibility correction as per AGA 8 detailed method.

(iv). Bidder shall refer the battery-limit conditions of start-up seal gas in Process Datasheet and Compressor datasheet. Any boosting system (if required) to boost the starting gas pressure shall be included by bidder in his scope.

9.7.5 Air inlet system:

(i) The air intake system shall be complete with silencer, plenum chamber, filter, filter housing, Pre-fabricated air inlet ducting, Expansion joints, flanged connections and transition pieces etc. as required along with necessary instruments and controls. The air intake shall be from safe area (16 m from nearest leakage source) and the air intake filter shall be at a height of minimum 6 meters from grade level. All parts coming into contact with inlet air shall be of Stainless Steel construction (SS)

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construction. The filter housing shall be of SS.

(ii) The air inlet system shall be equipped with a differential pressure transmitter and indicator in mm of water. There will be provision of an alarm in case of increase of pressure drop across filter. At still higher pressure drop, turbine shall shutdown by 2 out of 3 voting logic.

(iii) The Air Intake System shall be suitable for the operating conditions specified by the Gas Turbine Manufacturer.

(iv) Detailed fabrication, installation drawings & bill of materials for structural supports, access/maintenance platforms, ladders for the Inlet Air filters & Inlet Air Ducting shall be submitted for Purchaser's review/approval during detailed engineering.

(v) Design of inlet ducting shall be made in such a way that it requires minimum time and effort to remove when the Gas Turbine has to be maintained/overhauled.

(vi) Air filters shall be latest state of the art design such as synthetic type in place of conventional Cellulose type so as to ensure enhanced life. Air filtration capacity shall have an overdesign margin of 20% over capacity.

Filters shall be sourced from reputed manufacturers. Complete details of filter along with filter manufacturer's catalogues along with list of references shall be reviewed & approved by Purchaser during detailed engineering stage.

(vii) The inlet air filter shall meet the mandatory requirements of the Gas Generator (GG)/Gas Turbine (GT) manufacturer in all respects.

(viii) Inlet air filter shall be provided with a stainless steel weather hood/louvers and heavy mesh wire insect / bird screen.

(ix) The inlet air filter element shall be replaceable while the unit is in operation. Bidder shall furnish complete details of filter cleaning/replacement procedure and the expected time duration between each such operation and the expected life of filter elements (expected filter element change out period). The filters shall be provided with DPI, alarm & shutdown for high differential pressure.

9.7.6 Exhaust system and Emission control:

(i). The exhaust shall be routed to atmosphere through exhaust stack/chimney. The offered Gas Turbine shall mandatorily meet the emission norms/standards (latest in force) of "Central Pollution Control Board (CPCB)" of Government of India and the emission norms/standards of "Gujarat State Pollution Control Board (GPCB)" of Government of Gujarat state, whichever is stringent.

Bidder shall indicate the comparative data/table of the emission limits as per CPCB/GPCB and guaranteed emission data of the offered Gas Turbine in his bid/offer. The guaranteed exhaust gas emission datasheet (as in Gas Turbine Datasheet) shall be mandatorily filled-in and submitted with the bid/offer

It is reiterated that the use of water or steam to achieve emission limits of the offered Gas turbine equipped with DLE/DLN combustors shall not be permitted under any circumstances.

A categorical confirmation of compliance to the above with back-up documents shall be furnished in the bid/offer of the bidder.

(ii). The exhaust system for the Gas turbine shall include but not limited to:

- Exhaust collector
- Exhaust silencer
- Transition Pieces
- Exhaust duct
- Expansion joints
- Exhaust stack/chimney (minimum 30 m height)

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- Instrumentation and controls as required
- Necessary insulation for personnel protection. Surface temperature of cladding shall not exceed 60˚C at any point of time.
- Supports

(iii). The exhaust stack/chimney shall be of self supporting type complete with suitable ladder/staircase for maintenance of the same as per the specifications attached elsewhere. The stack//chimney shall be provided with connections/ tappings for measuring emission levels with emission-measuring equipments for on line emission measurement equipment (Purchaser's supply) etc.

(iv). The exhaust system shall be suitably located relative to the air inlet, ventilation inlet/exhaust and after cooling air, so that no recirculation of exhaust gas to inlet air filters, coolers is possible.

(v). The exhaust stack shall be suitably insulated and jacketed so as to minimise heat contribution to other units and to provide personnel protection. Exhaust system shall be adequately supported.

(vi). The exhaust shall be fitted with suitable silencer capable of reducing overall train noise levels to below the permissible noise level limit as specified in this specification.

(vii). Provision shall be made for preventing the accumulation of monsoon rainwater in the exhaust system when the unit is not running. The purchaser shall approve the details of this provision.

(viii). Design of exhaust ducting shall be made in such a way that it requires minimum time and effort to remove when the GT has to be maintained/overhauled.

9.7.7 Fuel Gas System

(i). The Fuel gas system shall be as per Clause 5.8 of EIL Standard 6-43-0041 Rev. 2 attached elsewhere in the inquiry document. In addition to what is specified in the EIL standard Specification as above, bidder shall also include all Instrumentation and valves, auto vent valve downstream of Shutdown valve (SDV) etc as indicated in Piping and Instrumentation diagrams (P&ID) forming part of the inquiry document.

(ii). **Qualification Criteria for Fuel Gas Skid:**

The offered Fuel Gas skid shall be field proven and similar to the specified operating parameters (capacity and pressure) as compared to at least TWO UNITS designed, manufactured, tested and supplied by the proposed manufacturer and at-least ONE of these units shall have completed at-least ONE year of satisfactory operation at site as on the bid due date of main equipment. Bidder shall furnish past supply experience list of the fuel gas skid manufacturer against the offered fuel gas skid and justify meeting accepting criteria, during detailed engineering stage.

(iii). Bidder shall obtain the detailed fuel gas specs from the Gas Turbine manufacturer and it shall be the responsibility of the bidder to engineer, design, manufacture, test the Fuel gas conditioning system so as to meet the specific fuel gas quality/requirements with the fuel gas for Gas Turbine offered by Purchaser. Bidder shall also take into account the possibility of cold starting of the unit during winter.

(iv). All fuel gas piping downstream of the fine filters shall be stainless steel 304.

(v). In case of tripping of compressor train (normal or emergency); gas supply to individual turbine compressor train shall be cut-off by SDV. Suitable arrangement for auto-venting of fuel gas downstream of SDV in such an event shall be provided.

(vi). Fuel gas supply from conditioning skid to each train shall be provided with a PCV. Gas turbine fuel gas control / governing (complete with instrumentation, piping and valves etc.) shall be Gas Turbine manufacturer's standard proven system and shall

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satisfy the established safety means for such systems.

(vii). Fuel Gas Conditioning skid shall be so designed that Proper maintenance space is provided around & within the Fuel Gas conditioning skid to take care of the bundle pulling arrangement for Fuel Gas Heater, filters etc. The local gauge board etc. should be located in such a manner so that accessibility/visibility is maintained. Gas conditioning skid shall be sourced from one of the vendors as listed in ANNEXURE-A of this job specification. Alternatively the same can be sourced/supplied from the main equipment OEM certified suppliers subject to availability of reference list for the intended application.

(viii). Fuel Gas Skid shall be complete with the following:

- Instrumentation, valves and controls as required.
- Fuel gas piping between "fuel gas conditioning skid" and the Gas Turbine shall be in bidder's scope along with any Insulation/heat tracing as required.
- Relief valves/thermal safety valves with block and bypass shall be provided as required. Discharge of all such PSV/PRV/TSVs shall be manifolded and terminated at skid edge with isolation valves.
- All condensate drains shall be manifolded and terminated at skid edge with isolation valves. Drains shall be connected to purchaser's nearest OWS point(s)

All vents shall be terminated at safe location.

9.7.8 Gas Turbine Washing System

The Gas Turbine shall be equipped with offline cleaning system along with crank/soak washing facility with all accessories, as required for internal turbine cleaning. Turbine shall have control for manual cranking and run up without firing. Gas Turbine manufacturer shall indicate recommended periods between cleaning under specified site and operation conditions. Liquid tank, piping and fitting etc. required for above purpose shall be of stainless steel. Instrument air (not gas generator air) shall be used for pressurisation of liquid tank, if required.

The Gas Turbine Washing/Cleaning System shall be portable trolley mounted complete with reservoir, driver, interconnecting flexible hose piping (10 m each at each port), hose-storage-wheel, valves, motor cable of approximately 30 m length & plug to suit the area classification & necessary instrumentation & controls.

9.7.9 Gas Turbine Enclosure

(i) Weather proof sound attenuating enclosure shall be provided for the Gas turbine which shall meet all the requirements as per Clause no. 5.7.5 of EIL Std. Specification no. 6-43-0041 Rev. 2 attached in the inquiry document. Additionally, the following requirements shall also be complied with.

(ii) The enclosure must be quickly detachable and equipped with lifting lugs for easy removal. Enclosure shall be constructed of easily handled sections to facilitate maintenance of and removal of the gas generator and power turbine (as applicable). Access door(s) shall be provided for inspection, repair and maintenance of the turbine and its system. Turbine enclosure shall also have glass window with seal tight metallic covers. The enclosures shall be suitable for operation under conditions as specified and shall be rigid enough to withstand all static and dynamic loads.

(iii) The enclosure shall be constructed with fire resistant materials. All enclosures shall be free of any depression or crevices where water or dust might collect.

(iv) Provision shall be made for removal of rainwater, which might collect inside ventilation exhaust duct. Ventilation air intake and exhaust shall be provided with silencers having stainless steel splitters.

(v) All instrument & electrical items, which are energised before start of pressurisation or remain energised after loss of pressurisation, shall be suitable for area classification

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as specified in Instrumentation and electrical specs attached elsewhere in the MR.

(vi) The enclosure shall be provided with fire detection system including thermal detectors, flame detectors etc., gas detection system and fire suppression system using CO_2 as per the specifications enclosed elsewhere in the inquiry document.

(vii) Detailed fabrication, installation drawings & bill of materials for structural supports, access/maintenance platforms, ladders for of the ventilation Fans & Ventilation Air Ducting shall be submitted during detailed engineering for the Purchaser's review.

9.8 LUBE OIL SYSTEM

9.8.1 General

(i) The lube oil system to be supplied with the GTC package shall conform to API standard 614, 4th edition and attached data sheets and other specifications as listed in the List of Attachments forming part of inquiry document. Console type common lube oil system shall be supplied for Compressor, Gear Unit & Gas Turbine Driver.

(ii) Gas Generator (GG) lube oil (LO) system may be independent if so recommended by the gas generator manufacturer. In such case GG LO system shall be as per GG manufacturer's standard. GG LO system shall comply with all the mandatory requirements of GG manufacturer.

(iii) Bidder shall ensure that the design of the lube oil consoles from the point of view of easy accessibility. Minimum 500 mm free space around and maintainability of the major pieces of equipments such as coolers, pumps, drivers, control valves, filters etc. shall be provided. Bidder to ensure easy personal movement and no criss crossing of piping in the consoles and shall not consider his standard congested consoles but shall design the layout in spread out manner. The layout shall be furnished for review and approval by the purchaser during detailed engineering.

(iv) The LO system shall be complete and include oil reservoir, lube oil pumps (main & auxiliary), Emergency Oil Pump (EOP), hydraulic oil pumps (main & auxiliary oil pumps), an overhead emergency lube oil run-down tank suitably sized so as to ensure supply of lube oil to compressor train for complete coast down time and cool off (separate accumulators shall be provided for pump change over), twin filters, air-cooled Lube-oil cooler, and all necessary valves, fittings, gauges etc. as required by purchaser's specifications.

(v) The material of construction of lube oil reservoir, lube oil supply and return piping, valve internals etc. shall be of Series 300 Stainless Steel.

(vi) Oil mist eliminator shall be provided in all lube oil vent lines to minimize the loss of lube oil due to vaporization. All the oil mist eliminator shall be mounted at suitable height by the bidder.

(vii) All inter-connecting lube oil piping from oil console to various consumption points in the equipment, including fittings, valves, instruments and supports shall be included in the bidder's scope of supply. Lube oil piping between compressor, oil console and lube oil run down tank shall also be in bidder's scope of supply. Bidder shall engineer the system and furnish detailed P&IDs as well as the piping drawings for the interconnecting piping for purchaser's review/ approval during detail engineering stage.

(viii) Reservoirs, pumps, coolers, filters and control valves shall be provided in an assembled console. Console shall have a steel baseplate with rim and drip lip for drainage.

(ix) Matching companion flanges, gaskets, fasteners etc. at all terminating points requiring Owner's interface (Applicable PMS shall be referred for flanges and gaskets etc.) and all Stainless Steel supply & return piping/tubing between LO console & compressor/Gas Turbine are included in bidder's scope.

(x) Supply of First fill of lubricants for the machines is not included in the bidder's scope

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of supply. However, the bidder, in his proposal, shall indicate the Grade of Oil and the quantities required for flushing oil and for first fill of Lubricant for each machine forming part of the GTC package.

9.8.2 Drivers for Lube oil Pumps

Following Driving arrangement is envisaged for LO pumps.

Main Lube oil Pump	:	driven by Electric (AC) Motor/shaft-driven
Standby Lube oil Pump	:	driven by Electric (AC) Motor (Emergency AC feeder)
Emergency Oil Pump	:	driven by Electric (DC) Motor (DC battery bank)

For voltage and frequency levels electrical specifications may please be referred.

9.8.3 Lube-Oil Coolers

(i) Lube-Oil coolers shall be Air-Cooled and shall be supplied and manufactured according to the requirements API standard 614, 4th edition.

(ii) The cooler tubes shall be series 300 stainless steel. The header boxes shall be made of hardened stainless steel plate. The header plug material shall be selected to prevent galling.

(iii) The oil cooler shall be equipped with temperature-controlled bypass valves and sized for a minimum temperature approach of 10 deg.C to the maximum ambient air temperature.

(iv) Oil cooler should be provided with adequate number of fans with 100% spare capacity. Cooling area shall be 200 % of the required surface area.

(v) Electronic vibration switches shall be provided for each fan and shall alarm on high vibration.

(vi) Each cooler shall be designed for 110 % of cooling capacity. ASME Code stamp is required on all coolers.

(vii) Cooler fans shall be electric motor driven directly (V Belt drives are not acceptable). Flexible metallic couplings shall be used for coupling motor & fan.

(viii) Equipment furnished for Air-cooled exchangers shall include, but not limited to:

- Coolers with fans and guards, electrical motor drivers.
- Vibration cutout switches.
- Pneumatically-actuated, opposed-action type louvers with Positioners for automatic control of oil temperature (controlled by temperature control system).
- Access platform and ladders.

(ix) Size and thickness of tubes, maximum number of fins per inch shall be as per relevant applicable functional specification and API code.

(x) Motors shall be in accordance with functional specification of electrical motors, suitable for area classification.

Provisions shall be made in the Cooler design to facilitate ease of cleaning of the cooler.

9.8.4 Filling/Emptying out Pump

One portable trolley mounted pump with necessary hose piping, valves, connections etc. shall be provided for emptying out / filling the main oil reservoir. Pump capacity shall be 3 m^3/hr (minimum) and it shall be electric motor driven, with a flexible motor cable of 30 m length and plug to suit the area classifications and motor rating. Ten metres of hose piping shall be provided both at inlet and outlet along with hose storage wheel by the Vendor.

9.8.5 Oil Purifier Unit

Bidder shall supply one portable trolley mounted oil purifier unit for the GTC package complete with automatic self cleaning centrifuge separator, flexible hose piping (10 m each at suction & discharge), hose-storage-wheel, valves, motor cable of approximately 30 m length & plug to suit the area classification/motor rating & necessary instrumentation and

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controls. The capacity of oil purifier shall be sufficient for total oil treatment in approximately 12 hours.

9.9 Couplings

(i) The coupling(s) shall conform to API-671, 3rd Edition, October 1998 with a service factor of 1.75. While selecting the coupling, it shall be ensured by the bidder that the allowable shaft stresses of the Compressor train are not exceeded under any circumstances including any offset condition or conditions of maximum torque.

(ii) In case of Compressor train having a gear-unit, the the coupling service factor shall not exceed the gear-box service factor.

(iii) Coupling shall be non-lubricated flexible metallic element type.

(iv) Coupling hubs and spacers shall be dynamically balanced at coupling manufacturer's works as one unit and all components shall be properly match marked.

9.10 Common Skid and Base-Plate

(i) Gas Turbine Compressor (GTC) train shall be mounted on a common skid/base-plate designed to support the compressor, Gear unit and gas turbine. The skid/base-plate shall be suitable for 4/6 point lift. Bidder shall provide non-skid decking on the skid/base-plate.

(ii) In case for transportation reasons from port/manufacturing works to site, splitting of this skid is required, the same shall be done by bidder. Splitting shall be done only with purchaser's prior approval. In case where splitting is essentially required, the skid/base-plate shall be designed so as to make a common skid/base-plate by bolting and dowelling at site and the complete skid/base-plate shall also be suitable for 4/6 point lift.

(iii) Bidder shall also provide suitable spreader bars/spreader frames for transportation of common skid/base-plate or independent skids/base-plates.

(iv) Auxilliary Skids (e.g. Fuel Gas Conditioning Skid, Buffer Gas Skid etc.) shall be so designed that Proper maintenance space is provided around & within the skids for maintenance purpose of individual skid components. Local gauge board etc. should be located in such a manner so that accessibility/visibility is maintained. All maintenance aspects of various skid components shall be reviewed by Purchaser and complied by the bidder.

9.11 Piping (Refer piping specification also)

Piping for lube oil and internal seal gas piping shall conform to API 614. Other piping requiring Purchaser’s interface shall conform to enclosed specifications.

All piping, fittings, valves etc. specified in bidder's scope of supply shall conform to the technical requirements specified in the relevant codes and standards. However, all interfaces shall conform to purchaser's requirements specified in the P&ID's and respective Piping Material Specification (PMS) & piping specifications enclosed with the inquiry document.

9.12 Pressure Vessels

All pressure vessels, tanks required for lube oil system, buffer gas supply system, fuel gas system & starter gas system etc. shall be in accordance with the relevant API standards namely API Std. 617, API Std. 616, API Std. 614 & ASME Section VIII Div I.

9.13 Electricals

All electrical and lighting systems for the package shall be as per the electrical specification and data sheets as per list of attachments forming part of the inquiry document and other codes/Standards referred therein.

9.14 Instrumentation and Controls

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Bidder shall supply all the necessary instrumentation and control system as described in Equipment and Instrument Data Sheets and Specifications, Process P&IDs and other specified instrumentation standards forming part of the inquiry document and other codes/Standards referred therein.

10.0 INSPECTION AND TESTING

10.1 General

(i) Inspection and test requirement have been detailed out in data sheets and/or specifications for various equipments.

(ii) All tests which are marked as witness tests may be witnessed by Owner's and/or Consultant's Inspector.

(iii) The successful bidder shall submit detailed Test Procedure for approval of the Purchaser at least four months in advance of the actual date of conducting each test.

(iv) Complete details of all tests and inspection requirements must be consolidated by the successful bidder in a single document entitled "Inspection and Test Schedule for Gas Turbine driven Centrifugal Compressor Package".

(v) For all witness tests, bidder shall give at least one month's notice and shall reconfirm the date of testing at least one week before the date of test.

(vi) The following tests besides being witnessed by OWNER's/CONSULTANT's Inspector may also be witnessed by OWNER's/CONSULTANT's equipment specialists. The successful bidder shall inform the Purchaser the scheduled test dates 6 weeks in advance and reconfirm the firm date of testing 1 week in advance.

(a). Mechanical Run Test for Compressor with Main Rotor as per API Std. 617 & EIL Standard Spec. 6-42-0005 at Compressor manufacturer's works.

(b). Mechanical Run Test for Compressor with Spare Rotor as per API Std. 617 & EIL Standard Spec. 6-42-0005 at Compressor manufacturer's works.

(c). Performance Test for Compressor (with main rotor) as per Type 2 ASME Code PTC-10 at Compressor Manufacturer's works.

(d). Mechanical run test for the Gas Turbine with main rotor / main Gas generator as per API Std. 616 & EIL Standard Spec. 6-43-0041 at Gas Turbine Manufacturer's works.

(e). Performance Test for Gas Turbine main rotor / main Gas generator as per API Std. 616, ASME Code PTC 1 & 22 and EIL Standard Spec. 6-43-0041 at Gas Turbine Manufacturer's works.

(f). Other tests as per respective datasheets.

10.2 Performance Guarantee test run at site:

10.2.1 The GTC package shall be subjected to **"Performance Guarantee test run (PGTR) at site"** within 3 months of commissioning of the GTC package. The PGTR at site shall be conducted inline with the requirements as per EIL Std. specification no. 7-76-0103 attached elsewhere in the inquiry document and ASME Code PTC 22 including the following requirements. The respective Codes and standards for Compressor and Gas Turbine (as defined and referred to in the inquiry document) shall also be applicable in this case.

Bidder shall be informed regarding the site readiness for PGTR (post commissioning of GTC package) within the time frame as mentioned above. Bidder shall accordingly arrive at site with required manpower, tools, instruments etc. on the notified dates (as communicated by purchaser) to make necessary arrangement for carrying out PGTR at site.

10.2.2 The PGTR shall be done with the process gas (as per Process datasheets) and at full load for 72 (Seventy two) hours duration to establish satisfactory performance (in terms of

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performance guarantee parameters, pressure and temperature etc. as per inquiry document). Alongwith the guarantee parameters, safe & smooth, reliable operation, mechanical integrity and sound level of the complete package shall also be established during the PGTR at site.

Note: The duration of 72 (Seventy two) hours shall be on sustained basis i.e. process interruptions shall be allowed to cumulate, however machine related interruptions shall not be counted.

10.2.3 Bidder shall submit the detailed test procedure, guaranteed parameters to be measured at site and methods of computation of results for review by the Owner/EIL during detail engineering stage. The performance testing procedures shall be mutually decided after finalization of order.

Note: All utilities required during PGTR shall be provided by client as FREE ISSUE.

10.2.4 If required and with prior approval from the Owner/EIL; the guarantee parameters shall be adjusted to account for variation in ambient conditions prevailing at site during performance testing. Necessary calculations, correction curves shall have to be furnished by the bidder for this purpose during detail engineering. Owner/EIL's comments on these documents shall be final and binding on the bidder without any commercial implication to Owner.

10.2.5 Modifications/additions/changes as required to resolve/correct any mechanical, electrical or Instrumentation related fault in the package, detected during PGTR shall be in bidder's scope without any cost implications to the purchaser. The above modifications/additions/changes etc. shall be carried out by the bidder within a reasonable time period mutually agreed upon.

10.2.6 If the GTC package fails to achieve the Guaranteed parameters at site, bidder shall carry out necessary modification at his own cost till the guaranteed parameters are achieved within a reasonable period (mutually agreed) from the date of failure of the first PGTR test and a second PGTR test shall be carried out by bidder at no extra cost implication to the purchaser.

Note: TECHNICAL PENALTY shall not be applicable to the PGTR at site. Commercial section of IFB shall be refered for further details.

10.2.7 If any additional equipments/instruments are necessary in addition to those in bidder's scope of supply for the purpose of testing & measurement, bidder shall bring them to site duly calibrated and shall take them back after successful completion. All utility and safety systems shall be operating during the test.

10.2.8 The cost for the *"**Performance Guarantee test run at site**"* shall be quoted as part of basic price.

10.3 Sound Level Test

(i) Sound pressure level of the complete unit operating at site at full load shall not exceed 85 dBA at any point when measured at 1 metre from the skid in any direction and the same shall be guaranteed at site.

(ii) In case specified noise level limit is not met at site, the bidder shall suggest and implement necessary modifications (without any time/cost implication to the purchaser) in the system to reduce the noise level to the specified noise level.

11.0 PARTICIPATION OF PURCHASER'S ENGINEERS DURING ASSEMBLY AND OTHER IMPORTANT ACTIVITIES:

Purchaser may depute his engineers at the Compressor/Gas turbine manufacturer's shop during the time of rotors assembly, balancing of rotor, main assembly of compressors and such other important activities which may be required to be performed during maintenance of the machines and the associated system. The Purchaser's engineers deputed in the Compressor/Gas turbine manufacturer's shop shall participate in the assembly operation and other activities and shall maintain record of all the final data like tolerances, clearances

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etc. Bidder shall have to provide all such data and records to the Purchaser's engineers and shall have to clarify all such data. Bidder shall submit along with the bid a list of activities in which such participation shall be useful for future maintenance work, along with the time period of each activities and the schedule when these activities are likely to be performed.

12.0 TRAINING

Bidder shall make arrangements for training of 15 persons x 02 weeks = 30 man weeks for the purchaser's operating and maintenance personnel at his/his sub-vendor's works to familiarize them with all aspects of operation and maintenance of mechanical, electrical, instrumentation & controls (inclusive of Compressor/Gear Box/Gas Turbine/ Anti-Surge Controller etc.) of these packages.

13.0 SPARE PARTS / SPECIAL TOOLS

13.1 Mandatory Spare Parts

Bidder shall include all the mandatory spare parts as specified in *"List of Mandatory Spares"* Doc. No. B240-910-80-42-SL-5010 as attached in the inquiry document.

13.2 Commissioning Spares

Bidder shall include in his proposal, sufficient spares required for commissioning of the GTC package as per his experience/recommendation & furnish a list for the same. If however, any additional spare is consumed over and above the quoted commissioning spares, during commissioning, the same shall be provided free of cost, by the Vendor. Any leftover spares after commissioning shall be handed over to the owner.

13.3 Special Tools / Tackles

(i) Special tools and tackles required, if any, for erection, site assembly & maintenance of each equipment of the GTC package as recommended by the equipment manufacturer shall be included in the bidder's proposal.

(ii) Bidder shall supply the following minimum special tools & tackles alongwith the GTC package. If any specific item in the list below is not applicable, then the same shall be justified with suitable technical justification by the bidder.

- Necessary power tools required for all bolts greater than 32 mm diameter.
- One set of Hydraulic tightening devices, as required shall be supplied along with low pressure and high-pressure pumps.
- One set alignment tools including fast align laser alignment tool for alignment purpose.
- Industrial digital video scope/boroscope.
- Torque Wrenches/Bolt Tensioners.
- Coupling removal tools
- Special tools for dismantling/assembly of GT
- Special tools for dismantling/assembly of Compressor
- Rotor lifting tools
- Seals mounting tools.
- Bearing tools
- Transportation stand / container for the Gas generator for transporting the Gas Generator to the work of OEM for overhaul / major repair.

All special lifting tools/tackles including spreader bar etc. shall also be included in the bidder's scope of supply.

13.4 RECOMMENDED SPARES FOR TWO YEAR NORMAL OPERATION

Bidder shall include in his proposal, recommended spares for 2 years normal operation (Mechanical, Electrical and Instrumentation) as per manufacturer's recommendation over and above the mandatory spares, for the GTC package (Quote only) including compressor, driver, lube oil and seal gas, electrical, instrumentation etc. together with, part no., name of the parts, cost and recommended quantity of spare against the GTC train. Prices shall be firm for two years from the date of order.

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14.0 SUPERVISION DURING ERECTION AND COMMISSIONING

14.1 The GTC package vendor shall provide his services for supervision during erection and commissioning of the GTC package. Electrical & Instrumentation engineers (as deemed necessary by the package vendor) shall also be present along with vendor's erection and commissioning engineer(s).

14.2 For supervision of erection and commissioning of the GTC package, a total of 200 mandays (maximum limit) have been envisaged alongwith pre-defined per diem rates (as defined in commercial document). Bidder shall categorically confirm compliance to the figure of 200 mandays and the pre-defined per diem rates (as defined in commercial documents) for supervision of erection and commissioning. Bidder may decide between days for Indian/Foreign supervisors and also discipline wise i.e. Mechanical, Electrical & Instrumentation etc., if required for supervision of erection and commissioning of GTC package, subject to the total of 200 mandays (maximum) as indicated above.

14.3 The cost for supervision of erection and commissioning shall NOT be considered for commercial comparison of bids.

15.0 EQUIPMENT LAYOUT

(i) The main equipment i.e. Compressor, Gear Unit & Gas Turbine train is envisaged to be installed on foundations (at a certain height above grade level). Lube oil console is also envisaged to be located at the Grade level below the main equipment.

(ii) The proposed Equipment Layout (Drawing No. B240-910-83-41-11901) enclosed with the inquiry document indicates tentative Equipment layout alongwith the space available for the complete GTC package. BIdder shall ensure that the proposed equipment package is accommodated within the space allocated in the above mentioned layout drawing The main and auxiliary equipments shall be so arranged within this area such that enough space is available around each equipment for ease of operation and routine maintenance.

NOTE: Space given in the layout cannot be further increased and Bidder has to give his acceptability to overall space during proposal stage itself. Any upward change in the area requirement at a later date shall not be allowed.

(iii) Bidder in his proposal shall include suggested detailed equipment layout indicating main equipment as well as auxiliary equipment various consoles, local panels/local gauge board etc. along with their dimensions and levels at which the same are to be placed.

(iv) Bidder shall also indicate weights of equipment, maintenance space required, crane capacity (recommended) and crane hook approach from the grade level etc. The data/information shall be adequate for designing of compressor house (shelter).

(v) General Arrangement Drawing (GAD)/ Equipment Layout of all equipment located inside compressor house as well as around the compressor house including main equipment, auxiliaries, and routing of piping etc. *(based on the indicative layout drawing provided in the inquiry)* shall be provided by the bidder along with the proposal.

16.0 VENDOR DATA AND DRAWING

16.1 General

(i) Vendor Drawings and Data shall be furnished in conformity with the Vendor Data Requirements Forms attached with inquiry document.

(ii) Vendor shall furnish all the information at the time of bidding as specified in the Vendor Data Requirement (VDR) and in this job specification.

(iii) The Vendor Data Requirement after placement of Letter/Fax of Intent is indicated in the Vendor Data Requirement. Vendor shall confirm that all data as required shall be

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furnished by him within the agreed dates.

(iv) After the placement of Letter/Fax of Intent, a conference (kick off meeting) will be held at such date and at such place, as may be mutually agreed upon between the Vendor and the purchaser. The intent of this conference shall be to discuss/clarify the various requirements and finalize the modus operandi of executing the order.

(v) Vendor shall furnish the Drawings/Documents for purchaser's review/approval as per the Vendor Data Requirement. The review comments for major and critical drawings (such as system P&ID's General Arrangement Drawings, Foundation Drawings, Performance characteristics, Frequency analysis reports etc.) shall be discussed across the table at such date and place as may be mutually agreed between the Purchaser and the Vendor.

(vi) Vendor shall also provide the operation and maintenance manuals as part of final documentation. The operation and maintenance must include Performance curves & characteristic curves for various operating conditions, Performance footprints at the time of shop testing. The operation and maintenance manual must clearly mention the schedule of all the overhauls along with detailed procedure for carrying out the same.

17.0 SUB-VENDOR LIST

17.1 Refer ANNEXURE-A for vendor list of Pumps, Mechanical Seal, Dry Gas Seal/Seal Skid, Fuel Gas Conditioning skid etc.

18.0 EQUIPMENT STORAGE

18.1 GTC package shall be packed for an outside storage period of 12 months.

18.2 The following shall be ensured before despatch of the GTC Package:

(a) All the openings shall be plugged & in sealed condition during dispatch.

(b) Instruments like gauges, probes, oiler etc shall be removed from the main equipment and dispatched separately to avoid the damage of these components during transportation handling and erection.

(c) In addition to normal packing the equipment skids shall be separately covered with transparent polythene cover with opening for piping.

19.0 TRANSPORTATION OF THE PACKAGE

19.1 For transportation of the packages to the project site, number of pieces and size and weight limitations shall be mutually discussed between the purchaser and the Vendor.

19.2 Spare rotors shall be separately shipped with vertical storage box with suitable preservative measures.

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ANNEXURE-A

GENERAL NOTES

1.0 BIDDER shall necessarily procure all the material / equipment forming permanent part of the unit / plant from OWNER / EIL approved vendors only. This shall include sub-ordered items / components also. The “Approved Vendors” shall be item specific.

2.0 OWNER / EIL approved vendor list for the various items is enclosed in this section.

3.0 BIDDER may procure material from any of OWNER / EIL approved vendors. However, current validity, holiday status and range of approval as per EIL enlistment letter, workload, stability and solvency need to be verified by the BIDDER with vendor before placement of order. BIDDER is also required to ensure that equipment qualification criteria, specified elsewhere in the bid document, are also simultaneously met.

4.0 Vendors on OWNER / EIL holiday list shall not be considered for ordering. BIDDER shall comply with this requirement without any time or cost implication to the OWNER. If a vendor is put on OWNER / EIL’s holiday list subsequent to BIDDER placing an order, it shall be BIDDER’s responsibility to ensure quality work and timely supply from the vendor.

5.0 For items not covered in the above list, the BIDDER shall approach OWNER / EIL for that list or the vendors list shall be approved by OWNER / EIL prior to placement or order by BIDDER. BIDDER shall list down the proposed suppliers / vendors for such items and submit the same for OWNER / EIL’s review / approval along with necessary documents / credentials. “Approval status” documents / credentials to be furnished by the vendors in such cases shall solely be the responsibility of the BIDDER. OWNER / EIL’s decision on above shall be final and non-negotiable. Acceptance or non-acceptance of a particular proposed vendor due to any reasons whatsoever shall not be a cause of schedule and cost implication.

6.0 BIDDER shall make an independent assessment of capability of all the vendors for timely deliveries of material / equipment. Any delays in deliveries by vendor(s) shall not be a cause of schedule and cost implication.

7.0 At any stage of the project, if it comes to the notice of OWNER / EIL that BIDDER has procured material / equipment, intentionally or unintentionally whatsoever, from an unapproved vendor and / or items not falling in approved range of vendor(s), the same shall be rejected forthwith and BIDDER shall be liable to replace such material / plant / machinery without any schedule and cost implication to the OWNER.

8.0 List of vendors appearing anywhere else in the contract document in case of duplication of the items at two or more places shall not be considered by BIDDER and shall be superseded by the vendor list enclosed herewith. And if in this vendor list also, items seems to be duplicated / repeated then BIDDER shall get clarified the issue by OWNER / EIL before proceeding ahead for procurement activity.

9.0 It is understood that should the name of vendor be changed due to change in their company or corporate shareholding. OWNER may accept such vendors under its new name with prior approval.

Any such approval shall however, not absolve the BIDDER from any of his obligations under the contract; neither shall any such approval signify nominations or instruction to use such a vendor. All approved vendors are deemed to have been freely chosen by the BIDDER at his own risk.

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SL. NO.	DESCRIPTION	REMARKS
1.0	**LUBE-OIL PUMPS-CENTRIFUGAL HORIZONTAL (SPECIAL PURPOSE PROCESS)**	
1.1	Arai Pump Manufacturing Company Ltd.	
1.2	Clyde Union Ltd.	
1.3	DMW Corporation [Mishima]	
1.4	Ebara Corporation [Japan]	
1.5	Flowserve Corporation [Japan]	
1.6	Flowserve India Controls Pvt. Ltd.	
1.7	Flowserve (Thompsons Kelly & Lewis Pty Ltd.)	
1.8	Goulds Pumps Inc.	
1.9	Goulds Pumps Co. Ltd.	
1.10	Hyosung Goodsprings Inc.	
1.11	ITT Corporation India Pvt. Ltd. [Vadodara]	
1.12	Kirloskar Ebara Pumps Ltd. [Sangli]	
1.13	KSB Limited [Pune]	
1.14	KSB Pumps Ltd. (Poona) [Satara]	
1.15	Ruhrpumpen Gmbh [Germany]	
1.16	Ruhrpumpen India Pvt. Ltd.	
1.17	Shin Nippon Machinery Co. Ltd.	
1.18	Sulzer Pumps (US) Inc.	
1.19	Sulzer Pumpen Deutschland Gmbh [Bruchsal, Germany]	
1.20	Sulzer Pumps India Pvt. Ltd.	

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SL. NO.	DESCRIPTION	REMARKS
1.21	Weir Minerals Netherlands BV	
2.0	**LUBE-OIL PUMPS-ROTARY GEAR**	
2.1	Allweiler India Private Limited	
2.2	DEL PD Pumps & Gears Pvt. Ltd.	
2.3	Flowserve Corporation	
2.4	MAAG Pumps Systems AG [Zurich]	
2.5	Shimadzu Corporation	
2.6	Viking Pump INC [USA]	
2.7	Witte Pumps & Technoclogy GMBH	
3.0	**LUBE-OIL PUMPS-ROTARY SCREW**	
3.1	Alekton Engg. Industries Pvt. Ltd.	
3.2	Allweiler India Private Limited	
3.3	Flowserve Corporation	
3.4	Netzsch Technologies India Pvt. Ltd.	
3.5	Plenty Mirrless Pumps [England]	
3.6	Pompe Vergani SPA	
3.7	Robbins & Myers Inc	
3.8	ROTO Pumps Ltd.	
3.9	Seepex GMBH (Bottrop)	
3.10	UT Pumps & Systems Pvt. Ltd. (Borneman)	
3.11	Warren Pumps INC.	

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SL. NO.	DESCRIPTION	REMARKS
4.0	**MECHANICAL SEALS (for Lube-Oil Pumps)**	
4.1	AESSEAL PLC [ROTHERHAM]	
4.2	Chetra Dichtungstechnik AG	
4.3	Eagle Burgmann India Pvt. Ltd.	
4.4	Flowserve Sanmar Limited (Chennai)	
4.5	John Crane Sealing Systems India Pvt. Ltd.	
4.6	Leak Proof Engg (I) Pvt. Ltd. (Banaskantha-Gujarat)	
5.0	**DRY GAS SEAL (REFER QC)**	
5.1	Eagle Burgmann	
5.2	Flowserve	
5.3	John Crane	
6.0	**DRY GAS SEAL SKID (REFER QC)**	
6.1	Eagle Burgmann	
6.2	Flowserve	
6.3	John Crane	
7.0	**GAS CONDITIONING SKID**	
7.1	Grand Prix Engineering Pvt. Ltd. [Faridabad]	
7.2	Multitex Filtration Engineers Ltd. [Noida UP]	
7.3	Nirmal Industrial Control PVt. Ltd. [Thane]	
7.4	Premabargo Italiana SRL	

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1	**GENERAL**										
2	Project:	**INSTALLATION OF GTC AT GANDHAR**				Job No.:	**B240**				
3	Owner:	**GAIL (INDIA) LTD.**				Site:	**GPU GANDHAR**				
4	Purchaser:					Unit:	**NEW COMPRESSOR AREA**	Unit No.: **910**			
5	Item No.:	**910-K-901**				Service:	**NATURAL GAS COMPRESSOR**				
6	No. of Units:	**ONE**	Working: **ONE**	Standby: **NONE**		Driver:	Working:	**GAS TURBINE**	Standby: **NONE**		
7	Applicable to:		■Proposal	☐Purchase			☐As				
8	■:Scope,Option & Information specified by Purchaser. ☐:Information reqd from and options left to vendor.Vendor to cross(☒)the selected Option.										
9	Manufacturer:			☐ Model		Driver Type:	☐Elec. Motor ■ GT ☐ ST				
10	Place of Mfrg.:			Drive Arrgmt.			☐ Direct ■Thru' gear box (as applicable)				
11	Duty:	■ Continuous		☐ Intermittent			☐ Standby				
12	No. of stages: 01 (One) **(Note-4)**										
13	**OPERATING CONDITIONS (Note-21)**										
14	**(ALL DATA ON PER UNIT BASIS)**			**Case-1**				**Case-2**			
15				**Case-1a**	**Case-1b**	**Case-1c**	**Case-1d**	**Case-2a**	**Case-2b**	**Case-2c**	**Case-2d**
16	■ Gas Handled (Also see Page 2 of 7)										
17	☐Nm^3/Hr (1.033 Kg/cm^2A, 0 ˚C Wet)										
18	■Weight Flow, kg/hr (Dry)		**(Note-1)**	**110121**	**110121**	**110121**	**110121**	**----**	**----**	**----**	**----**
19	■Weight Flow, kg/hr (Wet)			**----**	**----**	**----**	**----**	**122794**	**122965**	**122424**	**122940**
20	**Inlet Conditions**: @ **Compr. Suc. Flange**										
21	■ Pressure (kg/cm^2G)		**(Note-2)**	**36**	**36**	**39**	**39**	**25**	**25**	**28**	**28**
22	■ Temperature (˚C)			**40**	**55**	**40**	**55**	**15**	**35**	**15**	**35**
23	☐ Relative Humidity (%)										
24	■Avg. Molecular Weight (Dry basis)			**17.8811**	**17.8811**	**17.8811**	**17.8811**	**----**	**----**	**----**	**----**
25	■Avg. Molecular Weight (Wet basis)			**----**	**----**	**----**	**----**	**19.9163**	**19.9163**	**19.9163**	**19.9163**
26	■ C_p / C_v (K_1) or ($K_{Avg.}$)		**(Note-23)**	**1.3981**	**1.3731**	**1.4089**	**1.382**	**1.3849**	**1.3489**	**1.4022**	**1.3623**
27	■ Compressibility (Z_1) or ($Z_{Avg.}$)			**0.9242**	**0.936**	**0.9185**	**0.9313**	**0.9097**	**0.9282**	**0.8999**	**0.9202**
28	☐ Inlet Volume,(m^3/hr) (Wet / ~~Dry~~)										
29	☐ Inlet Volume,(m^3/hr) (~~Wet~~ / Dry)										
30	**Discharge Conditions**: @ **Compr. Dis. Flange**										
31	■ Pressure (kg/cm^2G)		**(Note-3)**	**92**				**92**			
32	■ Temperature (˚C) (Estimated/Actual)		**(Note-4)**								
33	☐ C_p / C_v (K_1) or ($K_{Avg.}$)										
34	☐ Compressibility (Z_1) or ($Z_{Avg.}$)										
35	**Performance**:										
36	☐ BKW Required (All losses Incl) (#)										
37	☐ Mech. & Seal Losses Included in BKW										
38	☐ Speed (rpm)										
39	☐ Estimated Surge m^3/hr (At above speed)										
40	☐ Polytropic Head (m)										
41	☐ Polytropic Efficiency (%)										
42	■ Certified/Guarantee Point			**----**	**Yes (#)**	**----**	**----**	**----**	**----**	**----**	**----**
43	☐ Performance Curve Number										
44	**Process Control Method**										
45	☐ Suction Throttling From (kg/cm²A) To (kg/cm²A). (If required/ recommended)										
46	☐ Variable Inlet Guide Vanes										
47	■ Speed Variation From % To %.										
48	☐ Discharge Blow off To .										
49	■ Cooled Bypass From **Discharge** To **Suction through Anti-Surge Valve**										
50	Signal ■ Source: (Refer Process P&ID)										
51	Type ☐ Electronic Manual from ☐ DCS ☐ Pneumatic ■ Other : Master Controller										
52	Range mA (Kg/cm²A).										
53	Antisurge Bypass (**Refer Job specification/P&IDs**) ■ Manual ■ Automatic ☐ None										
54	**REMARKS:**										
55	**(#)** BKW against Guarantee/Certified point shall be with 0% +ve tolerance										
56											
57											
58											
59											
60											
61											
62											

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OPERATING CONDITIONS (Continued)

Gas analysis ■ Mol % (Also refer Process Datasheet attached)		**Case-1**	**Case-2**
Constituent	MW		
Air	28.966		
Oxygen	32.000		
Nitrogen	28.016	**0.23**	**0.16**
Water	18.016		**FULLY SAT.**
CO	28.010		
CO_2	44.010	**2.36**	**2.47**
H_2S	34.076	**0.00141**	**0.00141**
Hydrogen	2.016		
Methane	16.042	**90.35**	**85.73**
Ethylene	28.052		
Ethane	30.068	**5.93**	**5.06**
Propylene	42.078		
Propane	44.094	**1.06**	**3.74**
i-butane	58.120		
n-butane	58.120	**0.05**	**1.79**
i-pentane	72.146		
n-pentane	72.146		**0.56**
n-Hexane			
C6+			**0.48**
Pentylene			
Total			
Avg. Mol. Wt.		**17.8811**	**19.9163**
Dew point (°C) @ Atm. Pressure		**(-)103**	**(-)35**

REMARKS

Mechanical Data- Casing

Upstream Design Pressure kg/cm^{2}g	**95.6 (*)**
Upstream Design Temperature °C	**75**
Downstream Design Pressure kg/cm^{2}g	**95.6**
Downstream Design Temperature °C	**Note-5**

(*) To be confirmed by vendor based on settle-out pressure. Also refer Note-10.

Location:

☐ Indoor ■ Outdoor ■ Grade

☐ Heated ■ Under-roof ☐ Mezzanine

■ Un-heated ■ Partial Sides ☐

■ Elect. Area Classification **(Note-6)**

☐ Winterization Reqd (2.1.8) ■ Tropicalization Reqd.

Site data: **(Note 7)**

☐ Elevation (m): ☐ Barometer (kg/cm²A):

☐ Range of Ambient Temps.	Dry Bulb	Wet Bulb
Normal (˚C):		
Max. (˚C):		
Min. (˚C):		
Site Rated(˚C):		

Unusual conditions:

■ Dust ■ Fumes

☐ Others :

Noise specifications:

■ Applicable to Machine: Max. **85** dBA @ **1** m.

See Specification

☐ Applicable to Neighborhood: Max. dBA @ m.

See Specification

■ Acoustic Housing ☐ Yes (If Reqd) ■ No

Applicable specifications:

■ Chapter 1 & 2 of API Std. 617, 7th edn. July 2002, EIL Std. Spec. 6-42-0005

■ Vendor having Unit Responsibility: SPRV Vendor

■ Governing Specification: **Job spec. No. B240-910-80-42-SP-5010**

Painting:

■ Manufacturer's Standard

☐ Other

Shipment:

☐ Domestic ■ Export ■ Export Boxing Reqd

■ Outdoor Storage More than **12** Months

■ Spare Rotor assembly packaged for:

☐ Horizontal Storage ■ Vertical Storage (N2 purging)

REMARKS:

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124	**CONSTRUCTION FEATURES**	
125	■ **Speeds**: [As per API 617]	Type (Open, Enclosed etc.): **Enclosed**
126	Max. Continuous: RPM Trip: RPM	Type Fabrication:
127	Max.TipSpeeds@Rated Speed (100% speed): m/s	Material:
128	Max.TipSpeed@Max. Continuous Speed: m/s	Max. Yield Strength (Kg/cm²):
129		Brinell Hardness: Max.: Min.:
130	■ **Lateral Critical Speeds (Damped)**: [As per API 617]	Smallest Tip Internal Width (mm):
131	First Critical RPM Mode	Max. MACH Number @ Impeller Eye:
132	Second Critical RPM Mode	Max. Impeller Head @ Rated Speed (m):
133	Third Critical RPM Mode	■ **Shaft**:
134	Fourth Critical RPM Mode	Material:
135		Dia @ Impeller (mm): Dia @ Coupling (mm):
136	■ Compressor Lateral Analysis Required	Shaft End: ☐ Tapered ☐Cylindrical
137	■ Train Torsional Analysis Required	Max. Yield Strength (Kg/cm²):
138	(Turbine Driven Train)	Shaft Hardness (BHN) (R_c):
139	■ **Torsional Critical Speeds**: [As per API 617]	Max. Torque Capability (kgm):
140	First Critical RPM	☐ **Balance Piston**:
141	Second Critical RPM	Material: Area (mm²):
142	Third Critical RPM	Fixation Method:
143	Fourth Critical RPM	■ **Shaft Sleeves**:
144	■ Vibration: Allowable Test Level (Peak To Peak) (mm):	At Intstg. Close Clearance Points: Material: **Stainless Steel**
145	**(including electrical & Mechanical Run-out)**	At Shaft Seals: Material: **Stainless Steel**
146	☐ Rotation Viewed From Driven End: ☐ CW ☐ CCW	☐ Accessible
147	■ **Materials Inspection Requirements**	■ **Labyrinths**:
148	☐ Special Charpy Testing	Interstage: Type: Material: **Aluminum Alloy or SS**
149	■ Radiography Required for **Casing and welds (100%)**	Balance piston: Type: Material: **Aluminum Alloy or SS**
150	■ Ultrasonic Required for **Shaft, Major Forging**	
151	■ Magnetic Particle Required for **Impellers**	■ **Shaft seals: (Note-8 & 9)**
152	■ Liquid Penetrant Required for **Impellers**	■ Seal Type: **Dry gas seal (Tandem with intermediate labyrinth)**
153	■ **Casing**:	■ Settling Out Pressure (Kg/cm²G): _____**(Note-10)**
154	Model:	☐ Special Operation:
155	Casing Split:	☐ Supplemental Device Required for Contact Seals:
156	Material:	Type:
157	Thickness (mm): Corrosion Allowance(mm):	■ Buffer Gas System Required: ☐ Manifold
158	Max. Working Pressure (Kg/cm²G):	■ Buffer Gas Type: Primary: **(Note-8 & 9)** Secondary: **(Note-8 & 9)**
159	Max. Design Pressure (Kg/cm²G): **≥95.6 (Note-10)**	■ Buffer Gas Control System (Schematic by vendor):
160	Test Pressure (Kg/cm²G): Helium: Hydro:1.5xDesgn.Pr. Or More	☐ Pressurising Gas for Subatmospheric Seals:
161	Max. Operating Temp. (˚C): Min. Operating Temp (˚C):	■ Type Seal: **Tandem (Refer Job specification)**
162	Max. No. of Impellers For Casing:	☐ Inner Oil Leakage (Guaranteed)(m^3/day/seal):
163	Max. Casing Capacity (m^3/hr):	Buffer Gas Required for:
164	Radiograph Quality: ■ Yes ☐ No	☐ Air Run In ☐ Other
165	Casing Split Sealing:	☐BufferGasFlow(PerSeal): ■Separation Gas:**Nitrogen**
166	■ System Relief Valve Set Point (Kg/cm²G): **95.6 (Note-10)**	Norm.: Kg/min @ Kg/cm²; Diff. Pr.:
167	■ **Diaphragms**:	Max.: Kg/min @ Kg/cm²; Diff. Pr.:
168	Material:	
169	■ **Impellers**:	☐ **Bearing housing construction**:
170	No.: Diameters:	Type (Separate/Integral) : Split:
171	No. Vanes EA. Impeller:	Material:
172		
173		
174	**REMARKS:**	
175		
176		
177		
178		
179		
180		
181		
182		
183		
184		
185		

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186	**CONSTRUCTION FEATURES**								
187	**Bearings & Bearing Housings**								
188	**Radial**	**Inlet**	**Exhaust**	**Thrust (§)**	**Active**	**In-active**			
189	■ Type	**Tilting Pad**	**Tilting Pad**	■Type	**Tilting Pad**	**Tilting Pad**			
190	☐ Manufacturer			☐Manufacturer					
191	☐ Length (mm)			☐Unit Load (Max.)					
192	☐ Shaft Dia (mm)			☐UnitLoad(Ult.)					
193	☐ Unit Load (Actual/Allowable)			☐Area (mm²)					
194	☐ Base Material			☐No. Of Pads					
195	☐ Babbit Thickness (mm)			☐PivotCentre/ Offset, %					
196	☐ No. Of Pads			☐Pad Base					
197	☐ Load Between / On Pads			☐					
198	☐ Pivot Centre / Offset, %			Lubrication: ☐ Flooded ☐ Directed					
199	☐			Thrust Collar: ☐ Integral ☐ Replaceable					
200	☐ Bearing Span (mm)			Material:					
201	**Bearing temperature devices**: ■ Also refer API 670 **(Note-11 &12)**			**Vibration detectors**: ■ Also refer API 670 **(Note-11 & 12)**					
202	☐ Thermistors			■ Type:**Non Contacting** ■ Model:					
203	☐ Type: +ve Temp. Coeff.: -ve Temp. Coeff.:			☐ Manufacturer:					
204	☐ Temp. Switch & Indicator By: Purchaser: Manuf.:			☐ No. at Each Shaft Brg.:**2** Total No.: **4**					
205	☐ Thermocouples			■ Oscillator-Demodulators supplied By: **Compressor Vendor**					
206	☐ Sel. Switch & Indicator By: Purchaser: Manuf.:			☐ Mfr.: ☐ Model:					
207	■ Resistance Temp. Detectors			Monitor Supplied By: **Compressor Vendor**					
208	■ Resistance Material:**Platinum** ■ **100** Ohms			☐ Location : Enclosure:					
209	■ Sel. Switch & Indicator By: Purchaser: Manuf.:**Yes**			☐ Mfr.: ☐ Model:					
210	■ Location - Journal Bearing: (⊆)			☐ Scale Range: Alarm; ☐ Set @ :m.					
211	No.: EA Pad: Every Other Pad: **2** Per Brg.			☐ Shutdown ☐ Set @ :m. ☐ Time Delay Sec.					
212	Other:			**Axial position detectors**:■ Also refer API 670**(Note-11 &12)**					
213	■ Location - Thrust Bearing: (⊇)			■ Type: **Non Contacting** ☐ Model:					
214	No.: EA Pad: Every Other Pad: **3** Per Brg.			☐ Manufacturer: ■ No. Reqd.:**2**					
215	Other:			■ Oscillator-Demodulators supplied By: **Compressor Vendor**					
216	No.(Inact): EA Pad: Every Other Pad: **2** Per Brg.			☐ Mfr.: ☐ Model:					
217	Other:			Monitor Supplied By: **Compressor Vendor**					
218	■ Monitor Supplied By: **Compressor Vendor**			☐ Location: Enclosure:					
219	☐ Location**:** Enclosure:			☐ Mfr.: ☐ Model:					
220	☐ Mfr.: ☐ Model:			☐ Scale Range: ☐ Alarm ; ☐ Set @ :m.					
221	☐ Scale Range: Alarm; ☐Set @ ˚C.			☐ Shutdown ☐ Set @ :m. ☐ Time Delay Sec.					
222	☐ Shutdown ■ Set @ ˚C. ☐ Time Delay Sec.			☐ Phase / Speed Detector: (At Shaft NDE)					
223	**Casing connections**:								
224	■ Design Approval Reqd. ☐ ASME ☐ API605 ☐ Other								
225	**Connection**	**Rating**	**Size**	**Facing**	**Position**	**Flanged or Studded**	**Mating flange & Gasket by Vendor**	**Gas Velocity (m/s)**	**Remarks**
226									
227									
228									
229	**Inlet**	**# 900 (min.)**		**RF**	**Top**	**Flanged**	**YES**		
230	**Discharge**	**# 900 (min.)**		**RF**	**Top**	**Flanged**	**YES**		**(Note-13)**
231									
232									
233									
234									
235									
236									
237	**REMARKS:**								
238									
239									
240	**§:** Max. Thrust Loading shall not exceed 50% of Design Load of Bearings.								
241	⊆: Each Journal Bearing shall have RTD's in no less than 50% of the Shoes.								
242	⊇: Each Thrust Bearing shall have RTD's in no less than 50% of Active Side & 2 in the Inactive Side.								
243	Legends: LCP -🖫 Local Control Panel MCR -🖫 Main Control Room. SRR: Satellite Rack Room								
244									
245									
246									

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CONSTRUCTION FEATURES

■ **Other connections**:

Service	No.	Size	Type
Lube-Oil Inlet			
Lube-Oil Outlet			
Seal-Oil Inlet			
Seal-Oil Outlet			
Seal-Gas Inlet			
Seal-Gas Outlet			
Casing Drains	**Provide for Complete Drainage**		
Stage Drains			
Vents			
Cooling Water			
Pressure			
Temperature			
Solvent Injection			
Purge For:			
-Bearing Housing			
-Between Brg & Seal			
-Between Seal & Gas			

■ Individual Stage Drains Required

☐ Valved & Blinded.

■ Valved & Blinded & Manifold.

■ **Allowable piping forces and moments(Note-14)**

	Inlet		Discharge			
	Force (Kg)	Moment (Kg.m)	Force (Kg)	Moment (Kg.m)	Force (Kg)	Moment (Kg.m)
Axial						
Vertical						
Horiz. 90°						
	Force (Kg)	Moment (Kg.m)	Force (Kg)	Moment (Kg.m)	Force (Kg)	Moment (Kg.m)
Axial						
Vertical						
Horiz. 90°						

☐ Casing Vibration Transducer

☐ See Attached API 678 Data Sheet.

☐ Type ☐ Model:

☐ Mfr.: No. Reqd.:

☐ Location:

☐ Oscillator-Demodulators supplied By:

☐ Mfr.: ☐ Model:

☐ Monitor Supplied By:

☐ Location: Enclosure:

☐ Mfr.: ☐ Model:

☐ Scale Range: ☐ Alarm; ☐ Set @ mm/sec².

☐ Shutdown ☐ Set @ mm/sec². ☐ Time Delay Sec.

Key Phasor Required

☐Compressor ■ Gear (LS/HS Shaft) ☐ Driver

ACCESSORIES

Couplings and Guards: [As per API 671]

Note: See Rotating Elements - SHAFT ENDS.

☐ See Attached API 671 Data Sheet. ☐ Keyless Hydraulic ☐ Keyed

Coupling Furnished By: **GTC Vendor**

Manufacturer: Type**: Metallic Flexible Element (Diaphragm / SS Flexible membrane**) Model:

Coupling Guard furnished by: **GTC Vendor**

Type: ■ Fully Enclosed ☐ Semi Open ■ Other: Non Sparking

Coupling Details:

☐ Max. O.D.: mm.

☐ Hub Weight:

☐ Spacer Length: mm.

☐ Spacer Weight:

☐ Vendor Mount Half Coupling ☐ Idling Adapter / Sole Plate Reqd. (3.2.4)

Lubricating Requirements:

☐ Non Lube ☐ Grease ☐ Cont. Oil Lube ☐ Other

Quantity per Hub (Kg or m^3/hr).

Mounting plates:

☐ **Baseplates**: Furnished by**:**

☐ Compressor Only ☐ Driver ☐ Gear

■ Other:Common base plate for Compressor,Gearbox & GT**(#)**

■ Drip Rim ■ Leveling Pads

■ Column Mounting ☐ Perimeter

☐ Sub Sole Plates Reqd.

■ Stainless Steel Shim Thickness (mm):

Primer for EPOXY Grout Reqd.:

Type:

■ Base Plate will be on Concrete Foundation

☐ Machine Mounting Pads Required

☐ **Soleplates**: Furnished by: Compressor Vendor.

☐ Thickness (mm):

☐ Sub Sole Plates Reqd.

☐ Leveling (Chock) Blocks Reqd..

☐ Stainless Steel Shim Thickness (mm):

☐ Driver ☐ Gear ☐ Compressor

☐ Primer for Epoxy Grout Reqd.

Type:

REMARKS:

(#) Also refer scope of supply (Sl. No. 1.6)

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	UTILITIES				
308	■ **Utility conditions**: **(Note-7)**				■ **Total utility consumption**: **(Note-15)**
309	**Steam** **Drivers** **Heating**				Cooling Water: m^3/hr
310	Inlet:Min. kg/cm^2G ˚C. kg/cm^2G ˚C.				Steam Normal: Kg/hr
311	Nor. kg/cm^2G ˚C. kg/cm^2G ˚C.				Steam Maximum: Kg/hr
312	Max. kg/cm^2G ˚C. kg/cm^2G ˚C.				Instrument Air: Nm^3/hr
313	Exhaust: Min. kg/cm^2G ˚C. kg/cm^2G ˚C.				HP (Driver): KW
314	Nor. kg/cm^2G ˚C. kg/cm^2G ˚C.				HP (Auxiliaries): kW
315	Max. kg/cm^2G ˚C. kg/cm^2G ˚C.				Heaters: kW
316	**Electricity**: **(Note-6)**				Purge (Air or N_2) Nm^3/hr
317	Drivers Heating Control Shutdown				**Miscellaneous**:
318	Voltage				■ Recommended Straight Run of Pipe Diameters
319	Hertz				Before Suction:
320	Phase				☐ Nomographs Reqd. for each Section
321	**Cooling Water**: **(Not available)**				■ Vendor's Review & Comments on Purch. Piping & Foundation
322	Temp. Inlet: ˚C. Max. Return: ˚C.				☐ Compressor to be suitable for Field Run in on Air
323	Press. Norm.: kg/cm^2G. Design: kg/cm^2G.				☐ Provision for Liquid Injection
324	Min. Return: kg/cm^2G. Max. Allow.)P: kg/cm^2.				■ Vendor's Review & Comments on Purch. Control System
325	Water Source: Fouling Factor:				■ Extent of Process Piping By Vendor as per Job Spec.
326	**Instrument air**: **(Note-6)**				☐ Shop Fit Up of Vendor Process Piping
327	Max. Press. kg/cm^2G. Min. Press.: kg/cm^2G.				☐ Welding Hardness Testing
328					■ Aux. Eqpt. Monitors Explosion Proof **(Note-6)**
329	**SHOP INSPECTION & TESTS**				■ Provide spare rotor for each Compressor Casing
330		Reqd.	Witn.	Obs.	■Optical Alignment flats reqd. for compressor & driver
331	Shop Inspection	■	☐	☐	Vendor's Representative shall
332	Cleanliness	■	☐	☐	☐ Observe Flange Parting
333	Hydrostatic	■	■	☐	■ Check Alignment at Temperature
334	Impeller Overspeed	■	■	☐	■ Be Present at Initial Alignment
335	Mechanical Run (main & spare rotor)	■	■	☐	☐ **Weights** (kg):
336	■ Contract Coupling ☐ Idling Adaptor(s)				Compr.: Gear: Driver: Base:
337	■ Contract Probe ☐ Shop Probes				Rotors: Compr: Driver: Gear:
338	Vary LO Pres. & Temp.	■	■	☐	Compr. Upper Case:
339	Polar Form Vib Data	■	☐	☐	Sour Seal Oil Traps:
340	Tape Record Vib Data	■	☐	☐	LO Console: SO Console:
341	Tape Data To Purch.	■	☐	☐	Overhead Seal Oil Tanks:
342	Shaft End Seal Insp.	■	■	☐	Max. Wt. For Maintenance: (Pl. Identify)
343	Gas Leak test Disch. Pressure	■	■	☐	Total Shipping Weight:
344	☐ Before ■ After Post Test Inspection				☐ Space requirements (m):
345	Performance Test (Gas/~~Air~~) **(Note-24)**	■	■	☐	Complete Unit: L: W: H:
346	Unitization of GTC @ SPRV shop **(GTC train)**	■	■	☐	LO Console: L: W: H:
347	Torsional vib Measurement	☐	☐	☐	SO Console: L: W: H:
348	Tandem Test	☐	☐	☐	Sour SO Traps:
349	Seal Leakage Performance Test **(@)**	■	■	☐	Ovhd. Seal Oil Tanks:
350	Dynamic Balancing of Rotor	■	☐	■	**@:At Seal Vendor's works** Bidder shall confirm the value of Guaranteed Seal leakage rate in his bid/offer.
351	Helium Leak Test	☐	☐	☐	
352	Sound Level test	■	■	☐	
353	Full Load/Speed/Pressure Test	☐	☐	☐	
354	Shop Verification of Unbalanced Response Analysis	■	■	☐	
355	Certf. Copies Of Test Data & Matrls	■	☐	☐	
356	Residual Elect. & Mech. Run Out	■	■	☐	
357	Check Bearings & Seals after Test **(§)**	■	■	☐	
358	Rotor insensitivity test	■	■	☐	**(§) Dis-assemble and Re-assemble after test shall be conducted only when any abnormality is observed during mechanical run test**
359	Dis-assemble & Re-assemble after Test **(§)**	■	■	☐	
360	Gear Unit Tests (Refer Gear Unit Data sheet)	■	☐	☐	
361	**REMARKS:**				
362					
363					

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Notes:

1. Capacity indicated is rated capacity of the compressor i.e. corresponding to 3.5 MMSCMD.
2. Suction Pressure indicated is at the Suction flange of the Compressor. Temporary Strainer shall be in suction line during start-up and same shall be replaced by permanent "T" type strainer subsequently. Pressure drop of 0.1 kg/cm2 has been considered to arrive at the Compressor suction pressure. Bidder shall provide the mesh size and the pressure drop across the permanent strainer in his bid/offer.
3. Discharge pressure indicated is at the compressor discharge flange.
4. Compressor is envisaged to be of SINGLE STAGE. The expected/actual discharge temperatures at the compressor discharge shall be indicated and by the bidder. However, the discharge temperature should not cross 165°C under any circumstances.
5. The design temperature at the compressor discharge shall be confirmed by the bidder.
6. Refer Electrical specifications forming part of inquiry document.
7. Refer site and utility data Doc. No. B240-910-80-42-SU-5010 Rev. A
8. Normal/Emergency gas supply shall be taken from Compressor discharge and the Seal gas supply for start-up shall be taken from upstream of Compressor (before Fuel/Gas conditioning skid inlet) as shown in P&ID No. B240-02-42-910-1111.
9. The composition, avg. MW and dew-point of the normal/emergency seal gas in case of each individual case shall be as indicated in Page 2 of 7 of this datasheet. The Battery-limit (B/L)conditions of normal/emergency seal gas shall be as noted below:

Details	B/L Pressure (kg/cm2G) (§)	B/L Temperature (°C)
Normal Seal Gas	92	55 **(#)**
Emergency Seal Gas	60 to 92 kg/cm2G	55 **(#)**
Start-up Seal Gas	**(@)**	**(@)**

(§) Any pressure-let down (or boosting) device required shall form part of bidder's scope of supply.
(#) The B/L temperature shall not exceed the max. temperature at aftercooler exit as indicated in Page 2 of 6 and 4 of 6 of Compressor datasheet no. B240-910-02-42-DS-1501. Seal gas cooler (Air-cooled type), if required, shall be included in the bidder's scope of supply.
(@) Seal gas for start-up shall be either RLNG or SRG to be used as a fuel for Gas Turbine. For Battery-limit conditions and composition of fuel gas, Note-14 of Process Datasheet no. B240-910-02-42-DS-1501 Rev. 2 may please be referred.
Bidder shall provide necessary filter, electric heater, pressure regulator, control valves etc. for seal gas system. For more details, please refer Job specification.

10. Bidder shall confirm the design pressure and temperature at Compressor suction/discharge. Please also refer P&ID Nos. B240-02-42-910-1113 and B240-02-42-910-1114 wherein the set-pressures of PSVs on suction and discharge KODs have been indicated with HOLDS. Bidder to confirm the same in his bid/offer. Also, during detailed engineering, the Compressor vendor shall furnish Settle-out Pressure calculations and Blow-down calculations for review by the Purchaser.
11. The make and model of bearing temperature monitoring system, vibration and axial displacement monitoring system shall be as per Instrumentation specification forming part of inquiry document.
12. The location of bearing temperature monitoring system, vibration and axial displacement monitoring system shall be as per Instrumentation specification forming part of inquiry document.
13. The flange rating indicated is minimum required. The same shall be confirmed by the bidder in his bid/proposal.
14. The compressor shall be designed to withstand external forces and moments on each nozzles based on 1.85 times NEMA SM-23 values or values calculated as per Annexure 2E of API Std. 617, 7th edition, whichever is higher.
15. Vendor shall furnish all utilities required for the complete package in a consolidated single document.
16. Vendor shall provide the performance curves for all cases of operation.
17. Vendor shall include in his scope of supply all normal instrumentation and control (including anti-surge control)/all essential auxiliaries for efficient operation, shutdown and safety requirements.
18. Apart from the vendors scope of supply as per P&IDs attached in the inquiry document, vendor shall supply additional instrumentation, control & shutdown logic devices for safe and efficient operation of machine.
19. Automatic spill back is considered for compressor.
20. Compressor will start from control panel located in main control room, however, start clearance from field will be provided. Monitoring & control of the compressor station shall be performed from DCS/PLC.
21. **CASE-1:** represents while GANDHAR GPU is running condition (normal operating case).
CASE-2: represents while GANDHAR GPU is stopped condition.
Compressor shall be running under CASE-1 for most of the time.
22. Vendor to provide max. Rate of depressurisation during compressor trip/ESD.
23. Cp/ Cv value is estimated for calculation purpose, Cp/ Cv value shall be confirmed by vendor.
24. Performance Test for Compressor shall be done as per Type 2 ASME PTC- 10-1997 at Compressor Manufacturer's Works.

DATE	REV	JOB ENGINEER	REV & APPROVED BY
16.09.2019	B	AS	JSD/NK
26.06.2019	A	AS	NK

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1	**GENERAL**						
2	Project:	**INSTALLATION OF NEW GTC AT GANDHAR**			Job No.:	**B240**	
3	Owner:	**GAIL (INDIA) LTD**			Site:	**GPU GANDHAR**	
4	Purchaser:				Unit:	**NEW COMPRESSOR AREA**	
5	Item No. :	**910-KT-901**			Duty :	■ Continuous	☐ Intermittent
6	No. of Units :	Working : **ONE**	Standby : **NONE**		Driven Equipment:	**Centrifugal Compressor**	
7	Applicable to:	■ Proposal	☐ Purchase	☐ As Built			
8	■ : Scope, Option & Information specified by Purchaser. ☐ : Information required from and options left to vendor. Vendor to cross (:) the selected option.						
9	Cycle:	☐ Regen	■ Simple	☐ Exhaust Heat recovery (Future)			
10	Type: ☒ Aero-Derivative --or-- ☒ Light industrial --or-- ☒ Heavy industrial			☒ Single Shaft **or** ☒ Two Shaft			
11	Driven Equipment : Normal Shaft Power (kW)	@ RPM	Rated Shaft Power (kW)	@ RPM			
12	Output Shaft Speed Range (RPM)	☐ Min.		☐ Max.			
13	Desired Minimum Site Power (kW)	@ RPM	**(See Note 1 & 2)**				
14	Manufacturer:		☐ Model	☐ ISO Rating			
15	Operation:	☐ Attended	■ Unattended	☐ Potential Max. Power (kW)			

PERFORMANCE(Note-1,2,3)

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
	Gas Turbine Including All Losses		☐ Dry Bulb Temp. ˚C	☐ Relative Humidity (%)	☐ Barometer kg/cm²a	☐ Output @ Turbine Shaft kW	☐ Heat Rate, LHV Kcal/kW-Hr	☐ Output Shaft Speed RPM	☐ Exhaust Flow Kg/Sec	☐ Firing Temp. ˚C	☐ Gas Generator Exhaust Temp. ˚C	☐ Power Turbine Exhaust Temp. ˚C	☐ Certified Point	(1) Incl. ☐ Steam ☐ Water Effects For	☐ Emission Control ☐ Augmentation	☐ Steam Flow Kg/Sec	☐ Water Flow Kg/Sec	
	Site Rated					**(♣)**	**(♣♣)**											
	ISO Rated																	
	Site Max. Temp.																	
	Site Min. Temp.																	

35 **(♣)** - Out Put KW guarantee; **(♣♣)** - Heat rate guarantee;

36	**Location** :			**Noise specifications** :	
37	☐ Indoor	■ Outdoor	■ Grade	■ Applicable to Machine: Max. 85 dBA @ 1m.	
38	☐ Heated	■ Under-roof	☐ Mezzanine	See Job Spec B240-910-80-42-SP-5010	
39	■ Un-heated	■ Partial Sides	☐	☐ Applicable to Neighbourhood: Max. dBA @ m.	
40	■ Elect**. Area Classification: (Ref. Elect. spec.)**			See Specification	
41		Non-Hazardous	Zone/ Gr./ Temp.	■ Acoustic Housing ■ Yes ☐ No	
42	Gas Turbine Area	☐			
43	Gas Turbine Enclosure	☐		**Applicable specifications** :	
44	Control Panel	☐		■ Job Specification No.:B240-910-80-42-SP-5010	
45	☐ Winterization Reqd (2.1.8)	☐ ■ Tropicalization Reqd		■ API Standard 616, 5th edn., EIL Std. Spec. 6-43-0041	
46	☐ Third Party Certification Reqd			■ Vendor having Unit Responsibility : SPRV	
47	**Site data** : (Refer Site & utility data B240-910-80-42-SU-5010)			**Painting** :	
48	☐ Elevation (m):	☐ Barometer (kg/cm²A):		■ Manufacturer's Standard	
49	☐ Range of Ambient Temps. Temp	Dry Bulb	Wet Bulb / Dry Bulb	☐ Other : Ref.Spec.:	
50	Normal (˚C) :			**Shipment** :	
51	Max. (˚C) :			☐ Domestic ■ Export ■ Export Boxing Reqd	
52	Min. (˚C) :			■ Outdoor Storage More than 12 Months	
53	Site Rated(˚C) :			■ Spare Rotor assembly packaged for :	
54	**Unusual conditions** :			☐ Domestic ■ Export Shipment	
55	■ Dust ☐ Fumes			■ Lift Slings & Spreaders by Vendor/ Packager	
56	☐ Corrosive Agents				
57	■ Other : Insulation for Heat conservation and Personnel protection.				
58	REMARKS :				

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59 FUEL SYSTEM

60 Type ■ Gas ☐ Liquid ☐ Dual: ☐ ☐ Gas/ Liquid ☐ Liquid/ Liquid

61 ■ Turbine Starting on: ■ Gas ☐ Liquid ☐ Either of the Fuel

62 ■ Complete Fuel Receiving System ☐ Max. Time Allowed for Complete Transfer Seconds

63 **GAS FUELS Fuel Analysis - Mol%** **LIQUID FUELS Not Applicable**

64

65

66	**Composition**	**MW**	**Normal (Mole %)**
67			**Please refer ANNEXURE-A to this datasheet for details of fuel gas for Gas Turbine**
68	**Air**	28.96	
69	**Oxygen**	32.000	
70	**Nitrogen**	28.016	
71	**Water Vap.**	18.016	
72	**CO**	28.010	
73	**CO_2**	44.010	
74	**Hydrogen**	2.016	
75	**Methane**	16.042	
76	**Ethylene**	28.052	
77	**Ethane**	30.068	
78	**Propylene**	42.078	
79	**Propane**	44.094	
80	**i-Butane**	58.120	
81	**N-Butane**	58.120	
82	**i-Pentane**	72.146	
83	**N-Pentane**	72.146	
84	**Hexane Plus**		
85	**Total**		
86	**Avg.Mol. Wt.**		
87	**HC Dew point˚C @ 30kg/cm2 g**		
88	**Cors.Agts-PPM**		
89	**Contamints-PPM**		
90	**LHV, Kcal/Kg | Kcal/Sm3**		
91	**Supply Pressure . kg/cm2 g**		
92	**Supply Temp. ˚C**		
93	■ **Fuel Press.**		
94	**Req. Mx/Mn. kg/cm2 g**		

Fuel Type:

Liquid Fuel	☐ Yes	☐ No
Treatment	☐ Vendor	☐ Others
Fuel Transfer	☐ Yes	☐ No
Heater Required	☐ Yes	☐ No
☐ Liquid Fuel Press. Regd. Max. / Min. (kg/cm²a): /		
Fuel Storage	☐ Vendor	☐
Fuel Unloading	☐ Vendor	☐
Fuel forwarding	☐ Vendor	☐

FUEL ANALYSIS DATA

PROPERTY	ASTM Method	Measured Value
Viscosity @ 38˚C SSU	D-445	
Sulphur Content (%wt), Max.		
Bomb Method	D-129	
Lamp Method	D-1266	
High Temp. Method	D-1552	
Specific Gravity	D-1298	
Flash Point ˚C	D-56	
Pour Point ˚C	D-97	
Water	D-95	
Filterable Dirt MG/100ml	D-2276	
Lower Heating Value, Kcal/Kg:		

95	Compression System Regd.	☐ Yes	☐ No
96	Compression System by (if regd)	■ Vendor	☐ Purchaser
97	Heater Regd.(Refer elect spec)	■ Yes	☐ No

98 Rate of Change of LHV

99 **Water / Steam Injection:**

100 ☐ Water Pressure Regd.: kg/cm²g

101 ☐ Steam Pressure Regd.: kg/cm²g

102 ☐ Steam Temp. Regd.: ˚C

103 ☐ Water/ Steam Quantity kg/hr

104 ☐ Water/ Steam Quality

105

106 **FUEL SYSTEM PIPING (Also refer Job specification no: B240-910-80-42-SP-5010)**

107	■ Bypass and Vent Valve	■ Isolation Block valves	■ ANSI Flange Rating
108	☐ Twin Y-Type Strainer with cont. Flow Transfer Valve	☐ NACE Material Standards	
109	■Stainless steel fuel piping manifold.		

110

111

112 **REMARKS :**

113

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119 CONSTRUCTION FEATURES (♣♣♣)

120 ■ **Speeds**

121 Max. Continuous : RPM ; Trip : RPM

122 ■ **Lateral Critical Speeds (Damped)**: [As per API 616]

123 First Critical RPM Mode

124 Second Critical RPM Mode

125 Third Critical RPM Mode

126 Fourth Critical RPM Mode

127 ☐ Above Critical Speed Test Proven Yes/ No

128 ■ Train Lateral Analysis Regd. ■ Undamped stiffness map reqd.

129 ■ Train Torsional Analysis Required

130 ☐ **Torsional Critical Speeds**

131 First Critical RPM

132 Second Critical RPM

133 Third Critical RPM

134 Fourth Critical RPM

135 ■ Vibration :

136 Allowable Test Level : Shaft Microns P/P

137 Allowable Test Level : Case mm/ Sec

138 ☐ **Rotation, Viewed From Drive End** :☐ CW ☐ CCW

139 **Air Compressor :**

140 Stages Max. Tip Speed m/Sec

141 Type Pressure Ratio

142 Casing Split ☐ Axial ☐ Radial

143 Rotor ☐ Solid ☐ Built-up

144 **Turbine : GG/ PT**

145 Stages Max. Tip Speed m/Sec

146 Casing Split ■ Axial ☐ Radial

147 Rotor ☐ Solid ☐ Built-up

148 **Combustors :**

149 ☐ Single ☐ Multiple, Number

150 ■ Gas ☐ Liquid ☐ Dual Fuel

151 Max. Allowable Temp. Variation (˚C)

152 Applicable Plane

153 Fuel Nozzles per Combustor

154 ☐ Wobbe Index No. Regd. ☐ Max. ☐ Min.

155

156 **Maintenance Intervals, Hours :**

157 ■ Hot Gas Path Inspections

158 ■ Major Overhauls

159 ☐ Other

160 **Governor :**

161 ■ Mfr's Std. ☐ Other ☐ Make: ☐ Model

162 ☐ Constant Speed ■ Variable Speed

163 ☐ Isochronous ☐ Droop

164 Remote Shutdown Signal ■ Electric

165 ☐ Pneumatic ☐ Hydraulic ☐ None

166 ■ Manual Speed Changer, RPM Max. Min.

167 ☐ Maintain Turbine Speed Upon Failure of Control Signal or Actuator

168 ■ Regulation, NEMA Class : 'D'

169

170

Materials of Construction:

Turbine Stage	Nozzles	Blades	Wheels or Discs
1			
2			
3			
4			

Compressor Rotor Blades

Compressor Stator Vanes

Combustors

Compressor Casing

Combustor Casing

Turbine Casing

Gauge Boards And Control Panels

Gauge Boards

■ Location; GT Compressor skid

Control Consoles ☐ On Skid ☐ Off Skid Local

☐ Off Skid Remote **(Central Control Room)**

Weather Protection Required ■ Yes ☐

☐ Specification

☐ Annunciation Required

☐ Visual Display Unit (VDU) ☐ Key Board

Control Systems (Refer Instrumentation Specifications)

Type Method of Control: Speed variation(Ref.Job. Spec.)

Controlled Process variable : Compressor suction pressure

☐ Mech. ☐ Pneu. ☐ Hydraulic ☐ Electric ☐ Electronic

☐Microprocessor Based ☐ Combined

☐Signal Source: Compressor dis. pressure(Refer Job Spec)

☐ Sensitivity ☐ Range To

☐ Time of AC Outage Protection Min.

☐ Shut Off Valves for Shutdown Sensors

Starting System

☐ Manual ■ Semi Automatic ■ Automatic

☐ Purge Minutes

☐ Provision for Shutdown Valve Test During Operation

171 REMARKS:

172

173 **(♣♣♣)** For Multiple-Shaft Turbine Vendor shall furnish all the information for each shaft.

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179	**CONSTRUCTION FEATURES (Continued) (♣♣♣)**								
180	**Bearings & Bearing Housings(♣♣♣♣)**								
181	**Radial**	**Inlet**	**Exhaust**	**Thrust**	**Active**	**In-active**			
182	☐ Type			☐ Type					
183	☐ Manufacturer			☐ Manufacturer					
184	☐ Length (mm)			☐ Unit Load (Ult.) (Kg/cm²)					
185	☐ Shaft Dia (mm)			☐ Unit Load (Site Rtd) (Kg/cm²)					
186	☐ Unit Load (Actual/Allowable)	/	/	☐ Unit Load (Max. Poten.)					
187	☐ Base Material			☐ No. Of Pads/ Area, m^2	/	/			
188	☐ Babbit Thickness (mm)			☐ Base Material					
189	☐ No. Of Pads			☐ Babbit Thickness, mm					
190	☐ Load Between / On Pads			☐ Pivot: Centre/ Offset, %					
191	☐ Pivot Centre / Offset, %			Lubrication : ☐ Flooded ☐ Directed					
192	☐ Damper Bearing			Thrust Collar : ☐ Integral ☐ Replaceable					
193				Material :					
194	**Bearing temperature devices** : ■ As per API 670 **(Note-5&6)**			**Vibration detectors** : ■ As per API 670 **(Note-5&6)**					
195	☐ Thermocouples			■ Type: Proximity ☐ Model:					
196	☐ Sel. Switch & Indicator By: Purchaser: Manuf.:			☐ Manufacturer:					
197	■ Resistance Temp. Detectors			■ No. at EA Shaft Brg.: Two Total No.:					
198	☐ Resistance Material : ☐ Ohms			■ Oscillator-Demodulators supplied By: Vendor					
199	☐ Sel. Switch & Indicator By: Purchaser: Manuf.:			☐ Mfr.: ☐ Model:					
200	■ Location - Journal Bearing : **(Φ)**			■Monitor Supplied By : **(Note-5&6)**					
201	No.: EA Pad: One Every Other Pad: Per Brg.			☐ Location: Enclosure:					
202	Other:			☐ Mfr.: ☐ Model:					
203	■ Location - Thrust Bearing :**(Ω)**			☐ Scale Range: Alarm; ☐ Set @ :m.					
204	No.: EA Pad: One Every Other Pad: Per Brg.			☐ Shutdown ☐ Set @ :m. ☐ Time Delay Sec.					
205	Other:			**Axial position detectors** : ■ As per API 670 **(Note-5&6)**					
206	No.(Inact): EA Pad: Every Other Pad: Two Per Brg.			■ Type: Proximity ☐ Model:					
207	Other:			☐ Manufacturer: ■ No.Regd.: 2					
208	■ Monitor Supplied By : **(Note-5&6)**			■ Oscillator-Demodulators supplied By: Vendor					
209	☐ Location: Enclosure:			☐ Mfr.: ☐ Model:					
210	☐ Mfr.: ☐ Model:			■Monitor Supplied By : **(Note-5&6)**					
211	☐ Scale Range: Alarm;☐ Set @ ˚C.			☐ Location: Enclosure:					
212	☐ Shutdown ☐ Set @ ˚C.; ☐ Time Delay Sec.			☐Mfr.: ☐ Model:					
213				☐ Scale Range: ☐ Alarm ; ☐ Set @ :m.					
214	**(Φ)** Each journal bearing (tilting pad) shall have			☐ Shutdown ☐ Set @ :m. ☐ Time Delay Sec.					
215	RTD's in no less than 50% of the shoes.			**Acceleration Transducers :** ☐ As per API 670					
216				☐ Mfr.: ☐ Model:					
217	**(Ω)** Each Thrust bearing(tilting pad) shall have RTD's in			☐ Location: Number:					
218	No less than 50% of the active shoes and two in the inactive			☐ Monitor Supplied By :					
219	Side shoes			☐ Location: Enclosure:					
220				☐ Mfr.: ☐ Model:					
221				☐ Scale Range: ☐ Alarm ; ☐ Set @ :m.					
222				☐ Shutdown ☐ Set @ :m. ☐ Time Delay Sec.					
223	**Purchaser's Connections** :								
224	■ Design Approval Regd. ☐ ASME ☐ API605 ☐ Other								
225	**Connection**	**Rating**	**Size**	**Facing**	**Position**	**Flanged Or Studded**	**Mating flange & Gasket by Vendor**	**Gas Velocity (m/s)**	**Remark**
226									
227									
228									
229	Inlet								
230	Exhaust								
231	Fuel Supply								
232	Steam								
233	Water								
234									
235									
236	REMARKS :								
237									
238	**(♣♣♣)** For Multiple-Shaft Turbine Vendor shall furnish all the information for each shaft.								
239	**(♣♣♣♣)For rolling element bearings if proposed please modify entry as required. Show L-10 Bearing life.**								

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ACCESSORIES SUPPLIED BY GAS TURBINE MANUFACTURER

Starting And Helper Drivers (Note-7)

■ Starter Only ☐ Starter / Helper
Type ☐ Motor/ Electrohydraulic ☐ Steam Turbine
☐ Gas Expander ☐ IC Engine ☐ Hydraulic
☐ Gas Turbine ■ Starter is Clutched
☐ Helper Rating, kW
☐ Starter Rating, kW
■ Shaft Turning Device Required

☐ **Motor**
Type Rating kW
Mfr. Model

☐ **Steam Turbine** (See attached API DS)
Mfr. Model
kW Max. Steam Flow, kg/hr
Total / Start, Kg

☐ **Gas Expander** See Appl. Spec. No.:
Mfr. Model
kW Max. Gas Flow, kg/hr
Total / Start, Kg

☐ **Gas for Expansion Turbine**

	Min.	Max.	Normal
Inlet Pressure, kPa			
Exhaust Press., kPa			
Gas Temp.Inlet, ℃			
Gas temp. Exh., ℃			
Molecular Wt.			

Speed Control ☐ Governor ☐ Pressure Regulator

	Yes	No
Inlet Control Valve furnished	☐	☐
Stainless Steel Piping Manifold	☐	☐
Carbon Steel Flanges	☐	☐
Y-Strainer w/breakout Flanges	☐	☐
Low Speed Capability (for compr. cleaning)	☐	☐

Relief Valve Pressure Set Point, kg/cm²g
Casing Material
Seal Type

☐ **Internal Combustion Engine** See Appl. Spec. No.:
Type ☐ Spark Ignited ☐ Diesel
Mfr. Model
Speed, RPM Power, kW

☐ **Combustion Gas Turbine** See Appl. Spec. No.:
Mfr. Model
Speed, RPM Power, kW

☐ **Black Start Capability Required**
☐ Black Start Type:
☐ A.C. Power not Available
☐ C.W. not Available
☐ Instrument Air not Available
☐ D.G. Set regd. to provide complete starting
Elec. power requirements
☐ Black Start on Gas/ Liquid/ Both fuel regd.

☐ Gears See API 613 Data Sheet
☐ Driven Equipment See API Data Shts.
■ Fire Protection Equipment
Type ☐ Clean Agent ■ CO_2 ☐ Others
☐ Type of Sensor ☐ Number of Detectors
☐ Ultra Violet Number
☐ Infra Red Number
☐ Additional Levels

Mounting Plates
Type ☐ Soleplate ■ Baseplate
☐ Shimpack Thickness, mm

Base Plate
■ Furnished By Vendor
☐ Gas Turbine Only ■ Extended for Compr., Gear Unit
☐ Soleplates Required ☐ Drip Rim
☐ Column Mounting ☐ Levelling Pads
■ Decking : Non skid decking
Remark:

Enclosures
■ Enclosures Required
Requirements: ■ Acoustical ☐ Weatherproof
☐ Safety ■ Fire Protection
■ Addl. Ventilation Ducting
■ Ventilation Fan 100% standby Regd.
■ Positive Pressure Ventilation:
■ Gas Turbine ☐ Gear ☐ Elec. Generator
☐ Negative Pressure Ventilation: ☐ Gas Turbine
■ Ventilation Filter
☐ Type: ☐ No. of stages
☐ D.C. Fan Regd.
☐ Others

Couplings And Guards See API-671 data sheet.
☐ Mfr. ■ Type: Metallic Flexible Element.
☐ Model
☐ Max. Outside Diameter, mm
☐ Hub Weight, kg
■ Spacer Length, mm ☐ Spacer Wt., kg
☐ Idling Adapter Regd. ☐ Solo Plate Regd.
■ Guard supplied by Vendor
Type ■ Fully Enclosed ☐ Semi Open ☐ Other
☐ Lubricating Requirements
■ Non Lube ☐ Grease ☐ Cont. Oil lube
Quantity per Hub, kg/m³/hr

Remarks:

Remarks:

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300	**ACCESSORIES SUPPLIED BY GAS TURBINE MANUFACTURER (Contd..)**	
301	**Air Inlet System(Refer Job spec: B240-910-80-42-SP-5010)**	**Exhaust System (Refer Job spec: B240-910-80-42-SP-5010)**
302	■ Air Filter (Refer Job Specifications)	■ Complete Exhaust System with stack/Chimney@min30 m ht
303	■ Complete Air Path Component Material : SS 304 (Internals)	■ Extent of furnished Insulation
304	☐ Internal Type Separator ☐ Media Filters	■ ~~(Relief)~~ (Diversion) Valve
305	☐ Pad Type Pre-filters ☐ Combination	☐ Exhaust Heat Recovery System:
306	☐ Self Cleaning Pulse (Pulse Type)	☐ Emission Control System
307	☐ Single Stage with provision for	■ Exhaust Silencer Plate Element Matl.
308	future Extra Stages ☐ Yes ☐ No	☐ Emissions Sampling System
309	☐ Normal Dust Loading, kg/Nm^3/hr	☐ Expn. Joint Mfr. **Turbine Vendor** Type
310	☐ Wind Design Velocity, km/hr	■ Ducting Gauge / Material: /
311	☐ Snow Load, kg/m^3	☐ Silencer Mfr. Diff. Pr, mm H_2O
312	☐ Seismic Zone	☐ Heat Recovery Device
313	Location ☐ Ground level ■ Elevated (Minimum 5 m)	Mfr. Type Diff.Pr, mm H_2O
314	☐ Filtration Efficiency	Steam Gen. Pr.,kPag Temp., ˚C
315	☐ Maintenance Interval, months	Rate, kg/hr
316	☐ Cleaning Frequency, months/days	■ Manometer Mfr. ☐ Model
317	☐ Implosion Door	Range, mm H_2O
318	☐ Evaporative Cooler ☐ Anti-Icing	☐ Atmospheric Relief Device
319	☐ Liquid to Air Exchanger	Type Mfr. Location
320	☐ Walkway, Ladders, Handrails Reqd.	☐ External diff. Pr. by Others, mm H_2O :
321	■ Compr. Cleaning System, Type	■ System Site Rated Pressure Drop, **100 mm H_2O**
322	■ Silencer Plate Element Material: SS	■ Disch. Flange Orientation:
323	■ Filter Mfr. ☐ Model	☐ Vertical ☐ Side Hzl. ☐ Side at an Angle ☐ Axial
324	100% Rated Air flow diff. Pr.	**Atmospheric Emissions (Note-8)**
325	Clean, mm H_2O Alarm, mm H_2O Changeover	☐ Emission Suppression System Reqd.
326	☐ Cooler Mfr. ☐ Model Diff.Pr, mm H_2O	☐NO_XRequirements:
327	☐ Exchgr. Mfr. ☐ Model Diff.Pr, mm H_2O	☐ NO_X Emitted
328	■ Ducting Gauge / Material: SS	Emissions Reduction Method (if reqd.)
329	☐ Expn. Joint Mfr. ☐ Type	☐ Water Injection ☐ SCR
330	☐ Silencer Mfr. ☐ Model	☐ Steam ☐ Dry Combustor
331	Diff. Pr, mm H_2O :	☐ Other ☐ SO_X Requirements
332	■ Manometer Mfr. ☐ Model	☐ Sulphur Content of Fuel
333	Range, mm H_2O :	☐ SO_X Emitted (Based on stated sulphur content)
334	■ System Site Rated Pressure Drop, 100mm H_2O	☐ CO Requirements ☐ CO Emitted
335	100% Rated Air Flow :	☐ Particulate Requirements:
336	REMARKS :	☐ Unburned HC Requirements ☐ Unburned HC Emitted
337		Applicable Emission Codes or Regulations
338		■ Refer Job Spec. (Rotating Eqpt.) Clause no. 9.7.6
339	**UTILITIES**	
340	■ **Utility conditions** : **Refer spec no: B240-910-80-42-SU-5010**	☐ **Total utility consumption** :
341	**Steam** **Aux. Drivers** **Heating**	Cooling Water : m^3/hr
342	Inlet: Min. /cm²G ˚C. kg/cm²G ˚C.	Steam Normal : Kg/hr
343	Nor. kg/cm²G ˚C. kg/cm²G ˚C.	Steam Maximum : Kg/hr
344	Max. kg/cm²G ˚C. kg/cm²G ˚C.	Instrument Air : Nm^3/hr
345	Exhaust :Min. kg/cm²G ˚C. kg/cm²G ˚C	HP (Aux.Driver) : kW
346	Nor. kg/cm²G ˚C. kg/cm²G ˚C.	HP (Auxiliaries) : kW
347	Max. kg/cm²G ˚C . kg/cm²G ˚C.	Battery Chargers/ Heaters : kW/ kW
348	**Electricity** : ☐ Pilot Light Indication	Purge (Air or N_2) Nm^3/hr
349	Motors Heating Control Shutdown	**Miscellaneous** :
350	Voltage	■ Vendor's Review&Comments on Purch. Piping&Foundation
351	Hertz	☐ Final assembly clearance ☐ Welding hardness testing
352	Phase	☐ Speed –Torque curve ☐ Increase power for Steam / Water
353	**Cooling Water** :	☐ Effect of Amb. Cond. On exhaust flow
354	Temp. Inlet: ˚C. Max. Return: ˚C., Design ˚C	☐ Special Test procedure
355	Press. Norm.: kg/cm²G. Design: kg/cm²G.	☐ Purchaser's review of Comp. / Goodman Diagram
356	Min. Return: kg/cm²G. Max. Allow. ΔP: kg/cm².	☐ Vendor witness alignment
357	Water Source: Fouling Factor :	☐ Technical Data manual
358	**Instrument air** :	■ Recommended straight run of Pipe diameters before suction:
359	Pr.: Max. kg/cm²G, Min. kg/cm²G,Nor. kg/cm²G	☐ Run down curves

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	INSPECTION AND TESTING				LUBRICATION & WEIGHTS			
360								
361	**SHOP INSPECTION & TESTS** :				**Lubrication Systems**: ■ See LO Sdatasht. (B240-910-80-42-DS-1005/1006)			
362		Regd.	Witn.	Obs.	☐ Lube oil Viscosity ISO Grade:			
363	Shop Inspection	■			Common to ☐ Gas Generator/ Single Shaft Turbine			
364	Cleanliness	■			■ Free Power Turbine ☐ Load Gear			
365	Hydrostatic	■	■		■ Driven Eqpt. ☐ Auxiliaries			
366	Mechanical Run	■	■		☐ Combined/ Separate Lube/Seal System			
367	☐ Contract Coupling ☐ Idling Adaptor(s)				☐ System Designed for Synthetic Lubricant			
368	■ Contract Probe ☐ Shop Probes				Lube Specification			
369	Vibration Plots	■			Common to ☐ Gas Generator ☐ Power Turbine			
370	Tape record Vib. Data	■			☐ Load Gear ☐ Driven Eqpt.			
371	Performance Test	■	■		☐ Auxiliaries			
372	PT spin test	☐	☐	☐	■ Oil Requirements	Flow	Pr.	Heat Load
373	Load Gear Test				GG or SS Turbine			
374	Sound Level test	■	■		Driven Equipment			
375	Aux. Equipment Test	■		■	Gear			
376	Post Test Inspection	■	■		Couplings			
377	Hydraulic Coupling Inspection				Power Turbine			
378	Governor Response Test & emergency overspeed trip system	■	■		Total			
379	Spare Parts	■	☐	■	☐ Mounting Arrangement			
380	Fire Protection/Enclosure leak test	■	☐	■	☐ Console ☐ Column ■ Baseplate			
381	Other : PGTR at site	■	■					
382								
383	**Material Inspection Requirements (Refer Job Specification)**				■ **Weights & Dimensions**			
384	☐ Special Charpy Testing					Dry Inst.Wt kg	Shipp. wt,kg	L x W x
385	☐ Radiography Reqd. for:				GG or SS Turbine			
386	☐ Magnetic Particle Reqd. for:				SS Turbine Rotor			
387	☐ Liquid Penatrant Reqd. for:				Power Turbine			
388	☐ Ultrasonic Reqd. for:				P.T. Rotor			
389	☐ Weld Inspection				Lube System			
390	☐ Welding Hardness Testing				Driven Equipment			
391	**Miscellaneous**				Filter			
392	■ Vendor's review & Comments **on Purch. Piping & Foundation**				Inlet Silencer			
393	☐ Final Assembly Clearances				Exhaust Silencer			
394	☐ Coordination Meeting Site				Ducting			
395	■ Speed-Torque Curve							
396	☐ Increase Power for Steam/Water							
397	■ Effects of Ambient Cond. On Exh. Flow				Max. Erection wt. Item No.			
398	☐ Run Down Curves				Max. Maintenance wt. Item No.			
399	☐ Purch. review of Campbell/ Goodman Diag.							
400	■ Vendor Witness Alignment							
401	■ Technical Data Manual							
402	☐ No. of Proposal Copies							
403								
404	**REMARKS :**							
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419	**NOTES:**
420	**1.** Both intake & exhaust losses shall be considered as 100mm WC for GT rating.
421	**2.** The continuous base rating of Gas turbine at the specified site conditions of altitude, intake & exhaust losses, site rated temperature, humidity shall not be less than: **(a). For Case-1**: 110% of maximum compressor power required among all cases/Guarantee case (inclusive of all losses i.e. compressor mechanical losses, Gear-box losses, transmission losses etc.). **(b). For Case-2**: 100% of maximum compressor power required among all cases (inclusive of all losses i.e. compressor mechanical losses, Gear-box losses, transmission losses etc.).
422	**3.** Performance data as per Page nos. 10 to 17 has to be filled-in for each of specified operating case of the Compressor against each specified LHV of fuel gas (RLNG and SRG).
423	**4.** In order to justify the site rating of the proposed Gas Turbine, bidder shall furnish all supporting data, deration curves/charts & calculations.
424	**5.** The make and model of bearing temperature monitoring system, vibration and axial displacement monitoring system shall be as per Instrumentation specification forming part of inquiry document.
425	**6.** The location of bearing temperature monitoring system, vibration and axial displacement monitoring system shall be as per Instrumentation specification forming part of inquiry document.
426	**7.** Please refer Job Spec. Doc. No. B240-910-80-42-SP-5010 for details of Gas Turbine starting system.
427	**8.** No water/steam injection is permissible for emission reduction. Please refer Job specification (Doc. No. B240-910-80-42-SP-5010) for emission requirements.
428	**9.** Vendor shall provide Insulation for heat conservation & personal protection.
429	**10.** Vendor shall supply suitable Fuel Gas conditioning skid based on the specified Fuel Supply conditions.
430	**11.** The offered Gas Turbine shall be equipped with DLE/DLN combustors to control emissions. A write-up with the details of the offered combustion system (with DLE/DLN combustors) shall be submitted with the bid/offer.

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ANNEXURE-A

1. **Primary Fuel for GT:** Re-gasified LNG (RLNG) from 18" Gandhar-Jhanore line.

   Fuel gas properties for RLNG are as below:

Sl. No.	Component	RLNG Gas Composition (in Mol %)	
		Max. LHV	Min. LHV
1.	C1	93.32912	90.74001
2.	C2	5.62274	6.24112
3.	C3	0.27888	1.81558
4.	iC4	0.04775	0.32322
5.	nC4	0.05217	0.47376
6.	iC5	0.00333	0.01843
7.	nC5	0.00086	0.00487
8.	N2	0.66510	0.38304
	Total		
	Molecular Weight		
	Fuel Gas Supply Conditions @ vendor's battery limit		
	Pressure (kg/cm^{2}G)	28-30	
	Temperature (°C)	18-35	
	LHV (kCal/Sm3)	8834	8445
	HC Dew Point (°C)	(-)68.75°C @ 30 kg/cm2G	

NOTE: Selection of Gas Turbine shall be based on Primary source of fuel i.e. RLNG

2. **Secondary Fuel for GT:** Semi-rich gas (SRG) from Compressor inlet common header (same as mentioned for Case-1 & Case-2 in Compressor Datasheet).

   Fuel Gas Properties for SRG are as follows:

Sl. No.	Component	SRG Gas Composition (in Mol %)	
		Case-1	Case-2
1.	Nitrogen	0.23	0.16
2.	Carbondioxide	2.36	2.47
3.	Hydrogen Sulphide	0.00141	0.00141
4.	Methane	90.35	85.73
5.	Ethane	5.93	5.06
6.	Propane	1.06	3.74
7.	N-Butane	0.05	1.79
8.	N-Pentane	----	0.56
9.	Hexane Plus	----	0.48
	Total		
	Molecular Weight		
	Fuel Gas Supply Conditions @ vendor's battery limit		
	Pressure (kg/cm^{2}G)	36-39	25-28
	Temperature (°C)	40-55	15-35
	LHV (kCal/Sm3)	8396.761	9288.321
	HC Dew Point (°C)	(-)103 @ Atm. Pr.	(-)35 @ Atm. Pr.

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PERFORMANCE DATASHEET (CASE-1): *(REFER NOTE-3)*

SL. NO.	DESCRIPTION	UNIT	PERFORMANCE DATA (CASE-1)			
			CASE-1A	CASE-1B	CASE-1C	CASE-1D
1.0	**COMPRESSOR**					
1.1	BKW required at compressor input shaft including all losses (with 0% positive tolerance)	kW				
1.2	Rated Speed	RPM				
2.0	**GEAR UNIT**					
2.1	Gear Unit efficiency	%				
2.2	Gear Unit Rating	kW				
2.3	Input Speed/Output Speed	RPM				
3.0	**GAS TURBINE**					
3.1	Gas Turbine ISO Rating	kW				
3.2	GT Site Rating (See 3.9 Below)	kW				
3.3	Heat Rate at Site Conditions *[While generating BKW at 1.0 above]* GT Heat rate @ Site rated temp.____ °C	kJ/kWh I kcal/kWh				
3.4	GG Rated Speed	RPM				
3.5	PT Rated Speed	RPM				
3.6	GGT Inlet Temperature *[While generating site rated power]*	˚C				
3.7	Expected TBO (Hot Section)	Hrs				
3.8	Expected TBO (Power Turbine)	Hrs				
3.9	**SITE CONDITIONS (Please refer Doc. No. B240-910-80-42-SU-5010)**					
	(i) Site Altitude	m				
	(ii) Max. Inlet Loss (At Site)	mm H_2O				
	(iii) Max. Exhaust Loss (At site)	mm H_2O				
	(iv) Site Rated/peak Temperature	˚C				

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SL. NO.	DESCRIPTION	UNIT	PERFORMANCE DATA (CASE-1)			
			CASE-1A	CASE-1B	CASE-1C	CASE-1D
	(v) Relative Humidity	%				
	(vi) LHV of fuel gas	kcal/kg | kcal/Sm3				
	(vii) HC Dew point	°C @ kg/cm2G				
4.0	**NOISE LEVEL**					
4.1	Overall Compressor package Noise level @ 1 meter from the equipment Train (including compressor, turbine and other aux. Equipment & piping)	dBA				

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PERFORMANCE DATASHEET (CASE-2): *(REFER NOTE-3)*

SL. NO.	DESCRIPTION	UNIT	PERFORMANCE DATA (CASE-2)			
			CASE-2A	CASE-2B	CASE-2C	CASE-2D
1.0	**COMPRESSOR**					
1.3	BKW required at compressor input shaft including all losses (with 0% positive tolerance)	kW				
1.4	Rated Speed	RPM				
2.0	**GEAR UNIT**					
2.4	Gear Unit efficiency	%				
2.5	Gear Unit Rating	kW				
2.6	Input Speed/Output Speed	RPM				
3.0	**GAS TURBINE**					
3.10	Gas Turbine ISO Rating	kW				
3.11	GT Site Rating (See 3.9 Below)	kW				
3.12	Heat Rate at Site Conditions *[While generating BKW at 1.0 above]* GT Heat rate @ Site rated temp.____°C	kJ/kWh I kcal/kWh				
3.13	GG Rated Speed	RPM				
3.14	PT Rated Speed	RPM				
3.15	GGT Inlet Temperature *[While generating site rated power]*	˚C				
3.16	Expected TBO (Hot Section)	Hrs				
3.17	Expected TBO (Power Turbine)	Hrs				
3.18	**SITE CONDITIONS (Please refer Doc. No. B240-910-80-42-SU-5010)**					
	(i) Site Altitude	m				
	(ii) Max. Inlet Loss (At Site)	mm H_2O				
	(iii) Max. Exhaust Loss (At site)	mm H_2O				
	(iv) Site Rated/peak Temperature	˚C				

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SL. NO.	DESCRIPTION	UNIT	PERFORMANCE DATA (CASE-2)			
			CASE-2A	CASE-2B	CASE-2C	CASE-2D
	(v) Relative Humidity	%				
	(vi) LHV of fuel gas	kcal/kg | kcal/Sm3				
	(vii) HC Dew point	°C @ kg/cm2G				
4.0	**NOISE LEVEL**					
4.2	Overall Compressor package Noise level @ 1 meter from the equipment Train (including compressor, turbine and other aux. Equipment & piping)	dBA				

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PERFORMANCE TABLE CASE-1 *(REFER NOTE-3)*							
SL NO	**DESCRIPTION**	**UNITS**	**OPERATING CASE-1 (NORMAL OPERATING CASE)**				**REMARKS**
			ISO	**RATED**	**MAX**	**MIN**	
1	Ambient temperature	°C					
2	Relative humidity	%					
3	LHV of Fuel gas	kcal/kg | kcal/Sm^3					
4	Compressor BKW (including seal losses, transmission losses)	kW					
5	Rated Speed of the Compressor	rpm					
7	Mech. Losses of Gas Turbine (Power to all auxiliaries)	kW					
8	Power Turbine Shaft speed	rpm					
9	Power required on Power Turbine Shaft [= (4) + (7)]	kW					
10	Site efficiency	%					
11	H_R: Heat Rate corresponding to (9)	kJ/kWh kcal/kWh					
12	$W_{max.}$: Max. Power on PT Shaft at corresponding shaft speed Site Elevation = _____ m above MSL Max. Inlet pressure Losses = 100 mm H_2O Max. Exhaust Pressure Losses = 100 mm H_2O & Including all other losses	kW					
13	η_S corresponding to $W_{max.}$	%					
14	H_R corresponding to $W_{max.}$	kJ/kWh kcal/kWh					
15	T_S: PT Exhaust Temperature	°C					
16	GG Exhaust Temp	°C					
17	Firing Temp	°C					
18	Exhaust Flow	kg/sec					
19	Actual Margin available with offered GT [= [{(12) – (9)}/(9)] * 100]	%					

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PERFORMANCE TABLE CASE-2 *(REFER NOTE-3)*							
SL NO	**DESCRIPTION**	**UNITS**	**OPERATING CASE–2**				**REMARKS**
			ISO	**RATED**	**MAX**	**MIN**	
1	Ambient temperature	°C					
2	Relative humidity	%					
3	LHV of Fuel gas	kcal/kg | kcal/Sm^3					
4	Compressor BKW (including seal losses, transmission losses)	kW					
5	Rated Speed of the Compressor	rpm					
7	Mech. Losses of Gas Turbine (Power to all auxiliaries)	kW					
8	Power Turbine Shaft speed	rpm					
9	Power required on Power Turbine Shaft [= (4) + (7)]	kW					
10	Site efficiency	%					
11	H_R: Heat Rate corresponding to (9)	kJ/kWh kcal/kWh					
12	$W_{max.}$: Max. Power on PT Shaft at corresponding shaft speed Site Elevation = _____ m above MSL Max. Inlet pressure Losses = 100 mm H_2O Max. Exhaust Pressure Losses = 100 mm H_2O & Including all other losses	kW					
13	η_S corresponding to $W_{max.}$	%					
14	H_R corresponding to $W_{max.}$	kJ/kWh kcal/kWh					
15	T_S: PT Exhaust Temperature	°C					
16	GG Exhaust Temp	°C					
17	Firing Temp	°C					
18	Exhaust Flow	kg/sec					
19	Actual Margin available with offered GT [= [{(12) – (9)}/(9)] * 100]	%					

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GAS TURBINE EXHAUST GAS EMISSION DATASHEET *(REFER NOTE-3)*

GUARANTEED GASEOUS EMISSION DATA FOR GLC PREDICTION STUDIES										
SL. NO.	DESCRIPTION	UNITS	OPERATING CASE						REMARKS
			CASE-1			CASE-2			
			ISO	RATED	PEAK	ISO	RATED	PEAK	
	Reference Temperature for Gas Turbine	˚C							
1.0	Fuel Gas, Calorific Value	kcal/kg | kcal/Sm^3							
2.0	Fuel Flow Rate	kg/hr							
3.0	Physical Height of exhaust chimney from ground level	meters							Min. 30 metres
4.0	Diameter of exhaust chimney at tip	meters							
5.0	Exit Velocity (Min. / Nor. / Max.)	m/sec							
6.0	Exit Temperature (Min. / Nor. / Max.)	˚C							
7.0	Volumetric Flow of Exhaust Gas (at _____ kg/cm^{2}G & _____ ˚C)	m^3/hr							
8.0	Mass flow rate of Exhaust Gas	kg/hr							
9.0	Avg. Molecular Weight of exhaust gas								
10.0	Composition of Exhaust Gas								
10.1	-CO_2	Vol.% (dry/wet)							
10.2	-N_2	Vol.% (dry/wet)							
10.3	-O_2	Vol.% (dry/wet)							
10.4	-Moisture	Vol. %							
10.5	-SO_2	Wt.% | mg/Nm^3							

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GUARANTEED GASEOUS EMISSION DATA FOR GLC PREDICTION STUDIES										
SL. NO.	DESCRIPTION	UNITS	OPERATING CASE						REMARKS
			CASE-1			CASE-2			
			ISO	RATED	PEAK	ISO	RATED	PEAK	
10.6	-NO_x	Wt.% | mg/Nm^3							
10.7	-CO	Wt.% | mg/Nm^3							
10.8	-HC	Wt.% | mg/Nm^3							
10.9	-Any other composition from GT exhaust ** Component A . . Component B ** Component C	Wt.% | mg/Nm^3							
11.0	Particulate matter : Size Distribution - < 10 : - > 10 :	mg/Nm^3							

DATE	REV	JOB ENGINEER	REV & APPROVED BY
17.09.2019	B	AS	JSD/NK
26.06.2019	A	AS	NK

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1	**GENERAL**												
2	Project:	**INSTALLATION OF GTC AT GANDHAR**					Job No.:	**B240**					
3	Owner:	**GAIL (INDIA) LIMITED**					Site:	**GPU GANDHAR**					
4	Purchaser:						Unit:	**NEW COMPR. AREA**		Unit No.:**910**			
5	Item No.:	**910-GB-901**					Service:	**Gear Unit between Centrifugal Comp. & Gas Turbine**					
6	No. reqd.:	**One**	Working: **One**		Standby: **None**		Driver Type:	**Gas Turbine**		Driven Eqpt. **Cent. Comp.**			
7	Applicable		■ Proposals				☐ Purchase			☐ As Built			
8	■: Scope, Option & Information specified by Purchaser. ☐: Information required from and options left to vendor. Vendor to cross (☒) the selected option.												
9	Manufacturer:						Model:						
10	**■ RATING REQUIREMENTS**						**☐ BASIC GEAR DATA**						
11	Driven Eqpt. Power (kW):		Nor.:		Max.:		Mechanical rating:		kW @		rpm		
12	Driver Power (kW):		Rated:		Max.:		Full load power loss (kW):						
13	Gear rated power (kW):						Mechanical efficiency (%):						
14	Torque @ Max. Cont. Speed (kg-m):						Pitch line velocity (m/s):						
15	Max.		kg-m @		rpm		Tooth pitting index, "K":	Actual:		Allowable:			
16	Rated speed (rpm):						Tangential load, "W_t" (kg):						
17	- Input	☐ Specified	☐ Nominal				Bending stress number S_t "W_t"	Pinion		Gear			
18	- Output	☐ Specified	☐ Nominal				Actual:						
19	Allow variation in gear ratio:	✂					Allowable:						
20	Max continuous speed (rpm):						Material index no.:						
21	Trip speed (rpm):						Anticipated SPL:		dBA @		m		
22	Gear service factor (Min.):	**(1.6 as per API 613)**					Journal static weight loads:						
23	Pinion Hardness:						Pinion:		kg	Gear:		g	
24	Shaft assembly designation:						WR^2 referred to LS shaft (kg-mm²):						
25	- HS shaft rot. Facing coupling end	☐ CW	☐ CCW				Breakaway Torque (kgf-m) @ LS shaft:						
26	- LS shaft rot. Facing coupling end	☐ CW	☐ CCW										
27	HS shaft	☐ Cylindrical	☐ Taper	☐ 1-Key			**☐ CONSTRUCTION FEATURES**						
28	☐ 2-Keys	☐ Hydraulic taper		☐ Integral flange			**Type of Gear**	☐ Reducer	■ Increaser				
29	LS shaft	☐ Cylindrical	☐ Taper	☐ 1-Key				■ Single stage	☐ Double stage				
30	☐ 2-Keys	☐ Hydraulic taper		☐ Integral flange				☐ Single helical	☐ Double helical				
31	External loads:							☐ Epicyclic	☐				
32	Other operating conditions:						**Teeth**						
33	**☐ INSTALLATION DATA**						Number of teeth: Pinion:		Gear:				
34	■ Indoor	☐ Heated	■ Under roof				Gear ratio		Centre Distance (mm):				
35	☐ Outdoor	■ Unheated	■ Partial sides				Pitch Dia: Pinion (mm)		Gear (mm):				
36	■ Grade	☐ Mezzanine	☐				Finish (RA):						
37	☐ Winterisation Required		■ Tropicalization Required				AGMA Geometry factor "J":						
38	Electrical Area Class:		Grp:		Div.:		Pinion:		Gear:				
39	Max. allow. SPL:	**88**	dBA @	**1**	m		Helix angle (˚):						
40	Elevation (m):		Barometer (kg/cm²A):				Normal pressure angle (˚):						
41	Range of ambient temperatures:						Net face width, "Fw" (mm):		Pinion L/D:				
42		Dry Bulb	Wet Bulb				Normal Diametrical Pitch:		Backlash (mm):				
43	Minimum	˚C	˚C				Tooth plating: ☐Recommended	☐ Not Recommended					
44	Normal	˚C	˚C				**MANUFACTURING METHODS**						
45	Maximum	˚C	˚C				Teeth generated by the:		Process				
46	Unusual Conditions	■ Dust	■ Fumes	☐Refinery atm			Teeth finished by the:		Process				
47	**■ ADDITIONAL REQUIREMENTS**						Teeth hardening method:						
48	**MOUNTING PLATES**						Gear to shaft: ☐ Integral	☐ Shrunk-on					
49	■ Gear furnished with:						Rim attachment:						
50	■ Baseplate	☐ Soleplate(s)	☐ Subplate(s)				**☐ RADIAL BEARINGS**						
51	☐ Mounting plate(s) furnished by:							Pinion	Gear				
52	■ Equipment(s) on base plate: **GT, GEAR UNIT & COMPRESSOR**						Type						
53	■ Baseplate with levelling pads:						Diameter mm						
54	■ Baseplate suitable for column mounting:						Length mm						
55	■ Grout type:	■	**Epoxy**				Journal Velocity m/s						
56	■ **PAINTING**:	■ Mfr. Std.	☐				Loading kg/cm²						
57	**APPLICABLE SPECIFICATIONS**						Clearance (min-max) mm						
58	■ API Std. 613 ☐						Span mm						
59	■ Other: **Job spec. B240-910-80-42-SP-5010**												
60													
61													

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62	**MISCELLANEOUS**				**☐ THRUST BEARING(S)**			
63	☐ Undamped critical analysis report:	☐ Yes	☐ No			Pinion	Gear	
64	☐ With damped rotor response analysis report				Location			
65	■ Torsional analysis by	☐ Gear Vendor	■ Other **(Rem.7)**		Manufacturer			
66	☐ Spare set of gear rotors				Type			
67	☐ Gear case furnished with inlet purge connection				Size			
68	☐ Orientation of oil inlet and drain connection				Area mm²			
69					Loading kg/cm²			
70	**■ VIBRATION DETECTORS**				Rating kg/cm²			
71	**Radial:**				Int. thrust load N (✂)			
72	■ Manufacturer **See Remark-3**				Ext. thrust load N (✂)			
73	■ No. at each shaft bearing	**2**	Total No.:	**4**	**■ COUPLING & GUARDS**			
74	■ Oscillator-Demodulators supplied by **Comp. Mfr.**					High Speed	Low Speed	
75	■ Manufacturer **See Remark-3**				Coupling Manufacturer			
76	■ Monitor supplied by **Comp. Vendor**				Coupling Furnished by	**Vendor**	**Vendor**	
77	■ Location **Remark-4** Enclosure				Coupling Type	**(Remark-8)**	**(Remark-8)**	
78	■ Manufacturer **See Remark-3**				Coupling Model			
79	■ Alarm ■ Shutdown				Coupling rating kW/100 rpm			
80	■ Shutdown time delay seconds				Coupling Lubrication	**Non Lube**	**Non Lube**	
81	**Axial:**				Taper mm/m			
82	■ Manufacturer **See Remark-3**		No. reqd.:		Taper guage furnished by			
83	■ Location **Remark-4**				Limited end float	**As Reqd.**	**As Reqd.**	
84	■ Oscillator-Demodulators supplied by				Mount coupling halves	■	■	
85	■ Manufacturer **See Remark-3**				Cplg. gear pitch dia mm	☐	☐	
86	■ Monitor supplied by **Compr. Mfr.**				Cplg. pressure angle (°)	☐	☐	
87	■ Location **Remark-4** Enclosure				Cylindrical / 1-key	☐	☐	
88	■ Manufacturer **See Remark-3**				Cylindrical / 2-keys	☐	☐	
89	■ Alarm ■ Shutdown				Tapered / 1-key			
90	■ Shutdown time delay seconds				Tapered / 2-keys			
91					Tapered / keyless			
92	**Accelerometer:**				**☐ PIPING CONNECTIONS**			
93	Manufacturer No. Required					No.	Size	Type
94	Location				Service			
95	Monitor supplied by				Lube oil inlet			
96					Lube oil outlet			
97	**■ INSTRUMENTS**				Casing drain			
98	■ Other instruments as per DS no. B240-910-80-42-DS-1004				Vent			
99	■ Bearing Temperature Monitoring System **See Remark 3 & 4**				Casing purge			
100	**☐ CONTRACT DATA**							
101	■ Vendor's Representative at site							
102	■ Test data prior to shipment				**■ LUBRICATION REQUIREMENTS**			
103	■ Progress reports				■ Oil System Furnished by **Compr. Vendor**			
104	**■ SHIPMENTS**				☐ Oil Visc.: cP @ 40˚C		cP @ 100˚C	
105		Contract unit	Spares		Min. start-up oil temperature			˚C
106	Export boxing	■	■		Unit oil flow(total)			m³ / hr
107	Domestic boxing	☐	☐		Unit oil pressure			kg/cm²g
108	**Outdoor strg. over 6 months**	■	■		Oil flow, Mesh			m³ / hr
109					Oil flow, HS Bearings			m³ / hr
110	**MATERIALS**				Oil flow, LS Bearings			m³ / hr
111	Gear Casing		Oil Seals		Oil flow, Thrust Bearing(s)			m³ / hr
112	Radial Bearings				**Additional Requirements**			
113	Thrust Bearing(s)				Filter breather location			
114	HS Shaft		LS Shaft					
115	Pinion(s)		Hardness					
116	Gear Rim(s)		Hardness					
117	Low Temp. Operation							
118	REMARKS:							
119								
120								
121								
122								

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	☐ INSPECTION AND TESTS					☐ GEAR DATA			
		Reqd.	Observe	Witness	Test log				
	Shop Inspection	■	■			Power loss each HS bearing			
	Cleanliness inspection	☐	☐	☐		Power loss each LS bearing			
	Hardness verification Insp	■	■	☐	■	Power loss each thrust bearing			
	Dismantle-Reassembly Insp.	■	☐	■				Pinion	Gear
	Contact check	■	■	☐	■	Outside diameter	mm		
	Contact check tape lift (2.5.2.2)	☐	☐	☐	☐	Root Diameter	mm		
	Journal runout check	■	■	☐	■	Center Groove Diameter	mm		
	Axial stability check	☐	☐	☐	☐	Durability Power			
	Rotor balancing machine	☐	☐	☐	☐	Strength Power			
	Sensitivity Check					Face overlap ratio			
	Residual Unbalance Check	☐	☐	☐	☐	Transverse contact ratio			
	Mech. run test	■	☐	■	■	Length line of action	mm		
	Mech. run test (Spare rotors)	☐	☐	☐	☐				
	Add'l mech. Test	☐	☐	☐	☐	☐ WEIGHTS & DIMENSIONS			
	Part or full load and full speed test	☐	☐	☐	☐	Net Weight:			
	Full torque slow roll test	■	☐	■	■	Gear Box: kg Auxiliaries: kg			
	Full torque static test	☐	☐	☐	☐	Max. Maintenance Weight [Identify]: kg			
	Back-to-back locked torque test	☐	☐	☐	☐	Total Shipping Weight: kg			
	Sound level test	■	☐	■	■	Total Shipping Dimensions: L: m W: m H: m			
	Add'l gear tooth test	☐	☐	☐	☐				
	Use shop lube system	■	☐	■					
	Use job lube system	☐	☐	☐					
	Use shop vibration probes, etc.	☐	☐	☐					
	Use job vibration probes, etc.	■	☐	■					
	Other:	☐	☐	☐					
	Final assembly maintenance & running clearance	■	☐	■	☐				
	Oil system cleanliness	■	■	☐					
	Oil system casing joint tightness	■	■	☐					
	Warning and protection devices	☐	☐	☐					

REMARKS:

1. The gear unit rated power shall be, as a minimum, equal to the installed power of the driver i.e. Gas Turbine ISO Rating
2. The oil system for gear unit shall be common with the main equipment i.e. Rich Gas Compressor and Gas turbine (if not separate).
3. The make and model of bearing temperature monitoring system , vibration and axial displacement monitoring system shall be as per Instrumentation specification forming part of inquiry document.
4. The location of bearing temperature monitoring system , vibration and axial displacement monitoring system shall be as per Instrumentation specification forming part of inquiry document.
5. Complete unit test shall be done as per the requirements indicated in the job specs. B240-910-80-42-SP-5010
6. Vendor shall furnish all utilities required for the Gear Unit.
7. The torsional analysis of the complete train comprising of Gas Turbine, gear unit and compressor shall be done by comp. vendor.
8. Coupling type shall be Metallic Flexible Element (Diaphragm / SS Flexible membrane).

26.06.2019	**A**	**AS**	**NK**
Date	**Rev**	**Job Engineer**	**Rev. & Approved By**

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1	**CONTROLS & INSTRUMENTATION SYSTEM FOR GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR**											
2	**Hazardous Electrical Area Classification**			**NEC:**			**Class**		**Div.**		**Group**	
3			**ISO:**				**Zone**			**Gas Group**		
4												
5	**Legends**:											
6	LM: Local Mounted:	☐By Vendor	☐ Others				H : Vendor's Supply and purchaser's remote Mount					
7	LGB: Local Gage Board:	■ By Vendor	☐ Others				M : Mount by Vendor of Purchaser's items					
8	LCP: Local Control Panel:	■ By Vendor	☐ Others				AV : Audio Visual					
9	UCP: Unit Control Panel:	■ By Vendor	☐ Others				C :Cut out for Purchaser's item by vendor					
10	MP : Main Pannel	☐ By Vendor	☐ Others				J :Vendor's supply and Mount on local control station					
11	PLC: Programmable Logic Control:	■ By Vendor	☐ Others				S :Switches vendor's supply and purchaser local mount.					
12	DCS: Distributed Control System:	☐ By Vendor	☐ Others				Vendor to provide A/V (audio/visual) annunciation in LCP					
13	CCR : Central Control Room						For alarms and trips					
14	SRR : Satellite Rack Room						VP : Vendor's Loose Supply and Purchaser's Mount					
15	V : Vendor Supply and Mount						P :Signal / Contacts to be provided by vendor at vendor's					
16							Battery limit (further connection by purchaser)					
17	■Scope option & information supplied by Purchaser											
18	☐Information required from & options left to vendor to cross ☒ the selected option											
19	**REMARKS : 1. Flow element & Transmitter , 2. Standby Pump Start**											
20												
21												
22												

	DESCRIPTION	**Location**					
		Loose Supply	**Locally Mtd.**	**LGB Mtd.**	**LCP/LCS Mtd.**	**CCR / UCP**	**PLC / DCS**
26	**I. GENERAL**						
27	■Start counter					V	
28	■Fired Hours Run Meter					V	
29	- No. Status Counter					V	
30	- Start Sequence Timer					V	
31	■Gas Detection Summary					V	
32	■Fire Detection Summary					V	
33	**II INDICATION LAMPS (STATUS INDICATIONS)**					V	
34	■AC Power On/Off					V	
35	■DC Power On/Off					V	
36	■Control Power On/Off					V	
37	■UPS Power On					V	
38	■Main Lube oil Pumps RUN/STOP (Shaft driven)					V	
39	■Stand-by Lube oil Pumps RUN/STOP (AC Motor driven)					V	
40	■Emergency Lube oil Pump RUN/STOP (D/C Motor driven)					V	
41	■Space Heater On/Off					V	
42	■Lube OIL Heater(if electrical type) On/Off					V	
43	■Ready to Run Light (Plant Ready light)					V	
44	■Preparation Start in progress					V	
45	■LO Shift Sealing System established					V	
46	■Loading valve open					V	
47	■Preparation start complete					V	
48	■Start in progress					V	
49	■Enclosure purged ready to start					V	
50	■Lube Oil system established					V	
51	■Running indication all auxiliaries (Individual)					V	
52	■All auxiliaries healthy					V	
53	■Gas Generator start initiated / Unit running					V	
54	■Started Motor on					V	
55	■Gas Generator Purging					V	
56	■Igniters on					V	
57	■Fuel on					V	
58	■Gas Generator Lit					V	
59	■Starter Motor Disengaged					V	
60	■Power turbine running					V	

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61	DESCRIPTION	Location					
62		Loose Supply	Locally Mtd.	LGB Mtd.	LCP/LCS Mtd.	CCR / UCP	PLC / DCS
63							
64	■Gas Generator above idling				V	V	
65	■Ready to load					V	
66	■Suction pressure control activated					V	
67	■Shutdown in progress					V	
68	■Blow down valve open					V	
69	■By pass valve open					V	
70	■GG Decelerating to idling					V	
71	■Gas Generator Run Down Start Inhibited					V	
72	■Ventilated shutdown				V	V	
73	■Alarm system fault					V	
74	■Valve open / closed indicated for - Shutdown valve on fuel gas supplier - Blow down valve					V	
75	■Dry crank in progress					V	
76	**III. SELECTOR SWITCHES FOR A/M OPERATIONS**						
77	■Master selector switch Compressor control panel/Remote/Crank/Off					V	
78	■Compressor control panel/DCS Control mode selector switch					V	
79	■ Selector Switch Auto/Remote Manual/Local Manual for the following: - Main L.O. Pump - Standby L.O. Pump - Emergency L.O. Pump (D.C. pump) - Control oil/Hydraulic oil pumps (as applicable) - Ventilation Fan					V	
80	■Auto/Manual Selector switch for selection of main and standby pump for each auxiliary					V	
81	■Local/Remote Selector switch for each auxiliary system					V	
82	**IV. PUSH BUTTONS**						
83	■ Start/Stop Push Button For Standby LO Pump (A/C Motor Driven)				V		
84	■ Start/Stop Push Button Emergency Lube oil Pump (D/C Motor Driven)				V		
85	■ Lamp Test Push Button				V	V	
86	■ Alarm/Trip Acknowledge /Reset Push Button				V	V	
87	■ Start/Stop Lube Oil Heater (if electrical type) Push Button				V		
88	■Dry Crank Start/Gas Generator Liquid Wash				V	V	
89	■Manual Gas Generator Start				V		
90	■Shelter Fan Start / Stop				V	V	
91	■Preparation start				V	V	
92	■Auto Sequential Start				V	V	
93	■Normal shutdown				V	V	
94	■Ventilated shutdown				V	V	
95	■Emergency shutdown				V	V	
96	■All auxiliaries Start / Stop				V		
97	**V AMMETERS**						
98	■Ammeters for all auxiliary drive motors(rating >=5.5 kW)	V					
99							

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	CONTROLS AND INSTRUMENTATION															
		Indication					A/V Annun. & Pre-Alalm					Trip & A/V Alarm Annun.				
	DESCRIPTION	Gauge- L M / Local	Gauge- LGB	Indicator -LCP	Indicator – CCR / UCP	Repeat Signal to MCC	Low - LCP	Low – CCR/UCP	High - LCP	High – CCR/UCP	Repeat Signal to MCC	Low Low - LCP	Low Low – UCP / CCR	High High - LCP	High High- UCP / CCR	Repeat Signal to MCC
100	**1.0 COMPRESSOR**															
101	**1.1 PROCESS GAS**															
102	■Compressor Suction Pressure	VP			V			V					V			
103	■Compressor Discharge Pressure)	VP			V					V					V	
104	■Compressor Suction Temperature	VP			V											
105	■Compressor Discharge Temperature	VP			V					V					V	
106	■Pressure Balance line(s) / chamber(s) of compressor	V			V					V						
107	■Differential pressure across inlet strainer (each)	VP			V					V						
108	■Compressor balance line-Differential pressure	V			V											
109	☐Compressor Suction Flow – First (section)															
110	■Compressor Suction Flow – Second (section)	VP[1]			V											
111	☐Compressor Discharge Flow – First (section)	VP[1]			V											
112	☐Compressor Spillback Line Flow –each section	VP[1]			V											
113	☐Compressor Spillback Line pressure –each section	VP			V			V								
114																
115																
116	**1.2 VIBRATION AND AXIAL DISPLACEMENT & BEARING TEMPERATURE MONITORING SYSTEM**															
117	■Radial shaft vibration (at each bearing) **(Note-5)**				V					V					V	
118	■Axial displacement **(Note-6)**				V					V					V	
119	■Key phasor (for each speed change)	V														
120	■Journal bearing metal temp. (Each bearing) **(Note-7,8)**				V					V					V	
121	■Thrust bearing metal temp. (Each bearing) **(Note-7,8)**				V					V					V	
122	■Accelerometer for Casing vibration (X & Y)				V					V					V	
123	■Display unit (For vibration , axial displacement , key phasor , bearing temperature and other diaganostics alarms and trips)															
124	☐Connectivity to purchaser's DCS/PLC for all repeat indications															
125																
126																
127	**1.3 SHAFT SEALING SYSTEM (DRY GAS SEAL)**															
128	■Primary seal gas Supply Pressure (each seal)		V		V			V					V			
129	■Primary seal gas Delivery Pressure (each seal)		V		V			V					V			
130	■Secondary seal gas Supply Pressure (each seal)		V		V			V					V			
131	■Secondary seal gas Delivery Pressure (each seal)		V		V			V					V			
132	■Separation gas Supply Pressure (each seal)		V		V			V					V			
133	■Separation delivery Pressure (each seal)		V		V			V					V			
134	■Seal Gas filters Differential Pressure		V		V					V						
135	■Seal and operating gas differential pressure (each seal)		V		V			V								
136	■Separation Gas and Secondary Vent Differential Pressure (each seal)		V		V			V								
137	■Primary seal vent		V													
138	■Secondary seal vent		V													
139	■Primary Seal Gas Vent flow / Pressure (each seal)	V			V			V		V					V	
140	■Secondary seal gas flow (inlet)	V			V					V						
141																
142																
143	**1.4 ANTI SURGE CONTROLLER (ASC)**															
144	■Compressor Anti surge controller (as per Inst. Specs)				V											
145	■Anti Surge, HIC with position indicator				V											
146	☐Differential Pressure across compressor inlet and outlet – Each stage (section) In Case of ASC)															
147	■All instruments associated with ASC	V														
148	■Anti Surge Control valve	V														
149	☐Emergency Surge Detector (ESD)															
150																
151																

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	CONTROLS AND INSTRUMENTATION															
		Indication					A/V Annun. & Pre-Alalm					Trip & A/V Alarm Annun.				
	DESCRIPTION	Gauge- L M / Local	Gauge- LGB	Indicator -LCP	Indicator – CCR / UCP	Repeat Signal to MCC	Low - LCP	Low – CCR/UCP	High - LCP	High – CCR/UCP	Repeat Signal to MCC	Low Low - LCP	Low Low – UCP / CCR	High High - LCP	High High- UCP / CCR	Repeat Signal to MCC
152	**1.5 PERFORMANCE CONTROLLER**															
153	☐Compressor suction pressure (PIC)															
154																
155																
156	**2. GEAR UNIT**															
157	**2.1 VIBRATION AND AXIAL DISPLACEMENT & BEARING TEMPERATURE MONITORING SYSTEM**															
158	■Radial shaft vibration (at each bearing) **(Note-5)**				V					V					V	
159	■Axial displacement **(Note-6)**				V					V					V	
160	■Key phasor (for each speed change)	V														
161	■Journal bearing metal temp. (Each bearing) **(Note-7,8)**				V					V					V	
162	■Thrust bearing metal temp. (Each bearing) **(Note-7,8)**				V					V					V	
163	■Accelerometer for Casing vibration (X & Y)				V					V					V	
164	■Display unit (For vibration , axial displacement , key phasor, bearing temperature and other diagnostics alarms and trips)															
165	☐Connectivity to purchaser's DCS/PLC for all repeat indications															
166																
167																
168	**3.0 GAS TURBINE**															
169	**3.1 COMBUSTION AIR INLET SYSTEM**															
170	■Inlet Air Filter differential pressure	V			V					V					V	
171																
172																
173	**3.2 TURBINE ENCLOSURE VENTILATION SYSTEM**															
174	■Enclosure Temperature (GG & PT)				V					V					V	
175	■Ventilation system filter Pressure Drop				V					V						
176	■Enclosure Purging differential pressure (GG & PT)				V			V					V			
177	■Enclosure Door unlocked Indicator				V											
178																
179																
180	**3.3 TURBINE START SYSYTEM**															
181	■Fail to Crank												V			
182	■Starting Sequence Incomplete							V					V			
183	■Auxiliary Sequence failure												V			
184																
185																
186	**3.4 GAS FUEL SYSTEM**															
187	■Fuel Supply Temperature (Battery Limit)	V			V			V								
188	■Fuel Supply Pressure (Battery Limit)															
189	■Fuel supply pressure (downstream of conditioning skid)	V			V			V					V			
190	■Fuel supply pressure (downstream of pressure regulator)	V			V			V					V			
191	■Fuel gas filter differential pressure	V								V					V	
192	■Fuel governing valve position feed back															
193	■Fuel System Malfunction							V					V			
194	■Fuel Gas Flow indication Note-2				V											
195	■Fail to Ignite												V			
196	■Flame out												V			
197																
198																
199	**3.5 GAS GENERATOR**															
200	■Air Compressor Inlet Air Temperature				V											
201	■Air Compressor discharge Air Temperature				V					V						
202	■Turbine firing temperature (Inlet to GG)															
203	■GG compressor Discharge Pressure				V											
204	■Speed Indicator				V					V					V	
205	■GG under speed							V					V			

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	CONTROLS AND INSTRUMENTATION															
		Indication					A/V Annun. & Pre-Alalm					Trip & A/V Alarm Annun.				
	DESCRIPTION	Gauge- L M / Local	Gauge- LGB	Indicator -LCP	Indicator – CCR / UCP	Repeat Signal to MCC	Low - LCP	Low – CCR/UCP	High - LCP	High – CCR/UCP	Repeat Signal to MCC	Low Low - LCP	Low Low – UCP / CCR	High High - LCP	High High- UCP / CCR	Repeat Signal to MCC
206	**3.6 POWER TURBINE**															
207	■PT/Inlet temp. / GG Exhaust Temp.															
208	■PT Locked Rotor (Under Speed)							V								
209	■Speed				V					V					V	
210	■Speed Raise / Lower Control (Governor control)				V											
211	■Turbine exhaust temperature (Mean of 8 points minimum)				V					V					V	
212	■Turbine exhaust pressure				V											
213	■Failure Exhaust over-temperature S/D Device (Open Thermocouple Condition)									V					V	
214	■Running at Peak Load									V						
215																
216																
217	NOTE : 1 – Differential temperature protection															
218	NOTE : 2 – Pressure and temperature compensated															
219	NOTE –3 : Only if waste heat recovery unit is provided															
220																
221																
222	**3.7 VIBRATION AND AXIAL DISPLACEMENT & BEARING TEMPERATURE MONITORING SYSTEM**															
223	■Radial shaft vibration (at each bearing) **(Note-5)**				V					V					V	
224	■Axial displacement **(Note-6)**				V					V					V	
225	■Key phasor (for each speed change) **(Note-6)**	V														
226	■Journal bearing metal temp. (Each bearing) **(Note-7,8)**				V					V					V	
227	■Thrust bearing metal temp. (Each bearing) **(Note-7,8)**				V					V					V	
228	■Display unit (For vibration , axial displacement , key phasor , bearing temperature and other diaganostics alarms and trips)															
229	■Connectivity to purchaser's DCS/PLC for all repeat indications															
230	■Accelerometer for Casing vibration (X & Y)				V					V					V	
231																
232																
233	**3.8 FIRE & GAS EXTINGUISHING SYSTEM**															
234	■CO 2 released									V					V	
235	■CO2 leaked off									V						
236																
237																
238	**4. LUBE OIL SYSTEM** (Common for Compressor/Gear unit and Gas Turbine)															
239	■Lube oil reservoir-Oil temp.	V	V													
240	■Lube Oil Reservoir-Oil level	V	V					V					V			
241	■Lube oil Reservoir purge (N2) flow	V			V											
242	■Main Lube Oil pump suction pressure	V						V								
243	■Main Lube Oil pump discharge pressue	V	V					V					V			
244	■Standby Lube Oil pump suction pressure	V						V								
245	■Standby Lube Oil pump discharge pressue	V	V					V					V			
246	■Standby Lube oil pump –Start/Running	V			V					P						
247	■Emergency Lube Oil pump suction pressure	V														
248	■Emergency Lube Oil pump discharge pressure	V	V		V											
249	■LO Cooler - Cooling Water Pressure at inlet	V														
250	■LO Cooler - Cooling Water Pressure at outlet	V	V													
251	■LO Cooler Cooling Water Temperature at inlet	V														
252	■LO Cooler Cooling Water Temperature at outlet	V														
253	■LO Cooler - Oil Temperature at inlet	V														
254	■LO Cooler- Oil Temperature at outlet	V														
255	■Lube oil cooler differential pressure	V														
256	■Lube oil teperature after TIC	V			V					V						
257	■Lube oil filters differential pressure (DP Indicator)	V			V											

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	CONTROLS AND INSTRUMENTATION															
		Indication					A/V Annun. & Pre-Alalm					Trip & A/V Alarm Annun.				
	DESCRIPTION	Gauge- L M / Local	Gauge- LGB	Indicator -LCP	Indicator – CCR / UCP	Repeat Signal to MCC	Low - LCP	Low – CCR/UCP	High - LCP	High – CCR/UCP	Repeat Signal to MCC	Low Low - LCP	Low Low – UCP / CCR	High High - LCP	High High- UCP / CCR	Repeat Signal to MCC
258	■Lube Oil header pressure (each level) (Independent for lube oil to compressor and turbine bearings respectively)	V			V			V					V			
259	■Accumulator (lube & control oil) pre-charge gas pressure	V			V					V						
260	■Lube oil supply Pressure in each line from header				V			V					V			
261	■Lube Oil Temp.at the outlet of each Journal bearing of GTC package	V								V				V		
262	■Sight flow indicator - drains lines from each Journal bearing of compressor	V														
263	■Sight flow indicator - drains lines from each Journal bearing of gear unit	V														
264	■Sight flow indicator - drains lines from each Journal bearing of electric motor	V														
265	■Lube Oil Temp.at the outlet of each Thrust bearing of GTC package	V								V				V		
266	■Sight flow indicator - drains lines from each Thrust bearing of compressor	V														
267	■Sight flow indicator - drains lines from each Thrust bearing of gear unit	V														
268	■Lube Oil rundown tank-Oil level				V				V							
269	■Sight flow indicator-Lube oil rundown tank outlet	V														
270	■Sight flow indicator -Lube Oil circulation lines between filters, coolers to Tank	V														
271																
272																
273	**5. MISCELLANEOUS**															
274	■Unit shutdown		V													
275	■All permissive start switches (connected starting interlock)				V											
276	■Common pre-alarm of all the machine alarms				V											
277	■Common pre-alarm of all the process alarms				V											
278	■Common trip alarm for all machine trips				V											
279	■Common trip alarm for all process trips				V											

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Electric Supply:					
	Lamps	:	V;	AC/DC; □;	Hz.
	Alaram Circuit	:	V;	AC/DC; □;	Hz.
	Trip Circuit	:	V;	AC/DC; □;	Hz.
	Control Circuit	:	V;	AC/DC; □;	Hz.
	Solenoid Valves	:	V;	AC/DC; □;	Hz.

Notes

(1). Pre-Alarms to proceed Trips.

(2). Instruments to be connected to junction boxes on skid and consoles.

(3). All Tubings, pipings, wiring between instruments and junction boxes, local gauge boards and local panels to be supplied by vendor.

(4). Instrumentation, Controls & Annunciation indicated are minimum required. Vendor shall add any additional instruments, which in his view may be required to ensure safe & reliable operation of the machines or additionally required as per API 617/616 and other documents/standards referred in the inquiry document. The above instrumentation and controls shall be discussed upon during detailed engineering (with the successful bidder) with regards to applicability of any indication, alarm or trip.

(5). Journal (Radial) bearings: Two numbers radial vibration probes (non-contacting proximity) per radial bearing.

(6). Thrust bearings: Two numbers axial vibration probes (non-contacting proximity) per thrust bearing (active/inactive side).

(7). Journal (Radial) bearings:
- For tilting pad bearings, each bearing shall have RTD's in no less than 50% of the shoes.
- For sleeve bearings, each bearing shall have two (2) RTD's located at two locations.

(8). Thrust bearing:
- For tilting pad bearings, each bearing shall have RTD's in no less than 50% of active side & 2 in the active side.

(9). Vendor shall also refer to P&ID's enclosed and any additional instruments required as per P&ID's shall be included by vendor in his scope of supply.

(10). All switching devices (hardware/software) for prealarms, trips, trip alarm ,and interlocking shall be in the vendor's scope.

(11). Separate ASC system shall be provided for each compressor stage/section as per the purchaser's specification and P & ID attached elsewhere.

(12). Any additional instruments, indications, control valves, relief valves, alarm and trip switches etc. required for dry gas seal system shall also be included in the vendor's scope of supply and shall be added to the above listing by vendor during detailing and the same shall be subject to approval of the Purchaser/Owner**.**

(13). For further details, instrumentation specifications may please be referred.

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1	**GENERAL**							
2	Project: **INSTALLATION OF GTC AT GANDHAR**				Job No.: **B240**			
3	Owner: **GAIL (INDIA) LIMITED**				Site: **GPU GANDHAR**			
4	Purchaser:				Unit: **NEW COMPR. AREA** Unit No.: **910**			
5	Item No.:				No. of Units: Installed: Spare:			
6	Applicable to: ■ Proposal ☐ Purchase ☐ As Built							
7	■: Scope, Option & Information specified by Purchaser. ☐: Information required from and options left to vendor. Vendor to cross (☐) the selected option.							
8	Gas Seal Module for**: Natural Gas Compressor**				Compressor Item No.: **910-K-901**			
9	Gas Seal Module Supplier: **Refer Job Specs**.				Gas Seal Module Manufacturer:			
10	Gas Seal: Mfr.: **Refer Job Specs**				Model No.: Suppl. by:			
11	■ Separate Modules for each unit				☐ Multiple Package for			
12	**Dry Gas Seal Details:**							
13	■ Dry Gas Seal Type	☐ Single	☐ Double		☐ Tandem	■ **Tandem Dry Gas seal with int. laby. (4A-2)**		
14	☐ Seal Gas Hazardous:	☐ Yes	☐ No		☐ For Seal Gas Composition, refer to: **Rem. 1**			
15	☐ Unidirectional ☐ Bidirectional	☐ Rot. Speed,max.,rpm:			☐ Dir. of Rotn. comptble with compr.	☐ Yes	☐ No	
16	☐ Max. Sealing Pr., kg/cm²g:		☐ Seal Max. Design Pr., kg/cm²g:			☐ Settleout Pr., kg/cm²g:		
17	☐ Eqpt.Suc. Pr.(max/min)Kg/cm²g:		☐ Eqpt. Discharge Temp. ˚C:			☐ R.V. Set Pr., kg/cm²g:		
18	**Vents**				**Leakage: Normal / Static**	**Connected to:**		
19	Primary Vent				/	■ Flare	☐ Safe	
20	Secondary Vent				/	☐ Flare	■ Safe	
21	Secondary Vent for Internal Labyrinth				/	☐ Flare	☐ Safe	
22	**Gas Supply:**				**Filters:**			
23		Primary Supply Gas	Secondary Seal Gas	Separation Gas		Primary Supply Gas	Secondary Seal Gas	Separation Gas
24	Type of Gas	**Compr. Disch.**	**Nitrogen**	**Nitrogen**	Twin Filters	**Yes**	**Yes**	
25	Pressure. kg/cm²g				Filt.Level-nom. :m			
26	Temp. ˚C				Manufaturer			
27	Flow, NM³/hr				Model			
28	**Modules:**				Design Pr., kg/cm²g			
29	Basic Modules:				Test Pr., kg/cm²g			
30	■ Seal Gas Filter Module (Fig. No. **4A-5a**)				Code constr./Stamp	/	/	/
31	■ Separation Gas Filter Module (Fig. No. **4A-5c**)				Matl. Case/ Top	**SS/SS**	**SS/SS**	**SS/SS**
32	■ Differential Pressure Control (Fig. No. **4A-6a**)				Spare Cartridges	4 sets	4 sets	4 sets
33	☐ Flow Control (Fig. No. _____)				**Continuous Flow Transfer Valves:** ■ Yes ☐ No			
34	Outlet Modules:					Primary Supply Gas	Secondary Seal Gas	Separation Gas
35	☐ Flow Monitoring - Diff. Pressure (Fig. No. _____)				Tight Shut off reqd.	**Yes**		
36	☐ Flow Monitoring - Back Pressure (Fig. No. _____)				Manufacturer			
37	☐ Flow Measuring (Fig. No. _____)				Model			
38	Separation Gas Modules: ☐ 4A-9a ☐ 4A-9b ☐ 4A-9c				Rating, kg/cm²g			
39	For Tandem with Internal Labyrinth type:				Matl: Body	**CS**	**CS**	
40	■ Differential Pressure Control (Fig. No. **4A-6a**)				Matl: Plug **or** Ball Ball	**SS**	**SS**	
41	☐ Flow Control (Fig. No. _____)				Matl: Trim	**SS**	**SS**	
42	☐ Material:	☐ Double Blocks & Bleeds						
43	☐ Instrument Test Valves Required				**Piping and Tubing:**			
44	☐ Special Requirements				☐ Tight Shut off Reqd. ☐ C.S. slip on flanges			
45					☐ Through Studs Reqd. ☐ SS Slip-on/Socket Weld/Weldneck Flng			
46					■ Heat Tracing reqd. ☐ By Purchaser ■ By Vendor			
47	**Shop Inspection and Tests: Rem.2**							
48					**Witness**	**Observed**		
49	■ Cleanliness				■	☐		
50	■ Check Controls				■	☐		
51	■ Changeover Filters				■	☐		
52	■ Sound level				☐	■		
53	■ Hydrotest Assembled System				■	☐		
54	☐ Use for Complete Unit System Test (refer compressor datasheet)				☐	☐		
55	■ Material test Certificates				☐	■		
56	■ Certified Copies of all Test Logs and Data				☐	■		
57	Applicable Codes: **API Std. 617 7th Edition & API Std. 614, 4th edition**							
58	**Remarks: 1.** Refer Job Spec. No. B240-910-80-42-SP-5010 and Compressor Datasheet No. B240-910-80-42-DS-1001							
59	2. Other Tests as per API 617, Appendix 1D shall also be conducted(Observed)							

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Date	**Rev**	**Job Engineer**	**Rev. & Approved By**

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1	**GENERAL**									
2	Project:	**INSTALLATION OF NEW GTC AT GANDHAR**			Job No.:	**B240**				
3	Owner:	**GAIL (INDIA) LIMITED**			Site:	**GPU GANDHAR**				
4	Purchaser:				Unit:	**NEW COMPR. AREA**	Unit No.:**910**			
5	Eqpt. item no. for which Oil System is reqd.: **910-K-901**				Service:	**Oil System for Comp. Gear Unit & GT**				
6	Oil System item no.: **910-OS-901**				Mfr. of Oil System:					
7	**No. of Eqpt. for which Oil System is reqd.: Centrifugal Compressor, Gear Unit and Gas Turbine**									
8	Applicable To	■ Proposal		☐ Purchase			☐ As Built			
9	■ Scope Option & Information specified by Purchaser		☐ Information Reqd. from & option left to vendor. Vendor to cross (☒)the selected option.							
10										
11	**APPLICABLE DOCUMENTS**									
12	■ Local Instruments and Panel Items as per				**Instrument Specifications**					
13	■ Instruments Suppliers as per				**Approved Vendor List**					
14	■ Special Purpose Oil System as per				**API Std 614 4th Ed., April 1999**					
15	☐ General Purpose Oil System as per									
16	■ Dry Gas Seal Support Modules/System as per				**API Std 614 4th Ed., April 1999**					
17	■ Additional Documents				**Job Spec.B240-910-80-42-SP-5010 and DS No. B240-910-80-42-DS-1005**					
18	☐ Additional Documents									
19	■ Pumps as per				**API Std. 676 3rd Edn. or API Std. 610 10th edn.**					
20	■ Pump Driver(Motor) as per				**Refer Electrical Specs.**					
21	☐Pump Driver(Turbine) as per									
22	☐ Referenced Standard as per									
23	☐ Additional Documents									
24	☐ Additional Documents									
25										
26	**INSTALLATION DATA(Rem1)**				**Site Data (Rem 1)**					
27	■General site data included in specification				☐ Ambient Condition:					
28	■ Utility data included in specification				☐ Min./Max. Temp.(˚C):					
29	☐ Space available for Oil System (LxWxH),m:				☐ Relative Humidity:					
30	■Max. noise level not to exceed **85** dBA @ 1 meter distance.				☐ Corrosive Atmosphere:					
31	☐ Winterize	■ Tropicalize			**Utility Data (Rem 1)**					
32	■ Area Classification **(Refer Electrical Specs.)**				☐ **Electrical**					
33	☐ Class				Voltage/Hertz/Phase:					
34	☐ Group				☐ **Cooling Water**					
35	☐ Division				☐ Water Source:					
36	☐ Or See				☐ Inlet Temp.(˚C):					
37					☐ Max. Return (˚C):					
38					☐Pressure (Nor./Design),kg/cm²G:					
39					☐ Min. Return(kg/cm²G):					
40					☐ Max.ΔP(kg/cm²G):					
41	**EQUIPMENT OIL REQUIREMENT**									
42		**Normal**		**After Trip**						
43	**Lube Oil:**	**Q:m³/hr**	**P:kg/cm²G**	**Q:m³/hr**	**P:kg/cm²G**	☐ **Steam for Drivers:**				
44	■ Driven Eqpt. **(LP Casing)**						Pressure(kg/cm²G)	Temperature(˚C)		
45	■ Driven Eqpt.**(HP Casing)**					Inlet: Min.				
46	☐ Driven Eqpt.					Inlet: Nor.				
47	■ Prime Mover (Gas Turbine)					Inlet: Max.				
48	■ Gear Unit					Exhaust: Min.				
49	☐ Coupling					Exhaust: Nor.				
50						Exhaust: Max.				
51	■ **Total:**					☐ **Steam for Heating:**				
52	**Control Oil:**						Pressure(kg/cm²G)	Temperature(˚C)		
53	☐ Normal					Inlet: Min.				
54	☐ Transient					Inlet: Nor.				
55	**Seal Oil:**					Inlet: Max.				
56	☐ At:					Exhaust: Min.				
57	☐ At:					Exhaust: Nor.				
58	☐ At:					Exhaust: Max.				
59	☐ **Total**									
60	**Grand Total**									
61										
62										

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63							
64	☐ Oil Type & Viscosity:			**Location:**			
65	☐ Required Heat Load (kW):				■ Indoor	☐ Heated	■ Under roof
66					☐ Outdoor	■ Unheated	■ Grade
67	■ **Preparation for Shipment:**			**Painting:**			
68	■ Install new filter and tag			■ Component supplier standard			
69	■ 2 years operational and maintenance spares.			☐ Unified per system supplier standard			
70	☐ Box extra sets with the system			☐ Purchaser standard per			
71	Other Parts			☐			
72	☐			☐			
73	☐			☐ **Weights(kg):**			
74	System and Components:			Console			
75		Vendor's Standard	Purch. Specification	Panel			
76	☐ Domestic	☐	☐	☐ **Dimensions(LxWxH):**			
77	■ Export	■	☐	Console			
78	■ Extended storage **6** months	■	☐	Panel			
79	Spare Parts:						
80		Vendor's Standard	Purch. Specification				
81	☐ Domestic	☐	☐				
82	■ Export	■	☐				
83	■ Extended storage **6** months	■	☐				
84							
85							
86	**Remarks**						
87							
88	1 .Refer Site & Utility Data Doc. No. B240-910-80-42-SU-5010						
89							
90							
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1	**GENERAL**								
2	Project:	**INSTALLATION OF GTC AT GANDHAR**			Job no. :	**B240**			
3	Owner:	**GAIL (INDIA) LIMITED**			Site:	**GPU GANDHAR**			
4	Purchaser:				Unit:	**NEW COMPR. AREA**	Unit No.:**901**		
5	Eqpt. Item No. for which oil system is reqd.: **910-K-901**				Service:	**Oil System for Comp., Gear unit & GT**			
6	Oil System Item No.: **910-OS-901**				Duty :	Continuous / ~~Intermittent~~			
7	No. of units:	**ONE**	Working: **ONE**	Standby: **NONE**					
8	Applicable to:	■ Proposal	☐ Purchase	☐ As Built					
9	■: Scope, Option & Information specified by Purchaser. ☐: Information required from and options left to vendor. Vendor to cross (☒) the selected option.								
10	Oil system(s) for: **Centrifugal Compressor, Gear Unit and Gas Turbine**								
11	Supplier:		Manufacturer:						

	Overall System Typical Schematics	**Fig. No.**	**Option No.**	**Comments**
12				
13	☐ Combined lube, seal & control oil system			
14	☐ Separate seal-oil system			
15	☐ Seal Module at Equipment			
16	■ Lube / Control System	**2A-8**		
17	■ Basic Oil supply module	**2A-10**		
18	■ Lube Module at Equipment	**2A-11**		
19	☐ Drawing requirements		☐ Component Review	
20	■ Relief Valves to protect low pressure systems	☐ NO	■ YES,	For:

	SUPPLY ARRANGEMENT	**Lube Oil**	**Seal Oil**	**Combined**	**BASIC SYSTEM DETAILS**	
21						
22	■ Separate Console	■	☐	☐	☐ Compressor Block-In time:	Minutes
23	☐ Multiple Package	☐	☐	☐	☐ Equipment Coast-Down time:	Minutes
24	☐ Package No. 1				☐ Equipment Cool-Off time: Driver:	Minutes
25	☐ Package No. 2				☐ Equipment Cool-Off time: Others:	Minutes
26	☐ Package No. 3				☐ Minimum Start-up oil temperature	˚C
27	☐				■ Settling Out Pressures Ref. Comp. DS	kg/cm²g
28	**BASEPLATES:**				☐ Process Relief Valve settings	kg/cm²g
29	☐Point Support	☐ Grout Hole/Vent Holes			☐ Shop Test Conditions	
30	☐ Epoxy Grout/ Precoat				☐ Field Start-up/Run-In Conditions	
31	**COMPONENTS:**				☐ Other Special Conditions	
32	**Piping & Tubing:**				■ Welding & Special Fabrication Requirements	
33	■ Material **SS304/SS316**					☐ 100% Radiography
34	☐ Double Block & Bleeds					☐ Magnetic Particle
35	☐ Tight Shut off					■ Liquid Penetrant
36	☐Tube Fittings Mfr.: Model:				**OIL CONDITIONERS**	
37	■ Slip-on Flanges				☐ Purchaser's Item No.	**910-OC-901**
38	☐ Through Studs required				■ Service Used in	**Lube Oil System**
39	☐ Heat Tracing Reqd. by: ☐ Purchaser ☐ Vendor				■ Type	**Centrifuge**
40	☐ Special Requirements				■ Portable, Or Mounted on	**Portable**
41	■ Utilities manifolded to common connections				☐ Rated flow (m³/hr) of Oil	
42	■ Air				■ Manufacturer	**ALFA LAVAL or eqv.**
43	☐ Cooling Water				☐ Model	
44	☐ Other				■ Driver (Electric Moto) for:	**Main & Standby LOP** / **EOP**
45	☐ Instrument Test Valves required				☐ kW & Enclosure	
46	☐ Valve heads vented to Reservoir				☐ V / Ph. / Hz.	
47					☐ Water Removal Rate	
48					■ Material of Construction	**SS**

	DEGASSING DRUM	**NOT APPLICABLE**		
49				
50	☐ Purchaser's Item No.		☐ Service Used in	
51	☐ As per Fig. No's or Other Specs.		☐ Flow Control	☐Thermostat Control
52	☐ Operating Temperature (˚C)		☐ Material	
53	☐ Flow Rate: Normal | Max. (m³/hr)		☐ Interior Coating	☐ Oversize Vent
54	☐ Normal Retention Time (minutes)		☐ Vent Relief Device	
55	☐ Capacity: Normal | Max. (m³)		☐ Omit Breather	
56	☐ Purge Gas: Type		☐ Code: Constrn.| Stamp	
57	☐ Required Flow (Nm³/hr)		☐ Other	
58	☐ Type Heating Device		☐ Other	
59	☐ Corrosion Allowance		☐ Other	
60	☐ Design / Test Pressure (kg/cm²g)			
61	☐ Other:	☐ Other:		

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62	**RESERVOIR**									
63	Service Application		■ Separate Lube/Ctrl		☐ Lube/Seal Combined		☐ Separate Seal			
64	☐ Purchaser's Item No.									
65	■ Figure No.		**2A-21**							
66	■ Include Options No.		**a, b, c, d, f**							
67	■ Heater: Steam / Electric (S / E)		**Electric**							
68	☐ Heater in Sealed Tube									
69	■ Material		**SS 304**							
70	☐ Normal Flow	m^3/hr								
71	☐ Free Surface	m^2								
72	■ Working Capacity	Minutes/~~Liters~~	**5**							
73	■ Retention Capacity	Minutes/~~Liters~~	**8**							
74	☐ Rundown Capacity	Liters								
75	☐ Normal Operating Range	Liters								
76	☐ Charge Capacity	Liters								
77	☐ Insulation Clips		☐		☐		☐			
78	■ Ladder with Hand-rail		■		☐		☐			
79	☐ Hand-Rails on Top		☐		☐		☐			
80	■ Non-skid Decking		■		☐		☐			
81	☐ Flanged Vent									
82	■ Oversize Flanged Vent		■		☐					
83	☐ Pressure Relief Device: Type & Mtrl.									
84	■ Siphon Breaker		■		☐		☐			
85	☐ Top Mounted Components permitted		☐		☐		☐			
86	☐ Top Mounted Components are									
87	■ Submerged Components and Materials		**None**							
88	Approx. Dimensions (Tank Only): L x W X H (m)									
89										
90	**PUMPS AND DRIVERS**									
91	Service Application		■Lube Oil/Ctrl			☐Lube/Seal Oil		☐ Separate Seal Oil		☐ Boost Seal Oil
92										
93	■ Figure No's:		**2A –19**							
94	■ Including Option No's.		**a, b, c**							
95	☐ Emergency Pump System									
96	**Pump Service**		Main	Stdby	Emerg. **($)**	Main	Stdby	Emerg.	Main	Stdby	Emerg.
97											
98	☐ Pump Item No.										
99	■ Pump Type (Centrifugal/Rotary)										
100	☐ Pump Data Sheet										
101	■ Horiz. or Vertical (H / V)										
102	☐ Driver Item No.										
103	☐ Turbine Driver for										
104	☐ Turbine Data Sheet										
105	■ Electric Motor Driver for		**Yes**	**Yes**	**Yes**						
106	☐ Electric Motor Data Sheet										
107	☐ Other Driver: Emergency AC Motor for										
108	☐ Other Driver: Data Sheet										
109	■ Coupling Type (Flexible Metallic)		**Yes**	**Yes**	**Yes**						
110	☐ Booster Pumps Required										
111	■Autostart		**Yes**	**Yes**	**Yes**						
112	☐ Solenoid Trip Valve										
113	■ Rotary Pump Relief Valve by ~~Purchaser~~/Vendor (P /V)		**V**	**V**	**V**						
114											
115	**($) If recommended by GT manufacturer.**										
116											
117											
118											
119											
120											
121											
122											

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123	**COOLERS:**										
124	Service Application	■ Lube/Ctrl		☐Lube / Seal		☐ Sep. Seal Oil					
125	☐ Purchaser's Item No.										
126	■ Twin Units/Air cooled Oil Cooler with Twin 100% Capacity fans	**2A-17**				☐					
127	■ Include Option No's.	**a, b, c**									
128	☐ Water Side for Steam Heating	☐				☐					
129	☐ Details on Data Sheet										
130	☐ Water Side Corrosion Allowance										
131	☐ Manufacturer										
132	☐ Model										
133	■ Applicable Code/Standard	**API Std. 661 & Job Specs**									
134	☐ Fouling Factor: Water Side | Oil Side (hr m^2°C/kCal)										
135	☐ Heat Duty kcal/hr										
136	☐ Tube: L x OD x BWG.										
137	☐ Design | Test Pressure: Shell Side kg/cm^2g										
138	☐ Design | Test Pressure: Tube Side kg/cm^2g										
139	☐ Code: Construction | Stamp	☐	☐	☐	☐	☐	☐				
140	☐ Tube Water velocity | Capacity: m/s | m^3/hr										
141	☐ Material: Shell										
142	☐ Material: Channel & Covers										
143	☐ Material: Tube Sheets | Tubes										
144	☐ Removable Tube Bundle	☐				☐					
145	☐ U – Bend Tubes permitted	☐		☐		☐					
146	☐Oil Temperature Control Valve	☐		☐		☐					
147	**FILTERS**										
148	Service Application	■ Lube & Control Oil		☐ Separate Control Oil		☐ Separate Seal Oil		☐ Booster Pump Disch. Oil		☐ Separate Coupling Oil	
149											
150	☐ Purchaser's Item No.										
151	■ Twin	■				☐		☐		☐	
152	☐ Second filter for Control Oil	☐				☐		☐		☐	
153	■ Include Option No's.	**2A-17, a**									
154	■ Filtration Level Microns (Nominal)	**10**									
155	☐ Manufacturer										
156	☐ Model										
157	☐ Design | Test Pressure kg/cm^2g										
158	■ Code: Construction | Stamp	■	☐	☐	☐	☐	☐	☐	☐	☐	☐
159	☐ Clean / Fail ΔP kg/cm^2										
160	■ Material: Case & Top	**CS**									
161	☐ Material: Cartridges										
162	☐ Furnish 4 Sets of Extra Cartridges:	☐ Per Service				☐ Per Filter (Extra over other spares)					
163	**CONTINUOUS FLOW TRANSFER VALVES**										
164	Service Application	■ Lube & Control Oil		☐ Separate Control Oil		☐ Separate Seal Oil		☐ Booster Pump Disch. Oil		☐ Separate Coupling Oil	
165											
166	■ Separate or Common for Coolers & Filters	**Separate**		☐		☐		☐		☐	
167	■ Tight Shut-off Reqd.	■		☐		☐		☐		☐	
168	■Type	**Two way-6 Ported**									
169	☐ Manufacturer										
170	☐ Model										
171	☐ With Lifting Jack	☐		☐		☐		☐		☐	
172	☐ Rating: kg/cm^2g										
173	■ Materials: Body	**CS**									
174	■ Materials: Plug or Ball	**SS**									
175	■ Materials: Trim	**SS**									
176											
177											
178											
179											
180											
181											
182											
183											

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184	**ACCUMULATORS**										
185	Service Application	Lube Oil		Control Oil		Seal Oil		Seal Oil Booster			
186	☐ Purchaser's Item No.										
187	■ Required: Yes or No & Quantity	**Yes**		**Yes**							
188	■ Service combined with	**Pump Switch Over**									
189	☐ Direct contact type	☐				☐		☐			
190	■ Bladder Type	**2 A-15**				☐		☐			
191	☐ Include Option No's.										
192	☐ Run-down minutes										
193	☐ Oil Temperature Control	☐				☐		☐			
194	☐ Constant Pressure Regulator	☐				☐		☐			
195	☐ Manufacturer										
196	☐ Model										
197	☐ Nominal | Usable Capacity Liters										
198	■ Material: Shell	**SS**		**SS**							
199	☐ Material: Bladder										
200	☐ Design | Test Pressure kg/cm²g										
201	■ Code: Construction | Stamp	■	☐	■	☐	☐	☐	☐	☐		
202	■ Include: Charge Pressure Gauge plus	■		■		☐		☐			
203	■ Manual Charge Valve or	■		■		☐		☐			
204	■ Gas Supply Regulator	■		■		☐		☐			
205	**OVERHEAD TANKS**										
206	Service Application	Rundown Lube		Low Press. Seal		Med. Press. Seal		High Press. Seal			
207	■ Figure No.	**2A-13 A**									
208	■ Required: Yes or No	**Yes**									
209	☐ Service combined with										
210	☐ Direct Contact Tank	☐		☐		☐		☐			
211	☐ Bladder Type	☐		☐		☐		☐			
212	☐ Include Option No's.										
213	☐ Capacity minutes / Liters										
214	☐ Blowdown Connection										
215	Rundown tanks (Fig. No.)	**2A-13 A**									
216	Overhead tanks (Fig. No.)										
217	☐ Corrosion Allowance										
218	■ Material	**SS**									
219	☐ Total Capacity Liters										
220	☐ Design | Test Pressure kg/cm²g										
221	■ Code: Construction | Stamp	■	☐	☐	☐	☐	☐	☐	☐		
222	**ACCUMULATOR UNITS**	Rundown Lube		Low Press. Seal		Med. Press. Seal		High Press. Seal			
223	☐ Purchaser's Item No.										
224	☐ Corrosion Allowance										
225	☐ Manufacturer & Quantity										
226	☐ Model										
227	☐ Material: Shell										
228	☐ Material: Bladder										
229	☐ Nominal | Usable Capacity Litres										
230	☐ Design | Test Pressure kg/cm²g										
231	☐ Code: Construction | Stamp	☐	☐	☐	☐	☐	☐	☐	☐		
232	**TRAPS FOR INNER SEAL OIL (Oil Seals)**	**NOT APPLICABLE**									
233	☐ Service Application	Low Pressure Seal Oil				Med. Pressure Seal Oil		High Press. Seal Oil			
234	☐ Purchaser's Item No.										
235	☐ Seal - Gas Vent Piping Arrangement										
236	☐ Float Controlled	☐				☐		☐			
237	☐ Transmitter Controlled	☐				☐		☐			
238	☐ Pots only, For Manual Drain	☐				☐		☐			
239	☐ With: Valving	☐				☐		☐			
240	☐ Flush Level Glass	☐				☐		☐			
241	☐ High Level Switch	☐				☐		☐			
242	☐ Include Option No's.										
243	☐ Retention: Hours & Liters										
244											

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245	**FLOAT TRAP**		Low Pressure Seal Oil		Med. Pressure Seal Oil		High Press. Seal Oil	
246	☐ Manufacturer | Model							
247	☐ Pressure Rating kg/cm²g							
248	☐ Material: Body							
249	☐ Material: Float | Trim							
250	☐ Drain Line piped to:							
251	**DRAIN POT**							
252	☐ Corrosion Allowance							
253	☐ Material							
254	☐ Design | Test Pressure Kg/cm²g							
255	☐ Code: Construction | Stamp		☐	☐	☐	☐	☐	☐
256	☐ Drain Line piped to:							
257	**MIST ELIMINATOR**							
258	☐ Corrosion Allowance							
259	☐ Material: Shell							
260	☐ Material: Demister Mesh							
261	☐ Design | Test Pressure kg/cm²g							
262	☐ Code: Construction | Stamp		☐	☐	☐	☐	☐	☐
263	**INSPECTION & TESTING**							
264	**SHOP TESTS:**	Requir	Witnessed		**SHOP INSPECTION:**			
265	■ Cleanliness	■	■		☐ Compliance with Inspector's Checklist			
266	■ Four Hour Run	■	■		■ Required for System Assemblies			
267	■ Check Controls	■	■		■ Cleanliness prior to closure			
268	■ Changeovers: Coolers / Filters	■	■		☐Required for Major Components			
269	■ One & Two Pump Operations	■	■		■ Material Certifications to be furnished			
270	■ Sound Level	■	■		☐ Special Examinations			
271	■ Hydrotest Assembled System	■	■		■ Code Construction / ~~**Stamp**~~ **ASME**			
272	■ Use for Complete Unit System Test	■	■		■ Supply Certified copies of all Test Logs and Data			
273	■ Certf. copies of all test logs & data	■	☐		☐			
274	☐	☐	☐		☐			
275	☐	☐	☐		☐			
276	☐	☐	☐		☐			
277	☐	☐	☐		☐			
278	☐	☐	☐		☐			
279	**REMARKS:**							
280	1. The drivers for Main , Standby and Emergency Lube Oil Pump shall be suitable for auto-start.							
281	2. For instrumentation requirements also refer Datasheet No. B240-910-80-42-DS-1004.							
282								
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26.06.2019	**A**	**AS**	**NK**
DATE	**REV**	**JOB ENGINEER**	**REVIEWED & APPROVED BY**

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1	**GENERAL**														
2	Project:	**INSTALLATION OF NEW GTC AT GANDHAR**							Job No.:	**B240**					
3	Owner:	**GAIL (INDIA) LIMITED**							Site:	**GPU GANDHAR**					
4	Purchaser:								Unit:	**NEW COMPR. AREA**		Unit No: **910**			
5	Item No.:	**910-PA-901A/B**							Service:	**LUBE OIL PUMP FOR NG COMP.**					
6	No. Reqd.: **TWO**		Working: **ONE**		Standby: **ONE**				Parallel Operation Required:	☐ Yes	☐ No				
7	Applicable to	■ Proposal			☐ Purchase				☐ As Built						
8	■ Scope option & Information specified by purchaser ☐ Information Reqd. from & option left to vendor. Vendor to cross ☒ the selected option.														
9	Driver: Working	**E. Motor**	Standby	**E. Motor**	Driver Supplied & Mounted By:	■ Pump Mfr.	☐ Other								
10	**OPERATING CONDITIONS**														
11	Liquid Handled	**Lube Oil**							Capacity (m^3/hr): Min/Nor/Rated:						
12	Pumping Temp. (˚C):	Normal		Max.					Discharge Pressure (kg/cm²,A):						
13	Specific Gravity at P.T./15˚C:								Suction Pressure: Nor./ Max. (kg/cm²,A):						
14	Vapour Pressure at P.T. (kg/cm²,A):								Diff. Pressure (kg/cm²) @ Rated Capacity:						
15	Viscosity at P.T. (cP/~~cst~~):		Corr. /Eros. By:						Diff. Head (m) @ Rated Capacity:						
16	Solids in suspension	☐ Yes ☐ No	Size:		%				NPSH Available (m):						
17	**MANUFACTURERS SPECIFICATIONS**														
18	Pump Manufacturer:								Model No.:						
19	**CONSTRUCTION**								**PERFORMANCE**						
20	Casing Mounting:	■ **Centerline**	☐ Foot	☐ Inline					Proposal Curve No.						
21	Casing Split:	☐ Axial	■ Radial						Visc. Corr. Factor:	C_0		C_Q		C_H	
22	Type:	■ Single Volute	☐ Double Volute	☐ Diffuser					NPSH Reqd. (Water) (m):			F/L Speed (rpm):			
23	Casing Connection:	■ Vent	■ Drain	☐ Gauge					No. of stages:			Efficiency (%):			
24	Nozzles	Size	ANSI Rating	Facing	Position				Rated BKW(0% Tol.):		kW	Max.BKW rtd. Imp.:			
25	Suction		**300#**						BKW @ MCF(Δ=1.0):		kW	Rec. Driver Rating: (kW)			
26	Discharge		**300#**						Max.head rtd imp.(m):			Cap@ BEP(m^3/hr):			
27	Imp. N (mm)	Max:	Rated:	Min:	Type:	**Closed**			MCF (m^3/hr):Stable			Thermal			
28	Brg.: Type/No. Radial:		Thrust:	Lub: **Oil**					M.A.W.P @ 15˚C /P.T./Design Temp.(kg/cm²,G):						
29	Cplg.:Make/Type:		**Flexmetl w spacer**	Nonspark Guard	■ Yes	☐ No			Hydrostatic Test pressure (kg/cm²,G):						
30	Driver Half cplg. mounted by:		■ Pump Mfr.	☐ Others					Rotation facing coupling end:	☐ CW	☐ CCW				
31	Packing Type:		Size:	No. of rings:					Seal flush/ Quench plan:	**11/61**		Material:			
32	Mech. Seal:		Model:	API Code:					Ext. seal flush fluid:			LPM: @	Kg/cm²G/	˚C	
33	Base Plate Drain Rim Type :	■ Yes	☐ No	Fdn. Bolts:	■ Yes	☐ No			Seal Barrier fluid:			LPM: @	Kg/cm²G/	˚C	
34	Throat Bush:	■ Yes	☐ No	Matl.:	Bal. Device:	☐ Yes	☐ No		Ext. quench fluid:			LPM: @	Kg/cm²G/	˚C	
35	Materials (API-610 Matl. Class):	**S-8**	MOC	ASTM Grades					C.W. Plan :			LPM: @	Kg/cm²G/	˚C	
36	I - Cast Iron (Ductile)	Casing	**S**						Weight(kg): Pump+Base+Coupling:				Driver:		
37	B – Bronze	Impeller	**L**						**AUXILIARY PIPING INTERFACE CONNECTIONS**						
38	S - Carbon Steel	Inner Case parts							(All interface conn.shall be termntd.with a flng. block valves)						
39	C - 11-13% Chr. Stl.	Sleeve Packed	**---**							**Size**	**Rating(ANSI)**	**Facing**			
40	h – Hardened	Sleeve Seal	**L**						Lantern Ring Inlet/Outlet						
41	f – Faced	Casing ring	)H-BHN	**Lhf**					Ext. Seal flush fluid Inlet/Outlet						
42	K -SS 304	Impeller ring	50(min)	**Lhf**					Seal Quench fluid Inlet						
43	L -SS 316	Shaft	**X**						Seal pot vent/ drain						
44	X - AISI 410	Throttle Bush							Casing vent/ drain						
45	Y	Throat Bush	**L**						C.W Inlet/ Outlet						
46	Z	Balance Drum							Base plate drain (only flanged)						
47	■ Driver suitable for Pump starting with open Disc. Valve condition.								Casing steam jacket						
48	**INSPECTION & TESTS (EACH PUMP)**														
49		Witness	Observe							Witness	Observe				
50	■ Shop Test / Inspection	☐	☐	■ NPSH As Reqd. ■ Per Spec. ☐ Mandatory						■	☐				
51	■ Material Certificates	☐	☐	■ Dismantle Insp. & Re-assembly after Test						■	☐				
52	■ Hydrostatic	■	☐	■ Unitisation/Dimensional Check						■	☐				
53	■ Performance/Sound Level	■	☐	■ Check for direction of rotation of pump & driver.						■	☐				
54	**Applicable Specification: API Std. 610, 10 th Edition**														
55	**REMARKS:-** 1) Max. allowable casing working pressure shall not be less than _____ kg/cm²g @ ___ ˚C.														
56	2) Down Stream Design Pressure is ____kg/cm²g. Maximum shut-off, considering max suction pressure, including all tolerances shall not exceed this value.														
57	3) Both main & standby pump shall be identical in design, construction, speed,etc.														
58	4) Vendor shall fill in all the data for LOP & submit to EIL approval during detailed engg. stage														
59	5) Mechanical Seal shall be one from the makes as listed in Annexure-A of Job specification.														
60	6) Driver rating shall be suitable for start up & operation of pump at max. viscosity of lube oil(heater out of operation)														
61	7). Driver shall be suitable for autostart.														

NOTE: In case the offered Lube Oil Pump is of Rotary type use sheet 2 of 3 and 3 of 3.

26.06.19	**A**	**AS**	**NK**
Date	**Rev**	**Job Engineer**	**Rev. & Approved By**

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1	**GENERAL**							
2	Project: **INSTALLATION OF NEW GTC AT GANDHAR**				Job no.: **B240**			
3	Owner: **GAIL (INDIA) LIMITED**				Site: **GPU GANDHAR**			
4	Purchaser:				Unit: **NEW COMPR. AREA**		Unit No.:**901**	
5	Item No. **910-PA-901 A/B**				Service **LUBE OIL PUMP FOR RICH GAS COMPRESSOR**			
6	No. Required: **Two** Working: **One**		Stand by:**One**		Driver: Working: **E. MOTOR**		Stand by: **E. MOTOR**	
7	Applicable to	■ Proposals			☐ Purchase		☐As Built	
8	■ Scope Option & Information specified by Purchaser ☐ Information required from & options left to vendor. Vendor to cross [☒] the selected Option							
9	Manufacturer:				Size &Type:		Model:	
10	**OPERATING CONDITIONS (Refer data sheets provided)**							
11	■ Liquid: **Lube Oil**				☐ Rated Capacity at PT (m^3/hr):		(@ Min. viscosity)	
12	☐ Pumping Temperature (˚C) (Max / Min):				☐ Capacity (m^3/hr): (@ Max. viscosity)			
13	☐ Specific Gravity at PT:				☐ Discharge Pressure (kg/cm², a) (Rated):			
14	☐Vapour Pressure at PT (kg/cm², a):				☐ Suction Pressure (kg/cm², a) (Rated):			
15	☐ Viscosity at PT (Cp/Cst) (Min / Max):				☐ Differential Pressure (kg/cm², a):			
16	☐ Corrosion Erosion caused by:				☐ NPSH available (m):			
17	☐ Presence of Solids:				☐ Jacketing / Tracing Required	☐ Steam	☐ Electric	
18								
19	**SITE / INSTALLATION / UTILITY DATA (Rem 4)**							
20	Location: ■ Indoor	☐ Outdoor w/w/o roof			☐ Heated	■ Unheated		
21	Site Temperature (˚C):	Max:	Min:		☐ Elect. Area Hazard:	Div:	Class:	Group:
22	☐ Available Steam Pr. (kg/cm²g):		Min:		Nor:	Max:		
23		Temperature (˚C)	Min:		Nor:	Max:		
24								
25								
26	**APPLICABLE CODES & STANDARDS**							
27	**APPLICABLE CODES & STANDARDS: API STANDARD 676, 3rd edition**							
28	**PERFORMANCE**							
29	☐ Rated Capacity (m^3/hr)	@ min. viscosity:			☐ Direction of Rotation from Coupling End	☐ CW	☐ CCW	
30	☐ Pump (rpm)	@ max. viscosity:			☐ Relief Valve Set Pressure (kg/cm², g):			
31	☐ NPSH Required (m):				☐ Relief Valve Acc. Pressure (kg/cm², g):			
32	☐ Rated speed (rpm):				☐ BKW @ Max Viscosity (kW):			
33	☐ Displacement (m^3/hr):				☐ BKW @ Relief Valve Setting (kW):			
34	☐ Volumetric efficiency (%):				☐ BKW at accumulation Pr.:			
35	☐ Mechanical Efficiency (%):				☐ Motor Rating (kW):			
36	☐ Overall Efficiency (%):				☐ Allowable Speed (rpm)	Max:	Min:	
37								
38								
39	**CONSTRUCTON FEATURES**							
40	**Nozzles**	**Size**	**Rating/Facing**	**Position**	**Nozzles**	**Size**		
41	Suction				Jacket Inlet			
42	Discharge				Jacket Outlet			
43	Vent				C.W Supply			
44	Drain				C.W Return			
45	Gland / Flush				Steam Quenching			
46	**PUMP TYPE:**	■ Gear	OR	■ Screw	☐ Sliding Vane			
47	☐ External Gear	☐ Internal Gear			Gear Type	☐ Spur Gear	☐ Helical Gear	
48	☐ Twin Screw	☐ Triple Screw	☐ Progressive Cavity					
49	Rotor Mount:	■ Between Brg.	☐ Overhung		☐ Packing:		☐No. Of Rings:	
50	■ Relief Valve: ☐ Built In	■ Ext.			Steam Jacketing:	☐ Casing	☐ Stuffing Box	☐ None
51	☐ Timing Gears: ☐ Yes	☐ No			■ Mechanical Seals:			
52	☐ **Bearing (Make/Model):**				☐ Manufacturer and Model:			
53	☐ **Lubrication Type for Bearing:**				☐ Mech. Seal API Code:	■ API 610 Seal Flush Plan:		
54	☐ Pumped Fluid	☐ Ring Oil	☐ Oil Mist		Piping for Seal Flush & Quench furnished by:			
55	☐ External	☐ Oil Flood	☐ Grease		■ Pump Vendor	☐ Others		
56	☐ Maximum Allowable Working Pressure (kg/cm², g):				☐ Piping for Cooling / Heating furnished by:			
57	☐ Hydrostatic Test Pressure (kg/cm², g):				☐ Pump Vendor	☐ Others		
58	☐ Steam Jacket Design Pressure (kg/cm², g):							
59								
60								
61								
62								

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63	**MATERIALS**					
64	■ Stator Body / Casing: **CS**			■ Sleeve(s): SS316		
65	☐ Stator Liner / Insert:			■ Bearing Housing: **CS OR CI**		
66	☐ End Plates:			☐ Timing Gears:		
67	■ Rotor(s): **Nitrided Steel or SS**			■ Mounting / Base Plate: **MS**		
68	☐ Vanes:			☐ Discharge Piping:		
69	☐ Shaft:			☐ Gland(s):		
70	☐ Packing: Mech. Seal Faces: **C Vs. WC**			■ Relief Valve: Body: **CS** Trim: **SS316**		
71						
72						
73	**INSPECTION & TESTING**					
74	**Description**	**Required**	**Witnessed**	**Description**	**Required**	**Witnessed**
75	Shop Inspection	■	☐	Performance Test	■	■
76	Material Certificates	■	☐	NPSH Test	■	■
77	Hydrostatic test (Casing & Jacket)	■	■	R.V Set Functional Test	■	■
78	Rotor Dyn. Balancing (Observed)	■	☐	Dismantle Inspection	■	■
79	Mechanical Run	■	■			
80						
81						
82	**DRIVER**					
83	■ Type of Driver:	■ Elec. Motor		☐ Steam Turbine ☐ Other:		
84	■Driver Supplied & mounted by Pump Manufacturer			☐ Driver Supplied and mounted by other		
85	☐ Driver kW:			☐ Speed (rpm):		
86						
87						
88	**DRIVE MECHANISM**					
89	■ Direct Coupled ☐ V- Belt ☐ Variable Speed ☐ Gear ☐ Gear Make:					
90	☐ Coupling Make: ☐ Coupling Type: ☐ Coupling Guard (Non-sparking type)					
91						
92						
93						
94	■ By Pump Manufacturer ■ Common Base plate for pump driver, auxiliaries					
95	■ Drain rim type ☐ Drip tray type ☐ Overall Size (lxbxh) (mm):					
96						
97						
98	**WEIGHT**					
99	☐ Pump only (kg): ☐ Driver (kg): ☐ Gear Box (kg):					
100	☐ Base plate (kg): ☐ Misc. (kg): ☐ Total Weight (kg):					
101						
102	**REMARKS:**					
103	1). Equipment Manufacturer to supply his standard design with respect to pump sealing.					
104	2). Pump casing design pressure shall not be less than kg/cm² @ ˚C.					
105	3). Mechanical Seal shall be one from the makes as listed in Annexure-A of Job specification.					
106	4). Refer Site & Utility data Doc. No. B240-910-80-42-SU-5010					
107	5). Driver rating shall be suitable for start up& operation of pump at max. viscosity of lube oil(heater out of operation)					
108	6). Both main &standby pump shall be identical in design, construction ,speed etc.					
109	7). Driver shall be suitable for autostart.					
110						
111						
112	***NOTE: In case the offered Lube Oil Pump is of Centrifugal type use sheet 1of 3.***					
113						
114						
115						

26.06.19	**A**	**AS**	**NK**
Date	**Rev**	**Job Engineer**	**Rev. & Approved By**

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1	**GENERAL**										
2	Project:	**INSTALLATION OF GTC AT GANDHAR**				Job	**B240**				
3	Owner:	**GAIL (INDIA) LIMITED**				Site:	**GPU GANDHAR**				
4	Purchaser:					Unit:	**NEW COMPR. AREA**		Unit No.:	**910**	
5	Item No.:					Service	**Lube Oil Cooler for GTC Package**				
6	No. Reqd:		Working:		Standby:						
7	Applicable to:		■ Proposal		☐ Purchase		☐ As Built				
8	■: Scope, Option & Information specified by Purchaser. ☐: Information required from and options left to vendor. Vendor to cross ☒ the selected option.										
9	Manufacturer:					Type:	☐ Forced Draft	☐ Induced Draft			
10	Bundle Size:	m x m x m	Bundles/Section			Number of Units:					
11	Bundles/Unit:		In Parallel / Series			Section Size:					
12	Surface/Bundle:	m²	Bare Tube:	m²		Section/Unit:					
13	Surface/Unit:	m²	Bare Tube:	m²		Plot Area/Unit:					
14	**PERFORMANCE (Of One Unit)**										
15	Heat Exchanged:	kcal/hr				MTD (Corrected):	˚C				
16	Transfer Rate:	kcal/hr m² ˚C				(Finned Surface)	(Bare Surface)				
17	**TUBE SIDE**										
18	Fluid Circulated					Gravity: Liquid	API SG @ 15.4˚C				
19	Total Entering Fluid	Kg/hr				Viscosity: In/Out/Avg.	cP				
20	Vapour	Kg/hr				Mol. Weight: Vapours					
21	Liquid	Kg/hr				Enthalpy / Latent Heat	Kcal/kg				
22	Steam	Kg/hr				Specific Heat	Kcal/kg ˚C				
23	Non-Condensable	Kg/hr				Conductivity	Kcal/hr m² ˚C				
24	Vapour Condensed	Kg/hr				Velocity	M/sec				
25	Steam Condensed	Kg/hr				Pressure Drop	Kg/cm²	All.:	Calc.:		
26	Operating Temperature	˚C	In:	Out:		Fouling Resistance	Hr m² ˚C /kcal				
27	Operating Pressure	Kg/cm²				Passes / Bundle					
28	**AIR SIDE**										
29	Temperature	˚C	In:	Out:		Altitude	m				
30	Total Flow/Unit	kg/hr				Static Pressure	kg/cm²				
31	Quantity/Fan	kg/hr				Power/Fan	kW				
32	Face Velocity	m/sec				Power/Unit	kW				
33	**CONSTRUCTION (Each Bundle)**										
34	Design Pressure:	kg/cm²g	Test Pressure:	kg/cm²g		Design Temperature:	˚C				
35	Code Requirements:										
36	**Tube**	Type of Tubing:		Tube Material:			Fin Material:				
37		Bare Tubes (no's):	No. of rows:		O.D.	BWG/Thk	Length	Pitch:) ☐ ①			
38		Fins: Spacing	/inch.		O.D.	Root Dia	Thickness:				
39	**Header**	Type: Plug / Cover	No. of Splits:			Material:	Corr. All.: mm				
40		Plugs/Gaskets				Side Frame:					
41		**Nozzles**	In:		**Couplings**	Vent:					
42			Out:			Drain:					
43	**CONSTRUCTION (Each section)**										
44	Structure		Sec./Gr. No.		Design Wind Load:	kgf/m					
45	Plenum Chamber				Type:						
46	Fans	No.	Dia.		RPM	Mfr.					
47	Blades	Material:			No./Fan	Pitch Angle(Design):					
48	Hubs	Material:			Pitch:	Autovariable / Adjustable (No.)					
49	Drivers	No.:	Type:			Mfr.					
50		kW (Each):	RPM:		Volts:	Cycles:	Phase:				
51	Coupling	No.:	Type:			Mfr.					
52	Speed Reducers	No.:	Type:		Mfr.						
53		Reduction Ratio:			Service Rating:						
54	Louvers	Material:	Type:			Mfr.					
55	Weights kg	Each Section (Dry):			Full of Water						
56		Each Bundle (Dry):			Full of Water						
57	**APPLICABLE SPECIFICATIONS: API Standard 661**										
58	**REMARKS: (1) Coolers to be Sized for 10% higher flows and Duty. (2). Bidder to furnish this datasheet duly filled-in.**										
59	**(2). Cooler shall be provided with 100% spare capacity fans.**										

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Date	**Rev**	**Job Engineer**	**Rev. & Approved By**

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1	**GENERAL**													
2	Project:	**INSTALLATION OF GTC AT GANDHAR**						Job No.:	**B240**					
3	Owner:	**GAIL (INDIA) LIMITED**						Site:	**GPU, GANDHAR**					
4	Purchaser:							Unit:	**NEW COMPR. AREA**			Unit No.:	**910**	
5	Item No.:	**910-CP-LS-101**						Service:	**Cent. Comp. thru' Gear unit & Gas Turbine**					
6	No. of Units:	**One**	Working:	**One**	Standby:	**None**								
7	Applicable to:		■ Proposal		☐ Purchase			☐ As Built						
8	■: Scope, Option & Information specified by Purchaser. ☐: Information required from and options left to vendor. Vendor to cross (:) the selected option.													
9	■ Driver:	Type:	**Gas Turbine**				Manufacturer:				Model:			
10		Nameplate Power (kW):					Service Factor:		S.No.:		Tag No.:			
11	■Driven Unit:	**Gear Unit**					Manufacturer:				Model:			
12		Serial No.:								Tag No.				
13	Coupling Type: ■	**Metallic Flex. Element (Diaphragm)**		☐ Gear		☐ Quill Shaft		☐ Other:						
14	☐ Manufacturer:			Model:		Size:		Assy. Dwg. No.:						
15														
16	☐ **CONDITIONS CONSIDERED FOR COUPLING SELECTION**				☐ **RATINGS**									
17	Conditions	Torque (kgf-m)	@ rpm			Torque (kgf-m)	@ rpm	Serv. Factor						
18	Normal				Normal									
19	Driven Rated Load				Peak									
20	Maximum Steady State				Momentary									
21	Maximum Transient				Shaft Juncture (Driving)									
22	Trip Condition				Shaft Juncture (Driven)									
23	Continuous Cyclic													
24	Other:													
25	☐ Frequency of Transients (Events/Time):				☐ Non-synchronous exciting frequency:									
26	■ Coupling Minimum Required Service Factor, SF: **1.5 (Rem-3)**				☐ Actual SF									
27	■ Ambient Temperature (˚C): **(Rem-2)**	Maximum:			Minimum:									
28	Environment:	☐ Hyd. Chloride	☐ Hyd. Sulphide	■ Other:**Dust, Fumes & Refinery Atmosphere**										
29	**LUBRICATION**													
30	☐ Continuous	☐ Batch	☐ Non-Lubricated	☐ Viscosity:		cP @								
31	☐ Filtration Microns:			☐ Pressure (kg/cm²g)		☐ Temp. (˚C):								
32				☐ Flow (m^3/hr)										
33	**COUPLING DATA**													
34	☐ Shaft Separation (including thermal growth) (mm B.S.E):													
35	@ Ambient Temp.:		@ Normal Operation:		@ Maximum Transient:									
36	☐ Motor Rotor Float (mm):		☐ Limited End Float (mm):											
37	☐ Marine Type Required		☐ Flex-Hub Type Required		☐ Electrically Insulated									
38	☐ Required Misalignment Capability:													
39	Steady State:	Angular (˚):	Parallel Offset (mm):		Axial (mm):									
40	Transient:	Angular (˚):	Parallel Offset (mm):		Axial (mm):									
41	☐ Maximum Allowable Misalignment:													
42	Steady State:	Angular (˚):	Parallel Offset (mm):		Axial (mm):									
43	Transient:	Angular (˚):	Parallel Offset (mm):		Axial (mm):									
44	☐Component Balance	☐ Component Balance & Assembly Check Balance			☐ Component Balance with Assy. Balance									
45	☐ Residual Unbalance Check of Assembled Couplings				☐ Balance Repeatability Check									
46	☐ Max. Allowable Residual Unbalance g-mm	Driver End:			Driven End:									
47	☐ Max. Actual Residual Unbalance g-mm	Driver End:			Driven End:									
48	☐ Torsional Stiffness (kg-mm/Rad):													
49	☐ WR² (kg-m²):	Driver End:			Driven End:									
50	☐ Spacer Lateral Natural Frequency:	☐ Torque Capacity of Hub/Shaft Interface for keyless fits (kgf-m):												
51	**Flexible-Element Coupling:**													
52	☐ Initial Deflection (mm):		☐ Pre-Stretch	☐ Compression	☐ Max. Axial Deflection (mm):									
53	☐ Calculated Axial Natural Frequency:				☐ Test of ANF:	☐ Actual ANF:								
54	☐ Maximum Enclosure Temperature at Max. Continuous speed (˚C):													
55	REMARKS:													
56	1. Coupling shall be of non-lubricated diaphragm type/SS flexible membrane type with spacer.													
57	2. Refer site & Utility Data enclosed elsewhere.													
58	3. Service factor shall be over the driver rating. However, coupling service factor shall not be higher than Gear-unit service factor.													
59														
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63	**MATERIALS**					
64	Component	Drive End Materials		Driven End Materials		
65	Hub / Flange					
66	Spacer					
67	Sleeve					
68	Flexible-Element					
69	Flexible-Element Guard					
70	Bolts					
71	Nuts					
72	■ Protective Coating:	■ Vendor Standard		☐ Other:		
73	☐ Internal Teeth Hardness: Rockwell C	Drive End Actual:		Driven End Actual:		
74	☐ External Teeth Hardness: Rockwell C	Drive End Actual:		Driven End Actual:		
75	**COUPLING HUB MACHINING**					
76				Drive End	Driven End	
77	☐ Type (Integral / Cylindrical / Taper)					
78	■ Keyed or Hydraulically Fitted					
79	☐ Taper					
80	☐ Keyway Dimensions and Number					
81	☐ Nominal Bore Diameter (mm)					
82	☐ Interference Fit (mm): Max. | Min.			|	|	
83	■ Puller Holes					
84	■ Trim Balance Holes					
85	**COUPLING GUARD**					
86	■ Co-ordinator: **Compressor Vendor**			☐ Purge Gas:	☐ Dry Air Purge:	
87	■ Flanged Cylindrical:	☐ Base Mount:		☐ Purge Connection Size & Type:		
88	☐ Air Tight:	☐ Oil Tight:		☐ Purge m^3/hr Required:		
89	■ Spark Resistant			☐ Oil Mist Cooling	☐ Gas Cooling	
90	☐ Transparent Window for Each Oil Spray Point:			■ Contract Guard to be used during Shop Test		
91	☐ Vent Connection:			☐ Additional Guard Details:		
92	☐ 1 inch NPT with Filter Breather					
93	☐ 1 inch Flanged, Rating & Facing:					
94	**ACCESSORIES**					
95	■ Prime Eqpt. supplier to furnish one set of Plug & Ring Gauges (Appe. D)			■ Hydraulic Installation/Removal Tooling (To include Hand		
96	☐ Lapping Tools			Pump(s), Pressure Gauge(s), Fittings & Hose(s)) By:		
97	☐ Drill Template for Internal Flanged Hubs by:			■ Coupling Manufacturer	☐ Purchaser	
98	☐ Coupling Manufacturer	☐ Purchaser		■ Puller By Coupling Manufacturer		
99	☐ Two-Piece Stop Rings by Coupling Manufacturer			☐ Moment Simulator	☐ Solo Plate	

100	**APPLICABLE SPECIFICATIONS**	**PREPARATION FOR SHIPMENT**				
101	■ API Std. 671 3rd edition, October 1998	■ Outdoor Storage for more than 12 months				
102	■ Others: **Special Purpose Couplings,3rd edition**	☐ Expected Storage Time (Months):				
103	☐	■ Shipping	☐ Domestic	■ Storage	☐ Indoor	
104	☐ Coordination Meeting Attendance Required		■ Export		■ Outdoor	
105	REMARKS:					
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26.06.2019	**A**	**AS**	**NK**
Date	**Rev**	**Job Engineer**	**Rev. & Approved By**

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1	**GENERAL**													
2	Project:	**INSTALLATION OF GTC AT GANDHAR**						Job No.:	**B240**					
3	Owner:	**GAIL (INDIA) LIMITED**						Site:	**GPU GANDHAR**					
4	Purchaser:							Unit:	**NEW COMPR. AREA**			Unit No.:	**910**	
5	Item No.:	**910-CP-HS-101**						Service:	**Cent. Comp. thru' Gear unit & Gas Turbine**					
6	No. of Units:	**One**	Working:	**One**	Standby:	**None**								
7	Applicable to:		■ Proposal		☐ Purchase			☐ As Built						
8	■: Scope, Option & Information specified by Purchaser. ☐: Information required from and options left to vendor. Vendor to cross (:) the selected option.													
9	■ Driver:	Type:	**Gear Unit**				Manufacturer:				Model:			
10		Nameplate Power (kW):					Service Factor:		S.No.:		Tag No.:			
11	■Driven Unit:	**Compressor**					Manufacturer:				Model:			
12		Serial No.:								Tag No.				
13	Coupling Type: ■	**Metallic Flex. Element (Diaphragm)**		☐ Gear		☐ Quill Shaft		☐ Other:						
14	☐ Manufacturer:			Model:		Size:		Assy. Dwg. No.:						
15														
16	☐ **CONDITIONS CONSIDERED FOR COUPLING SELECTION**				☐ **RATINGS**									
17	Conditions	Torque (kgf-m)	@ rpm			Torque (kgf-m)	@ rpm	Serv. Factor						
18	Normal				Normal									
19	Driven Rated Load				Peak									
20	Maximum Steady State				Momentary									
21	Maximum Transient				Shaft Juncture (Driving)									
22	Trip Condition				Shaft Juncture (Driven)									
23	Continuous Cyclic													
24	Other:													
25	☐ Frequency of Transients (Events/Time):				☐ Non-synchronous exciting frequency:									
26	■ Coupling Minimum Required Service Factor, SF: **1.5 (Rem-3)**				☐ Actual SF									
27	■ Ambient Temperature (℃): **(Rem-2)**	Maximum:			Minimum:									
28	Environment:	☐ Hyd. Chloride	☐ Hyd. Sulphide	■ Other:**Dust, Fumes & Refinery Atmosphere**										
29	**LUBRICATION**													
30	☐ Continuous	☐ Batch	☐ Non-Lubricated	☐ Viscosity:		cP @								
31	☐ Filtration Microns:			☐ Pressure (kg/cm²g)		☐ Temp. (˚C):								
32				☐ Flow (m^3/hr)										
33	**COUPLING DATA**													
34	☐ Shaft Separation (including thermal growth) (mm B.S.E):													
35	@ Ambient Temp.:		@ Normal Operation:		@ Maximum Transient:									
36	☐ Motor Rotor Float (mm):		☐ Limited End Float (mm):											
37	☐ Marine Type Required		☐ Flex-Hub Type Required		☐ Electrically Insulated									
38	☐ Required Misalignment Capability:													
39	Steady State:	Angular (˚):	Parallel Offset (mm):		Axial (mm):									
40	Transient:	Angular (˚):	Parallel Offset (mm):		Axial (mm):									
41	☐ Maximum Allowable Misalignment:													
42	Steady State:	Angular (˚):	Parallel Offset (mm):		Axial (mm):									
43	Transient:	Angular (˚):	Parallel Offset (mm):		Axial (mm):									
44	☐Component Balance	☐ Component Balance & Assembly Check Balance			☐ Component Balance with Assy. Balance									
45	☐ Residual Unbalance Check of Assembled Couplings				☐ Balance Repeatability Check									
46	☐ Max. Allowable Residual Unbalance g-mm	Driver End:			Driven End:									
47	☐ Max. Actual Residual Unbalance g-mm	Driver End:			Driven End:									
48	☐ Torsional Stiffness (kg-mm/Rad):													
49	☐ WR² (kg-m²):	Driver End:			Driven End:									
50	☐ Spacer Lateral Natural Frequency:			☐ Torque Capacity of Hub/Shaft Interface for keyless fits (kgf-m):										
51	**Flexible-Element Coupling:**													
52	☐ Initial Deflection (mm):		☐ Pre-Stretch	☐ Compression	☐ Max. Axial Deflection (mm):									
53	☐ Calculated Axial Natural Frequency:				☐ Test of ANF:		☐ Actual ANF:							
54	☐ Maximum Enclosure Temperature at Max. Continuous speed (˚C):													
55	REMARKS:													
56	1.Coupling shall be of non-lubricated diaphragm type/SS flexible membrane type with spacer.													
57	2.Refer site & Utility Data enclosed elsewhere.													
58	3. Service factor shall be over the driver rating. However, coupling service factor shall not be higher than Gear-unit service factor.													
59														
60														
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62														

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63	**MATERIALS**					
64	Component	Drive End Materials		Driven End Materials		
65	Hub / Flange					
66	Spacer					
67	Sleeve					
68	Flexible-Element					
69	Flexible-Element Guard					
70	Bolts					
71	Nuts					
72	■ Protective Coating:		■ Vendor Standard	☐ Other:		
73	☐ Internal Teeth Hardness: Rockwell C		Drive End Actual:	Driven End Actual:		
74	☐ External Teeth Hardness: Rockwell C		Drive End Actual:	Driven End Actual:		
75	**COUPLING HUB MACHINING**					
76				Drive End	Driven End	
77	☐ Type (Integral / Cylindrical / Taper)					
78	■ Keyed or Hydraulically Fitted					
79	☐ Taper					
80	☐ Keyway Dimensions and Number					
81	☐ Nominal Bore Diameter (mm)					
82	☐ Interference Fit (mm): Max. | Min.			|	|	
83	■ Puller Holes					
84	■ Trim Balance Holes					
85	**COUPLING GUARD**					
86	■ Co-ordinator: **Compressor Vendor**			☐ Purge Gas:	☐ Dry Air Purge:	
87	■ Flanged Cylindrical:	☐ Base Mount:		☐ Purge Connection Size & Type:		
88	☐ Air Tight:	☐ Oil Tight:		☐ Purge m^3/hr Required:		
89	■ Spark Resistant			☐ Oil Mist Cooling	☐ Gas Cooling	
90	☐ Transparent Window for Each Oil Spray Point:			■ Contract Guard to be used during Shop Test		
91	☐ Vent Connection:			☐ Additional Guard Details:		
92		☐ 1 inch NPT with Filter Breather				
93		☐ 1 inch Flanged, Rating & Facing:				
94	**ACCESSORIES**					
95	■ Prime Eqpt. supplier to furnish one set of Plug & Ring Gauges (Appe. D)			■ Hydraulic Installation/Removal Tooling (To include Hand		
96	☐ Lapping Tools			Pump(s), Pressure Gauge(s), Fittings & Hose(s)) By:		
97	☐ Drill Template for Internal Flanged Hubs by:			■ Coupling Manufacturer	☐ Purchaser	
98		☐ Coupling Manufacturer	☐ Purchaser	■ Puller By Coupling Manufacturer		
99	☐ Two-Piece Stop Rings by Coupling Manufacturer			☐ Moment Simulator	☐ Solo Plate	

100	**APPLICABLE SPECIFICATIONS**	**PREPARATION FOR SHIPMENT**				
101	■ API Std. 671 3rd edition, October 1998	■ Outdoor Storage for more than 12 months				
102	■ Others: **Special Purpose Couplings,3rd edition**	☐ Expected Storage Time (Months):				
103	☐	■ Shipping	☐ Domestic	■ Storage	☐ Indoor	
104	☐ Coordination Meeting Attendance Required		■ Export		■ Outdoor	
105	REMARKS:					
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26.06.2019	**A**	**AS**	**NK**
Date	**Rev**	**Job Engineer**	**Rev. & Approved By**

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NOTES TO BIDDERS:

1. Prototype model/ model series shall not be considered.
2. It is mandatory that all references furnished for model/ model series should have similar parameters and in similar service.

DESCRIPTION OF MODEL DESIGNATION SYSTEM: _____

S. NO.	PARAMETER	INFORMATION ON PROPOSED MODEL	INFORMATION ON REFERRED EXISTING INSTALLATIONS		
			Ref.- 1	Ref.-2	Remarks
1.	2.	3.	4.	5.	6.
1	**GENERAL**				
1.1	Make/ Model Number	----			
1.2	Type of Driver / Driver Rating (kW)				
1.3	Rated Speed (rpm)				
1.4	Driven Machine(CF Pumps/Reciprocating Pumps etrc.)				
1.5	Shop where Gear Box is designed, manufactured and tested with location and address				
2	**GEAR BOX DETAILS**				
2.1	Codes / Standards followed (API-613/API-677/ Others)	**API 613**			
2.2	Gear Box Rating (kW)				
2.3	Speed / Maximum continuous speed (input/output) (rpm)				
2.4	AGMA / API S.F.				
2.5	Pitch Circle Diameter (Pinion / Gear)(mm)/ Pitch line velocity(m/sec.)	**Min. 2.0**			
2.6	Gear Ratio/ No. of stages/ Bearing Span				

Place:
Date:

[Signature of Authorized Signatory]*

Name:
Designation:

[To be submitted in original, along with bid]

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S. NO.	PARAMETER	INFORMATION ON PROPOSED MODEL	INFORMATION ON REFERRED EXISTING INSTALLATIONS		
			Ref.- 1	Ref.-2	Remarks
1.	2.	3.	4.	5.	6.
2.7	Center to Center distance between high speed & low speed shafts(mm)				
2.8	Tooth profile / Type & No. of Bearings (Radial)				
2.9	Type of Gears : Single helical / Double helical / Herringbone				
2.10	Type & No. of Bearings (Radial/ Thrust)- Gear/Pinion shaft				
2.11	**MATERIAL OF CONSTRUCTION :**				
2.12	Casing /Pinion/ Gear/ Shaft /Bearings				
3	**OTHER INFORMATION ON INSTALLATIONS**				
3.1	Date of supply				
3.2	Purchaser's Name, Address, Contact No. & email ID				

Place:
Date:

[Signature of Authorized Signatory]*

Name:
Designation:

[To be submitted in original, along with bid]

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VENDOR DATA REQUIREMENTS
FOR
GAS TURBINE DRIVEN CENTRIFUGAL
COMPRESSOR PACKAGE

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
A	27-JUN-2019	Issued with MR	AS	NK	NK

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VENDOR DATA REQUIREMENTS

The following drawings/documents marked "✔" shall be furnished by the bidder.

CENTRIFUGAL COMPRESSOR (GT DRIVEN)

S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Cross Sectional Drawings (with Bill of Materials & Part No's) for Centrifugal Compressor & its rotor assembly	✔	✔		✔	*MANDATORILY REQUIRED with bid to prove that offered Compressor is not with Modular rotor design*
2.	General Arrangement Drawings (certified dimensional outline drawing) for Coupling for compressor train ans auxilliary pumps	✔		✔	✔	*Required with bid for information*
3.	Cross Sectional Drawings (with Bill of Materials & Part No's) for Journal and thrust bearing assembly for compressor and gear box (as applicable)	✔		✔	✔	*Required with bid for information*
4.	Cross Sectional Drawings (with Bill of Materials & Part No's) for LOP, EOP & CEP along with their seal assembly & Gas turbines (as applicable)			✔	✔	
5.	Gas turbine datasheet, its performance curves and deration curves (for altitude, ambient conditions, RH, inlet/exhaust losses etc.) Following min. GT curves shall be provided. Turbine efficiency Vs rate Speed & rated power MAP. Rated Power Vs. % rated speed curve. Rated Power Vs Ambient temperature curve. Rated Heat rate Vs Ambient temperature curve. Power Vs Humidity. Power Vs. Altitude. Rated Heat Rate, rated power, rated temperature	✔	✔		✔	
6.	Data Sheets alongwith performance curves for Auxiliary Pumps like LOP, EOP and their respective drivers		✔		✔	
7.	Data Sheets alongwith performance curves for Fuel gas booster compressor (as applicable)		✔		✔	
8.	Piping & Instrumentation diagrams (P&IDs) for Gas turbine and its associated on-skid auxiliary system		✔		✔	*Required with bid for information*
9.	Piping & Instrumentation diagrams (P&IDs) for Off-skid fuel gas system including fuel treatment and fuel control system	✔	✔		✔	*Required with bid for information*
10.	Piping & Instrumentation diagrams (P&IDs) for Fire detection and suppression system	✔	✔		✔	*Required with bid for information*
11.	Piping & Instrumentation diagrams (P&IDs) for Gas turbine enclosure ventilation system	✔		✔	✔	*Required with bid for information*
12.	Piping & Instrumentation diagrams (P&IDs) for Gas Turbine exhaust system	✔	✔		✔	*Required with bid for information*

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S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
13.	Piping & Instrumentation diagrams (P&IDs) for Utility Distribution System within package battery-limit (N2, instrument air, buffer gas etc.)	✔	✔		✔	*Required with bid for information*
14.	Piping & Instrumentation diagrams (P&IDs) for Bearing Temp. & Vibration monitoring System	✔	✔		✔	*Required with bid for information*
15.	Piping & Instrumentation diagrams (P&IDs) for Compressor wash water/ wash oil injection system (as applicable)	✔	✔		✔	*Required with bid for information*
16.	General Arrangement Drawings (certified dimensional outline drawing) for Gas Turbine	✔		✔	✔	*Required with bid for information*
17.	General Arrangement Drawings (certified dimensional outline drawing) for Compressor Sealing System/Dry Gas Seal module and Wash water/ wash oil injection system			✔	✔	
18.	General Arrangement Drawings (certified dimensional outline drawing) for Fuel gas conditioning skid, fuel gas booster skid (as applicable), fire suppression system skid, GT air inlet filter system, GT exhaust system, LCP etc.			✔	✔	
19.	General Arrangement Drawings (certified dimensional outline drawing) for LO System (if off-skid of GT)			✔	✔	
20.	General Arrangement Drawings (certified dimensional outline drawing) for Loose supply piping items (like strainer, flow element, ASV, QCNRV, PSVs etc.) in vendor's scope, to be installed in purchaser's piping			✔	✔	
21.	Cross Sectional Drawings (with Bill of Materials & Part No's) for Gas Turbine & its rotor assembly			✔	✔	
22.	Cross Sectional Drawings (with Bill of Materials & Part No's) for Compressor end seals/ Dry Gas Seal (as applicable)			✔	✔	
23.	Mechanical Run Test procedure for Centrifugal Compressor, Gear Box (as applicable) and Gas Turbine		✔		✔	@
24.	Performance Test procedure for Centrifugal Compressor and Gas turbine		✔		✔	@
25.	General Arrangement showing compressor, drive transmission system (as applicable) & Gas Turbine driver including all assosciated auxiliary systems [like sealing system, lube oil system, local control panel, injection panels (as applicable) and rundown tank etc.] along with interface connections/ terminal point details including their location coordinates, maintenance space, erection & maintenance weights, capacity & hook height of maintenance crane etc.	✔	✔		✔	*Required with bid for information*

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S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
26.	Foundation drawing of compressor train [i.e. for compressor, drive transmission system (as applicable) & Gas Turbine driver] including details of load points location and their details, foundation load data (static & dynamic), foundation bolts, their location, foundation bolt pocket dimensions and recommended type of grout, grout thickness, make, grade and quantity.	✔	✔		✔	*Required with bid for information*
27.	Drawing for underground points indicating the required undergroud drain points in the compressor house			✔	✔	
28.	Allowable forces and moments at compressor suction and discharge nozzles.			✔	✔	
29.	Allowable thermal movements compressor suction and discharge nozzles.			✔	✔	
30.	Utility consumption data including electric load data.	✔	✔		✔	*Required with bid for information*
31.	Schedule of lubricants, chemicals & consumables with their specifications.	✔		✔	✔	*Required with bid for information*
32.	List of Purchaser's interface points with their connection details	✔		✔	✔	*Required with bid for information*
33.	Centrifugal Compressor datasheet alongwith performance curves. Following min. Compressor Curves shall be provided Discharge Pressure Vs Inlet Capacity. BKW Vs Inlet Capacity. Polytropic Head Vs Inlet capacity. Polytropic efficiency Vs Inlet capacity with performance. Curves for various speeds viz. Minimum speed in steps of 10% till 90% of speed & thereafter in steps of 5% till 105% of speed. Pressure ratio Vs Inlet capacity. Discharge Temperature Vs. Inlet capacity. Minimum and Maximum Speed for Compressor.	✔	✔		✔	
34.	Data Sheets for Gear box (as applicable).	✔	✔		✔	*Required with bid for information*
35.	Data Sheets for Coupling for compressor train		✔		✔	
36.	Data Sheets for Lube oil system and LO Cooler			✔	✔	
37.	Data Sheets for Dry Gas Seal (as applicable)		✔		✔	
38.	P&ID for Process Gas System including Anti Surge Control & Process controls	✔	✔		✔	*Required with bid for information*
39.	P&ID for Compressor shaft Sealing System/Dry gas sealing system	✔	✔		✔	*Required with bid for information*
40.	Compressor shaft seal performance test procedure		✔		✔	
41.	Complete Unit test Procedure (as applicable)		✔		✔	@
42.	Lateral Analysis Reports of Compressor, Gear Box (as applicable) and Electric motor drive			✔	✔	
43.	Train Torsional & Lateral Analysis Report (as applicable)			✔	✔	

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S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
44.	Cause & effect diagram			✔	✔	
45.	Control Narrative			✔	✔	
46.	Installation, Operation & Maintenance manuals for complete compressor package			✔	✔	
47.	Precommissioning & commissioning procedure for complete compressor package			✔	✔	
48.	List of Mandatory Spares (indicating exact name of the part, part no. and material of construction)	✔	✔		✔	
49.	Quotation for recommended spare parts for two years of normal operation (indicating exact name of the part, part no. and material of construction)	✔		✔		
50.	List of recommended commissioning spares (indicating exact name of the part, part no. and material of construction)	✔		✔	✔	
51.	List of recommended Special Tools & Tackles (indicating exact name of the part and part no.)	✔		✔	✔	
52.	List of Deviations to specifications/datasheets/standards of MR	✔				
53.	Filled in experience record proforma for main equipment and its driver	✔		✔		
54.	Signed and stamped check list scope of supply (as applicable)	✔		✔		
55.	List of loose supply items in vendor's scope, to be installed in purchaser's piping			✔	✔	
56.	P&ID for Lube Oil System	✔	✔		✔	*Required with bid for information*
57.	Test Procedure(s) : Witness tests as specified in data sheets / other specs enclosed in the inquiry / MR or as required by approved ITP/QAP			✔	✔	@
58.	Foundation drawing of auxiliaries to be installed at grade or at mezzanine floor such as lube oil console, dry gas sealing system, governing console (as applicable), Local control panel, injection panels (as applicable), run down tank, lube oil and control oil accumulators etc.	✔	✔		✔	*Required with bid for information*
59.	General Arrangement Drawings (certified dimensional outline drawing) for Centrifugal Compressor	✔		✔	✔	*Required with bid for information*
60.	Cross Sectional Drawings (with Bill of Materials & Part No's) for Gear box (as applicable)			✔	✔	
61.	P&ID for Gas Turbine Combustion air intake system	✔	✔			*Required with bid for information*
62.	P&ID for Gas Turbine starting system	✔	✔			*Required with bid for information*
63.	P&ID for skid drain/vent system (Compressor and Gas Turbine)	✔	✔			*Required with bid for information*
64.	General Arrangement drawing of Lube-Oil system/skid and overhead LO tank			✔		
65.	General arrangement drawing of auxilliary pumps i.e. Lube-Oil Pumps, Emergency pumps etc.			✔		

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S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
66.	Equipment layout showing main as well as all associated equipment/skids (compressor, gear box, driver, L.O. console, Dry gas module, GT exhaust, L.O. Cooler, Maintenance platform, Maintenance space, walkways, local guage board, overhead tanks etc.) with interface piping connection, maintenance space, cable trays etc.	✔	✔			*Required with bid for information*
67.	Foundation layout showing foundation details of main as well as all associated equipment/skids (compressor, gear box, gas turbine driver, L.O. Cooler, Air filtration unit, GT exhaust stack, L.O. console, overhead tanks, etc.)	✔	✔			*Required with bid for information*
68.	Thermal & Mechanical design calculations for Air-Coolers (LO cooler)			✔		
69.	Procedure for Performance Test Guarantee Run at site		✔			

Notes :

1. "TICK" denotes applicability.
2. Post order, drawing / document review shall commence only after approval of Document Control Index (DCI).
3. All post order documents shall be submitted / approved through EIL eDMS portal.
4. Final documentation shall be submitted in hard copy (Six prints) and soft (two CDs/DVDs) in addition to submission through EIL eDMS.
5. Refer - 6-78-0001: Specification for quality management system from Bidders.
6. Refer - 6-78-0003: Specification for documentation requirement from Suppliers.
7. All drawings & documents shall be submitted in A4 or A3 paper sizes. Documents in higher paper size shall be submitted in exceptional circumstances or as indicated in the MR/Tender.
8. Post order- The schedule of drawing / data submission shall be mutually agreed between EIL & the bidder / contractor / supplier during finalization of Document Control Index (DCI).
9. "@" indicates submission of documents to Inspection Agency.
10. Bill of Material shall form part of the respective drawing.
11. Also refer other department's VDR :-
12. Electrical
13. Instrumentation
14. Rotating Equipment
15. Piping
16. Structures

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COMPRESSOR
PROCESS DATA SHEET

Document No. B240-910-02-42-DS-1501
Rev. No. 3

PROJECT	INSTALLATION OF GTC AT GANDHAR	**CLIENT**	GAIL
UNIT	New Compressor Area at Gandhar	**JOB NO.**	B240
		UNIT NO.	910

ITEM NO	910-K-901	CASE	CASE 1	
SERVICE		NATURAL GAS COMPRESSOR		
TYPE		CENTRIFUGAL		
LOCATION		GANDHAR (UNDER ROOF)		
NO OF COMPRESSOR REQUIRED				
IN REGULAR USE		ONE		
AS SPARE		NONE		
LUBRICATING OR NON LUBRICATING TYPE				
TYPE OF DRIVER				
REGULAR COMPRESSOR		GAS TURBINE		
SPARE COMPRESSOR		NONE		
VARIABLE SPEED MOTOR REQUIRED		NO		
COMPRESSOR CONNECTED TO EMERGENCY POWER/STEAM		NO		
NUMBER OF STAGES		ONE (NOTE-22)		
OPERATION		CONTINUOUS		
PROPERTIES OF GAS(COMPOSITION AT SUCTION)				
COMPOSITION (MOLE %)		CASE-1(NOTE-13,25,27)		
WATER VAPOUR		NIL		
HYDROGEN		-		
NITROGEN		0.23		
OXYGEN				
CARBON MONOXIDE		-		
CARBON DIOXIDE		2.36		
HYDROGEN SULPHIDE		0.00141		
METHANE		90.35		
ETHYLENE				
ETHANE		5.93		
PROPYLENE				
PROPANE		1.06		
I-BUTANE				
N-BUTANE		0.05		
I-PENTANE				
N-PENTANE		-		
HEXANE PLUS(AVERAGE M.WT.)		-		
AMMONIA				
HYDROGEN CHLORIDE				
CHLORINE				
INERTS(AVERAGE M.WT.)				
AIR(DRY BASIS)				
FLOW RATE FOR ONE COMPRESSOR	NM3/HR			
	KG/HR	110121 (NOTE-1,25)		
AVERAGE M.WT.	DRY BASIS	17.88		
DENSITY	DRY BASIS KG/M3	25.42-29.35		
COMPRESSIBILITY FACTOR		0.9185-0.936		
RATIO OF SPECIFIC HEATS (CP/CV)		1.3731-1.4089 (NOTE-21)		
CORROSIVE/EROSIVE ELEMENTS		NIL		
PARTICLE SIZE OF EROSIVES (IF ANY)				
IS DESIGN FOR NACE CODE IS REQUIRED		NO	--	--
LINE RATING				
SUCTION		600# (NOTE-19,20)		
DISCHARGE		900# (NOTE-19)		
OPERATING CONDITION				

3	21-JUN-2019	ıents Incorporated & Re-Issued For Engine	GS	JKS	SS
2	12-JUN-2019	Re-Issued For Engineering	GS	JKS	SS
1	23-APR-2019	Re-Issued For Engineering	GS	JKS	SS
0	12-MAR-2019	Re-Issued For Comments/Engineering	GS	JKS	SS
B	31-JAN-2019	omments incorporated & Re-Issued For C	GS	JKS	SS
A	16-JAN-2019	Issued For Comments	GS	JKS	SS

PROJECT	**INSTALLATION OF GTC AT GANDHAR**		**CLIENT**	**GAIL**		
UNIT	**New Compressor Area at Gandhar**		**JOB NO.**	**B240**	**UNIT NO.**	**910**
SUCTION PRESSURE	KG/CM2 G	36-39 (NOTE-2)				
SUCTION TEMPERATURE	DEG C	40-55				
DISCHARGE PRESSURE	KG/CM2 G	92 (NOTE-16)				
DISCHARGE TEMPERATURE	DEG C	(NOTE-24)				
DEW POINT TEMPERATURE	DEG C	-103 (NOTE-30)				
COMPRESSION RATIO		2.52 (NOTE-22)				
AFTER COOLER BY VENDOR		NO	--	--		
MAX DISCH. TEMP AT AFTER COOLER EXIT	DEG C	55				
CONDENATE FROM INTERSTAGES		--	REFER P&ID NO.			
CAPACITY CONTROL						
MODE		AUTOMATIC				
RANGE FOR RECIPROCATING MACHINE(STEPS/S						
TYPE OF CONTROL						
AUTO START/AUTO STOP REQUIREMENT		AUTOSTOP REQUIRED				
MECHANICAL DATA						
UPSTREAM DESIGN PRESSURE	KG/CM2 G	95.6 (NOTE-17,32)				3
UPSTREAN DESIGN TEMPERATURE	DEG C	75 (NOTE-17)				
DOWNSTREAM DESIGN PRESSURE	KG/CM2 G	95.6 (NOTE-17,32)				3
DOWNSTREAM DESIGN TEMPERATURE	DEG C	NOTE-17				
UTILITIES AVAILABLE		MINIMUM	NORMAL	MAXIMUM	DESIGN	
COOLING MEDIUM		AIR				
TYPE		AIR COOLED				
SUPPLY TEMPERATURE	DEG C					
SUPPLY PRESSURE	KG/CM2 G					
RETURN TEMPERATURE	DEG C					
RETURN PRESSURE	KG/CM2 G					
STEAM TURBINE DATA		NA				
INLET TEMPERATURE	DEG C					
INLET PRESSURE	KG/CM2 G					
OUTLET PRESSURE	KG/CM2 G					
SAFETY VALVE REQUIRED ON THE STEAM TURBINE EXHAUST		--				
STEAM CONDENSATE						
PRESSURE	KG/CM2 G					
INSTRUMENT AIR		NOTE-23				
TEMPERATURE	DEG C		AMB		65	
PRESSURE	KG/CM2 G	4.5	6.0	6.5	9.5	
NITROGEN		NOTE-18				
TEMPERATURE	DEG C		40			
PRESSURE	KG/CM2 G	3.0	4.0		9.5	
REFERENCE P&ID (IF ANY)						

3	21-JUN-2019	ıents Incorporated & Re-Issued For Engin	GS	JKS	SS
2	12-JUN-2019	Re-Issued For Engineering	GS	JKS	SS
1	23-APR-2019	Re-Issued For Engineering	GS	JKS	SS
0	12-MAR-2019	Re-Issued For Comments/Engineering	GS	JKS	SS
B	31-JAN-2019	omments incorporated & Re-Issued For C	GS	JKS	SS
A	16-JAN-2019	Issued For Comments	GS	JKS	SS

PROJECT	INSTALLATION OF GTC AT GANDHAR	**CLIENT**	GAIL
UNIT	New Compressor Area at Gandhar	**JOB NO.**	B240
UNIT NO.	910		

ITEM NO	910-K-901	CASE	CASE 2	
SERVICE		NATURAL GAS COMPRESSOR		
TYPE		CENTRIFUGAL		
LOCATION		GANDHAR (UNDER ROOF)		
NO OF COMPRESSOR REQUIRED				
IN REGULAR USE		ONE		
AS SPARE		NONE		
LUBRICATING OR NON LUBRICATING TYPE				
TYPE OF DRIVER				
REGULAR COMPRESSOR		GAS TURBINE		
SPARE COMPRESSOR		NONE		
VARIABLE SPEED MOTOR REQUIRED		NO		
COMPRESSOR CONNECTED TO EMERGENCY POWER/STEAM		NO		
NUMBER OF STAGES		ONE (NOTE-22)		
OPERATION		CONTINUOUS		
PROPERTIES OF GAS(COMPOSITION AT SUCTION)				
COMPOSITION (MOLE %)		CASE-2 (NOTE-13,25,29)		
WATER VAPOUR		FULLY SATURATED		
HYDROGEN		-		
NITROGEN		0.16		
OXYGEN				
CARBON MONOXIDE		-		
CARBON DIOXIDE		2.47		
HYDROGEN SULPHIDE		0.00141		
METHANE		85.73		
ETHYLENE				
ETHANE		5.06		
PROPYLENE				
PROPANE		3.74		
I-BUTANE				
N-BUTANE		1.79		
I-PENTANE				
N-PENTANE		0.56		
HEXANE PLUS(AVERAGE M.WT.)		0.48		
AMMONIA				
HYDROGEN CHLORIDE				
CHLORINE				
INERTS(AVERAGE M.WT.)				
AIR(DRY BASIS)				
FLOW RATE FOR ONE COMPRESSOR	NM3/HR			
	KG/HR	122424-122965 (NOTE-1,2		
AVERAGE M.WT.	WET BASIS	19.9163		
DENSITY	WET BASIS KG/M3	21.38-26.249		
COMPRESSIBILITY FACTOR		0.8999-0.9282		
RATIO OF SPECIFIC HEATS (CP/CV)		1.3497-1.4022 (NOTE-21)		
CORROSIVE/EROSIVE ELEMENTS		NIL		
PARTICLE SIZE OF EROSIVES (IF ANY)				
IS DESIGN FOR NACE CODE IS REQUIRED		NO	--	--
LINE RATING				
SUCTION		600# (NOTE-19,20)		
DISCHARGE		900# (NOTE-19)		
OPERATING CONDITION				

3	21-JUN-2019	ıents Incorporated & Re-Issued For Engin	GS	JKS	SS
2	12-JUN-2019	Re-Issued For Engineering	GS	JKS	SS
1	23-APR-2019	Re-Issued For Engineering	GS	JKS	SS
0	12-MAR-2019	Re-Issued For Comments/Engineering	GS	JKS	SS
B	31-JAN-2019	omments incorporated & Re-Issued For C	GS	JKS	SS
A	16-JAN-2019	Issued For Comments	GS	JKS	SS

PROJECT INSTALLATION OF GTC AT GANDHAR | CLIENT GAIL
UNIT New Compressor Area at Gandhar | JOB NO. B240 | UNIT NO. 910

SUCTION PRESSURE	KG/CM2 G	25-28 (NOTE-2)				
SUCTION TEMPERATURE	DEG C	15-35				
DISCHARGE PRESSURE	KG/CM2 G	92 (NOTE-16)				
DISCHARGE TEMPERATURE	DEG C	(NOTE-24)				
DEW POINT TEMPERATURE	DEG C	-35 (NOTE-30)				
COMPRESSION RATIO		3.58 (NOTE-22)				
AFTER COOLER BY VENDOR		NO	--	--		
MAX DISCH. TEMP AT AFTER COOLER EXIT	DEG C	55				
CONDENATE FROM INTERSTAGES		--	REFER P&ID NO.			
CAPACITY CONTROL						
MODE		AUTOMATIC				
RANGE FOR RECIPROCATING MACHINE(STEPS/S						
TYPE OF CONTROL						
AUTO START/AUTO STOP REQUIREMENT		AUTOSTOP REQUIRED				
MECHANICAL DATA						
UPSTREAM DESIGN PRESSURE	KG/CM2 G	95.6 (NOTE-17,32)				3
UPSTREAN DESIGN TEMPERATURE	DEG C	75 (NOTE-17)				
DOWNSTREAM DESIGN PRESSURE	KG/CM2 G	95.6 (NOTE-17,32)				3
DOWNSTREAM DESIGN TEMPERATURE	DEG C	NOTE-17				

UTILITIES AVAILABLE		MINIMUM	NORMAL	MAXIMUM	DESIGN
COOLING MEDIUM		AIR			
TYPE		AIR COOLED			
SUPPLY TEMPERATURE	DEG C				
SUPPLY PRESSURE	KG/CM2 G				
RETURN TEMPERATURE	DEG C				
RETURN PRESSURE	KG/CM2 G				
STEAM TURBINE DATA		NA			
INLET TEMPERATURE	DEG C				
INLET PRESSURE	KG/CM2 G				
OUTLET PRESSURE	KG/CM2 G				
SAFETY VALVE REQUIRED ON THE STEAM TURBINE EXHAUST		--			
STEAM CONDENSATE					
PRESSURE	KG/CM2 G				
INSTRUMENT AIR		NOTE-23			
TEMPERATURE	DEG C		AMB		65
PRESSURE	KG/CM2 G	4.5	6.0	6.5	9.5
NITROGEN		NOTE-18			
TEMPERATURE	DEG C		40		
PRESSURE	KG/CM2 G	3.0	4.0		9.5
REFERENCE P&ID (IF ANY)					

NOTES:

1. CAPACITY INDICATED IS RATED CAPACITY OF COMPRESSOR i.e., CORRESPONDING TO 3.5 MMSCMD.
2. SUCTION PRESSURE INDICATED IS AT THE SUCTION FLANGE OF THE COMPRESSOR.TEMPORARY STRIANER SHALL BE IN SUCTION LINE DURING START UP AND THE SAME SHALL BE REPLACED BY PERMANENT STRAINER SUBSEQUENTLY. STRAINER PRESSURE DROP OF 0.1 KG/CM2 HAS BEEN CONSIDERED TO ARRIVE AT THE COMPRESSOR SUCTION PRESSURE.
3. VENDOR TO PROVIDE THE MESH SIZE AND THE PRESSURE DROP ACROSS THE PERMANENT STRAINER.
4. VENDOR SHALL SUPPLY PERFORMANCE CURVES FOR ALL CASES OF OPERATION.
5. VENDOR TO INCLUDE IN THE SCOPE OF SUPPLY ALL NORMAL INSTRUMENTATION AND CONTROL (INCLUDING ANTI SURGE CONTROL) FOR EFFICIENT OPERATION, SHUTDOWN AND SAFETY REQUIREMENTS AND ESSENTIAL ACCESSORIES.

3	21-JUN-2019	ıents Incorporated & Re-Issued For Engin	GS	JKS	SS
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0	12-MAR-2019	Re-Issued For Comments/Engineering	GS	JKS	SS
B	31-JAN-2019	omments incorporated & Re-Issued For C	GS	JKS	SS
A	16-JAN-2019	Issued For Comments	GS	JKS	SS

PROJECT	**INSTALLATION OF GTC AT GANDHAR**	**CLIENT**	**GAIL**
UNIT	**New Compressor Area at Gandhar**	**JOB NO.**	**B240**
		UNIT NO.	**910**

6 APART FROM THE VENDORS SCOPE OF SUPPLY AS PER P&ID NO. B240-02-42-910-1111/1112/1113 & 1114,VENDOR SHALL SUPPLY ADDITIONAL INSTRUMENTATION, CONTROL & SHUTDOWN LOGIC DEVICES FOR SAFE AND EFFICIENT OPERATION OF MACHINE.

7 AUTOMATIC SPILL BACK IS CONSIDERED FOR COMPRESSOR.

8 COMPRESSOR WILL START FROM CONTROL PANEL LOCATED IN MAIN CONTROL ROOM, HOWEVER, START CLEARANCE FROM FIELD WILL BE PROVIDED. MONITORING & CONTROL OF THE COMPRESSOR STATION SHALL BE PERFORMED FROM DCS/PLC.

9 VENDOR TO INDICATE UTILITY REQUIREMENT.

10 VENDOR TO PROVIDE NECESSARY FILTER, ELECTRIC HEATER, PRESSURE REGULATOR, CONTROL VALVES ETC. FOR SEAL GAS SYSTEM.

11 NORMAL AS WELL AS EMERGENCY SEAL GAS SUPPLY SHALL BE FROM COMPRESSOR DISCHARGE.
EMERGENCY SEAL GAS SUPPLY PRESSURE SHALL BE 60 TO 92 KG/CM2G AT COMPRESSOR B/L.
ENGG TO PROVIDE THE START-UP/NORMAL/EMERGENCY SEAL GAS FLOWRATES REQUIREMENT AT COMPRESSOR B/L.
VENDOR TO PROVIDE FLOW INDICATION AND ALARM IN SEAL GAS SUPPLY LINE.

12 ACCERSSORIES LIKE INSTRUMENTATION AND CONTROL PANEL ARE IN VENDOR SCOPE OF SUPPLY.

13 CASE-1 REPRESENTS WHILE GANDHAR GPU IS RUNNING CONDITION (NORMAL OPERATING CASE)
CASE-2 REPRESENTS WHILE GANDHAR GPU IS STOPPED CONDITION.

14 RLNG FROM 18INCH GANDHAR-JHANORE LINE SHALL BE USED FOR FUEL NORMALLY. RLNG WILL BE AVAILABLE AT PRESSURE ABOUT 28 to 30 KG/CM2G AND TEMPERATURE ABOUT 18-35 °C.
LHV (KCAL/SM3) - 8445 TO 8834
DEW POINT - (-)68.75 DEGC AT 30 KG/CM2G
REFER NOTE-31 FOR RLNG COMPOSITION IN MOLE%.

SRG SHALL BE USED AS SECONDARY FUEL. SRG SHALL BE TAKEN FROM COMPRESSOR INLET COMMON HEADER AND BATTERY LIMIT CONDITIONS AT FUEL GAS CONDITIONING SKID SHALL BE SAME AS MENTIONED UNDER CASE-1 (NORMAL OPERATING CASE) & CASE-2.
LHV (KCAL/SM3) - CASE-1: 8396.761; CASE-2: 9288.321
VENDOR SCOPE SHALL INCLUDE A SUITABLE FUEL GAS LETDOWN/BOOSTER/CONTROL SYSTEM ALSO.
SELECTION OF GT SHALL BE BASED ON PRIMARY SOURCE OF FUEL i.e. RLNG FROM DVPL-I/II.

15 VENDOR TO PROVIDE MAX. RATE OF DEPRESSURISATION DURING COMPRESSOR TRIP/ESD.

16 DISCHARGE PRESSURE INDICATED IS AT THE COMPRESSOR DISCHARGE FLANGE.

17 DESIGN PRESSURE AND TEMPERATURE AT COMPRESSOR SUCTION, INTERMEDIATE STAGES (IF ANY) AND DISCHARGE TO BE PROVIDED/CONFIRMED BY ENGG/VENDOR

18 VENDOR TO INDICATE NITROGEN REQUIREMENT FOR COMPRESSOR.

19 INDICATED IS MINIMUM RATING. VENDOR TO CHECK AND CONFIRM THE SAME. TO BE FIRMED UP BY ENGINEERING.

20 COMPRESSOR VENDOR TO FURNISH SETTLE OUT PRESSURE CALCULATION AND BLOW DOWN CALCULATIONS FOR REVIEW BY EIL.

21 CP/ CV VALUE IS ESTIMATED FOR CALCUALTION PURPOSE, CP/ CV VALUE SHOULD BE USED FROM VENDOR COMPRESSOR DATA SHEET

22 DATA SHEET HAS BEEN PREPARED CONSIDERING SINGLE STAGE. ENGG TO CONFIRM THE NUMBER OF STAGES, INTERSTAGE PRESSURE, TEMPERATURE AND COMPRESSION RATIO.

23 INSTRUMENT AIR REQUIRMENT SHALL BE CONFIRMED BY GTC VENDOR

24 ENGINEERING/VENDOR TO PROVIDE THE COMPRESSOR DISCHARGE TEMPERATURE

25 COMPRESSOR SHALL BE RUNNING UNDER CASE-I FOR MOST OF THE TIME.

26 VENDOR TO MENTION THE EMERGENCY POWER LOAD REQUIREMENT FOR COMPRESSOR AUXILLARIES.

27 FOR CASE-1 OPERATION, PROCESS PARAMETERS AT EXTREME CONDITIONS AS FOLLOWS:

Suction Pressure, Kg/cm2g	36	36	39	39
Suction Temperature, Degree C	40	55	40	55
Flowrate, kg/hr	110121	110121	110121	110121
Avg. Molecular weight, Dry Basis	17.8811	17.8811	17.8811	17.8811
Density (Dry Basis),Kg/m3	26.9884	25.4284	29.353	27.6263
Compressibility Factor	0.9242	0.936	0.9185	0.9313
Cp/Cv Ratio	1.3981	1.3731	1.4089	1.382

28 DELETED

29 FOR CASE-2 OPERATION, PROCESS PARAMETERS AT EXTREME CONDITIONS AS FOLLOWS:

Suction Pressure, Kg/cm2g	25	25	28	28
Suction Temperature, Deg.C	15	35	15	35
Flowrate, kg/hr	122794	122965	122424	122940
Avg. Mol.wt. (Wet Basis)	19.9163	19.9163	19.916	19.9163
Density (Wet Basis),Kg/m3	23.3317	21.3845	26.2488	24.0558
Compressibility Factor	0.9097	0.9282	0.8999	0.9202
Cp/Cv Ratio	1.3849	1.3489	1.4022	1.3623

30 DEW POINT TEMPERATURE IS MENTIONED AT ATMOSPHERIC PRESSURE

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0	12-MAR-2019	Re-Issued For Comments/Engineering	GS	JKS	SS
B	31-JAN-2019	omments incorporated & Re-Issued For C	GS	JKS	SS
A	16-JAN-2019	Issued For Comments	GS	JKS	SS

PROJECT	**INSTALLATION OF GTC AT GANDHAR**	**CLIENT**	**GAIL**
UNIT	**New Compressor Area at Gandhar**	**JOB NO.**	**B240**
		UNIT NO.	**910**

31 REFER BELOW FOR RLNG COMPOSITION IN MOLE % BASED ON MINIMUM AND MAXIMUM LHV VALUES.

COMPONENT	MIN. LHV VALUE COMP.	MAX. LHV VALUE COMP.
C1	93.32912	90.74001
C2	5.62274	6.24112
C3	0.27888	1.81558
iC4	0.04775	0.32322
nC4	0.05217	0.47376
iC5	0.00333	0.01843
nC5	0.00086	0.00487
N2	0.66510	0.38304

32 PSV ON COMPRESSOR SUCTION & DISCHARGE SHALL BE SET AT 95.6 KG/CM2G. 3

3	21-JUN-2019	ıents Incorporated & Re-Issued For Engin	GS	JKS	SS
2	12-JUN-2019	Re-Issued For Engineering	GS	JKS	SS
1	23-APR-2019	Re-Issued For Engineering	GS	JKS	SS
0	12-MAR-2019	Re-Issued For Comments/Engineering	GS	JKS	SS
B	31-JAN-2019	omments incorporated & Re-Issued For C	GS	JKS	SS
A	16-JAN-2019	Issued For Comments	GS	JKS	SS

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LINES

LINES IDENTIFICATION

3"– P – 07 – 1101 – A1A – IH

- INSULATION SPECIFICATION
- PIPE MATERIAL SPECIFICATION
- LINE NUMBER
- UNIT NUMBER
- LINE DESIGNATION
- LINE SIZE (IN INCHES)

LINE LEGEND

- NEW PROCESS/UTILITY LINE
- EXISTING PROCESS/UTILITY LINE
- REPLACED PROCESS/UTILITY LINE
- BURIED LINE
- TRACED LINE
- DISMANTLED LINE
- VENDOR LIMIT LINE

INSTRUMENT LINE SYMBOLS

- ELECTRICAL SIGNAL
- CAPILLARY TUBING (FILLED SYSTEM)
- SOFTWARE SIGNAL
- PNEUMATIC SIGNAL
- HYDRAULIC SIGNAL
- ELECTROMAGNETIC/SONIC SIGNAL
- WIRELESS SIGNAL

LINE DESIGNATION

DESIGNATION	SERVICE
PROCESS LINES	
PL	PROCESS, LIQUID
PG	PROCESS, GAS
PZ	PROCESS, TWO–PHASE
P	PROCESS, GENERAL
WATER LINES	
WB	BOILER FEED WATER
BWCS	BEARING COOLING WATER SUPPLY
BWCR	BEARING COOLING WATER RETURN
WDK	DRINKING WATER
WDM	DEMINERALIZED WATER
WQ	QUENCH WATER
WS	SERVICE WATER
WF	FIRE WATER
WR	RAW WATER
WT	TEMPERED WATER
WP	PROCESS WATER
STEAM & CONDENSATE LINES	
SH	HIGH PRESSURE STEAM
SM	MEDIUM PRESSURE STEAM
SL	LOW PRESSURE STEAM
SVH	VERY HIGH PRESSURE STEAM
CL	LOW PRESSURE CONDENSATE
CM	MEDIUM PRESSURE CONDENSATE
CH	HIGH PRESSURE CONDENSATE
CVH	VERY HIGH PRESSURE CONDENSATE
AIR LINES	
AI	INSTRUMENT AIR
AP	PLANT AIR
AB	BREATHING AIR
PA	PROCESS AIR
VENT LINES	
V	VENT ATMOSPHERIC
SV	SAFETY VALVE OUTLET (OTHER THAN FLARE ROUTING)
FLARE LINES	
FL	FLARE
BLOW DOWN LINES	
BD	BLOW DOWN
CBD	CLOSED BLOW DOWN
HBD	HIGH CONGEALING LIQUID BLOWDOWN
UTILITY OIL LINES	
FO	FUEL OIL
HO	HYDRAULIC OIL
FLO	FLUSHING OIL
LSFLO	LOW SULPHUR FLUSHING OIL
HFLO	HEAVY FLUSHING OIL
HTO	HOT OIL
PFL	PRESSURIZED FLUSHING OIL
UTILITY GAS LINES	
FG	FUEL GAS
IG	INERT GAS
DRAIN LINES	
OWS	OILY WATER SEWER
CS	CHEMICAL SEWER
SS	STORM SEWER
OTHERS	
CA	CAUSTIC
AC	ACID
C	OTHER CHEMICALS
CT	CATALYST
RP	PROPYLENE/PROPANE REFRIGERATION
RE	ETHYLENE REFRIGERATION
RA	AMMONIA REFRIGERATION
ME	METHANOL
ETH	ETHANOL

VALVE, INSTRUMENT AND LINE SYMBOLS

- GATE VALVE NORMALLY OPEN
- GATE VALVE NORMALLY CLOSED (OPTIONAL DESIGNATION)
- GLOBE VALVE NORMALLY OPEN
- CHECK VALVE
- BUTTERFLY VALVE
- PLUG VALVE
- BALL VALVE
- NEEDLE VALVE
- DIAPHRAGM VALVE
- ANGLE VALVE
- BLOWDOWN ANGLE VALVE
- ANGLE BALL VALVE
- ANGLE CHOKE VALVE
- 3–WAY VALVE
- ACTUATED PLUG VALVE
- ACTUATED GATE VALVE
- ACTUATED BALL VALVE
- CONTROL VALVE (GENERAL/GLOBE)
- CONTROL VALVE (BALL)
- CONTROL VALVE (DIAPHRAGM)
- CONTROL VALVE (BUTTERFLY)
- 3–WAY CONTROL VALVE
- CONTROL VALVE (ANGLE TYPE)
- CONTROL VALVE (DOWNSTREAM SELF ACTUATING)
- CONTROL VALVE (UPSTREAM SELF ACTUATING)
- CONTROL VALVE WITH POSITIONER
- PILOT OPERATED VALVE
- CONTROL VALVE WITH HAND WHEEL
- PLUNGER OPERATED VALVE
- MOTOR OPERATED VALVE
- SOLENOID VALVE (2–WAY)
- SOLENOID VALVE (3–WAY)
- DRAIN WITH BLIND FLANGE
- DRAIN WITH THREADED CAP
- FLOW ELEMENT (ORIFICE)
- TURBINE METER
- PD METER
- ROTAMETER
- SONIC METER
- MAGNETIC METER
- PITOT TUBE
- ANNUBAR
- VENTURI METER
- STRAIGHTENING VANES
- IN LINE INSTRUMENT (SIGHT GLASS,MASS FLOW METER ETC.)
- CORIOLIS MASS FLOW METER
- STATIC MIXER
- INLET SIZE, INCHES / ORIFICE CODE, LETTER / OUTLET SIZE, INCHES (2.33 / 24)
- SET PRESS. Kg/CM²G RELIEF VALVE (PSV 1101)
- SAFETY VALVE NUMBER

- 'T'– TYPE STRAINER
- 'Y'– TYPE STRAINER
- TS — TEMPORARY STRAINER
- PS — PERMANENT STRAINER
- CONE TYPE STRAINER
- BASKET STRAINER
- FILTER
- SPECTACLE BLIND
- SPACER
- OPEN DRAIN FUNNEL
- EXPANDER/REDUCER
- BELLOWS
- ST — STEAM TRAP
- AT — AIR TRAP
- RUPTURE DISK
- UNION
- COUPLING
- BLIND FLANGE
- CAP THREADED
- CAP WELDED
- ADAPTOR
- SLOPE
- TP XXXX — TIE–POINT
- RAIN CAP
- XXXXX / XX–XXXX — CONTINUITY ARROW, LINES
- XXXXX / XX–XXXX — CONTINUITY ARROW INSTRUMENT SIGNAL
- XXXXX / XX–XXXX — CONTINUITY ARROW, B/L
- PULSATION DAMPNER
- VORTEX BREAKER
- FLEXIBLE LINE/HOSE
- SP — SPECIALITY ITEM
- SILENCER
- SC – SAMPLE CONNECTION
  AP – AIR PURGE
  SP – STEAM PURGE
  AA – AERATION AIR
  AS – AERATION STEAM
  AG – AERATION GAS
  NP – NITROGEN PURGE

INSULATION/TRACING TYPE

IH	HOT INSULATION
IC	COLD INSULATION
IS	SAFETY INSULATION
IT	STEAM TRACED
IE	ELECTRICAL TRACED
IJ	STEAM JACKETED
IA	ACOUSTIC INSULATION

GENERAL ABBREVIATIONS

ATM	ATMOSPHERE
BL	BATTERY LIMIT
CS	CHEMICAL SEWER
CSC	CAR SEAL CLOSED
CSO	CAR SEAL OPEN
FB	FULL BORE
FL	FAIL LOCK
FC	FAIL CLOSED
FO	FAIL OPEN
HLL	HIGH LIQUID LEVEL
HS	HOSE STATION
ISBL	INSIDE BATTERY LIMIT
LC	LOCK CLOSE
LLL	LOW LIQUID LEVEL
LO	LOCK OPEN
MOV	MOTOR OPERATED VALVE
MW	MANWAY
NNF	NORMALLY NO FLOW
NLL	NORMAL LIQUID LEVEL
NO	NORMALLY OPEN
NC	NORMALLY CLOSED
OSBL	OUTSIDE BATTERY LIMIT
OWS	OILY WATER SEWER
PB	PUSH BUTTON
TL	TANGENT LINE
TSO	TIGHT SHUT OFF (CL.IV&V)
UC	UTILITY CONNECTION
VAC	VACUUM
VF	VENDOR FURNISHED
PSO	POSITIVE SHUT OFF (CL.VI)
FMR	FIELD MANUAL RESET (FOR SOV)
CMR	CONTROL ROOM MANUAL RESET (FOR SOV)
DI	DENSITY INDICATE
QOEC	QUICK OPENING END CLOSURE

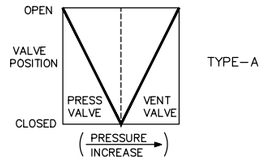
INSTRUMENTATION SYMBOLS AND LEGEND

NOTE: INSTRUMENTATION SYMBOLS AND LEGEND SHALL BE AS PER ISA "STANDARDS AND RECOMMENDED PRACTICES FOR INSTRUMENTATION AND CONTROL".

IDENTIFICATION LETTERS

	FIRST–LETTER		SUCCEEDING–LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	USER'S CHOICE			CONTROL	
D	USER'S CHOICE	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO(FRACTION)			
G	USER'S CHOICE		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	USER'S CHOICE	MOMENTARY			MIDDLE, INTERMEDIATE
N	USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

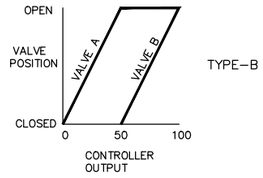
1. SPLIT RANGE VALVES: SOME CONTROL LOOPS HAVE TWO CONTROL VALVES ON THE OUTPUT SIGNAL OF ONE CONTROLLER. FOR EXAMPLE WITH TWO CONTROL VALVES, ONE VALVE PRESSURIZES AND THE OTHER VENTS A VESSEL. A PLOT SHOWS THE VALVE POSITION VERSES PRESSURE.



TYPE–A

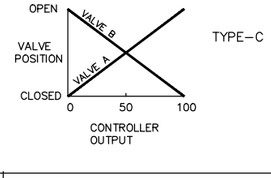
IT IS IMPORTANT TO KEEP THE CONTROL LOOP GAIN CONSTANT FOR GOOD SPLIT RANGE OPERATION. THE GAIN OF EACH VALVE (INCLUDING THE PROCESS) MUST BE MADE SIMILAR. OTHERWISE LIMIT CYCLING OR POOR CONTROL WILL RESULT.

2. WHERE SEQUENCE VALVE OPERATION IS CALLED FOR, THEY ARE INTENDED TO WORK AS FOLLOWS:



TYPE–B

3. OPPOSITE ACTING VALVES CONTROL LOOP NOTED AS OPPOSITE ACTING VALVES HAVE THE FOLLOWING ACTION.



TYPE–C

OTHERS

- CC — CORROSION COUPON
- CP — CORROSION PROBE
- RUNNING LIGHT (LOCAL)
- RUNNING LIGHT (PANEL)
- RUNNING LIGHT (LOCAL PANEL)
- RUNNING LIGHT (DCS)
- RTU — REMOTE TRANSMISSION UNIT
- DIAPHRAGM

LESS FREQUENTLY USED SYMBOLS

- STOP CHECK VALVE
- FOUR WAY VALVE
- PRESSURE VACUUM SAFETY VALVE
- PILOT OPERATED SAFETY VALVE
- CONTINUOUS DRAIN
- VANES CONTROL VALVE
- HAND OPERATED VANES VALVE
- SPRING LOADED VALVE
- HAND OPERATED VALVE
- DOUBLE BLOCK AND BLEED VALVE (DBBV)
- VARIABLE FREQUENCY DRIVE
- FLAME ARRESTOR
- IJ — INSULATION JOINT
- B — BURRIED PIPELINE

FUNCTION BLOCKS – FUNCTION DESIGNATIONS

NO.	FUNCTION	SYMBOL	NO.	FUNCTION	SYMBOL
1.	SUMMING	Σ	12.	TIME FUNCTION	F(T)
2.	AVERAGING	Σ/n	13.	HIGH SELECTING	>
3.	DIFFERENCE	Δ	14.	LOW SELECTING	<
4.	PROPORTIONAL	K	15.	HIGH LIMITING	≯
5.	INTEGRAL	∫	16.	LOW LIMITING	≮
6.	DERIVATIVE	d/dt	17.	REVERSE PROPORTIONAL	–K
7.	MULTIPLYING	X			+
8.	DIVIDING	÷	18.	BIAS	–
9.	ROOT EXTRACTION	√			±
10.	EXPONENTIAL	X^n	19.	CONVERT	
11.	NON LINEAROR UNSPECIFIED FUNCTION	F(X)		* E– VOLTAGE I– CURRENT P– PNEUMATIC A– ANALOG H– HYDRAULIC D– DIGITAL	

FUNCTIONAL SYMBOLS

- FIELD MOUNTED INSTRUMENT
- LOCAL PANEL INSTRUMENT
- REAR LOCAL PANEL INSTRUMENT
- CENTRAL PANEL MOUNTED INSTRUMENT
- REAR CENTRAL PANEL MOUNTED INSTRUMENT

DCS/ SCADA COMPUTER SYSTEM SYMBOLS

- SHARED DISPLAY INDICATOR,CONTROLLER, OR OTHER DEVICES WITH OPERATOR ACCESS TO ADJUSTMENTS. (Z2)
- SHARED DISPLAY DEVICES WITH LIMITED ACCESS TO ADJUSTMENTS LOCATED IN FIELD.
- AUXILLIARY OPERATORS INTERFACE DEVICE FOR EXAMPLE, BACK UP CONTROLLER OR MANUALSTATION.
- COMPUTER COMPONENTS NOT ACCESSIBLE TO OPERATOR LIKE I/O INTERFACE,BLIND CONTROLLER OR A SOFTWARE CALCULATION BOX.
- SCADA INDICATOR/CONTROLLER/RECORDER OR ALARM POINT NORMALLY ACCESSIBLE TO OPERATOR THROUGH VIDEO DISPLAY.
- AUXILLIARY COMPUTER COMPONENTS NORMALLY ACCESSIBLE TO OPERATOR.
- SEQUENTIAL LOGIC CONTROL LIMITED ACCESS TO OPERATOR.
- SEQUENTIAL LOGIC CONTROL ACCESSIBLE TO OPERATOR / SHARED DISPLAY INDICATOR,CONTROLLER, OR OTHER DEVICES WITH OPERATOR ACCESS TO ADJUSTMENTS.
- INTERLOCK FUNCTION

No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.
2	11.07.19	ISSUED FOR ENGG.	Varun	GS	JKS	SS
1	13.06.19	ISSUED FOR HAZOP	Varun	GS	JKS	SS
0	22.04.19	ISSUED FOR ENGG.	Varun	GS	JKS	SS
A	28.02.19	ISSUED FOR COMMENTS	Varun	GS	JKS	SS

संख्या / तिथि / संशोधन / ड्रॉन द्वारा / जाँच / अनुमोदित

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GAIL (INDIA) LIMITED
गैल (इन्डिया) लिमिटेड
GT COMPRESSOR PROJECT, GANDHAR

पाइपिंग एण्ड इंस्ट्रूमेन्टेशन डायाग्राम
PIPING AND INSTRUMENTATION DIAGRAM
STANDARD SYMBOLS AND NOMENCLATURE

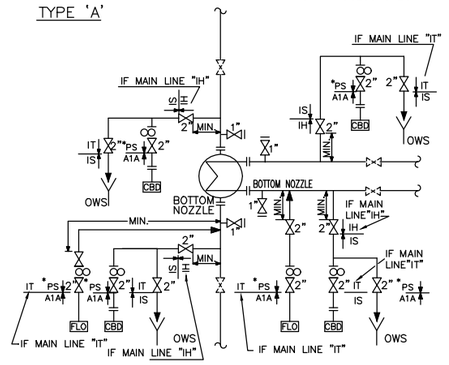
अनुमाप SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG. No.	संशो. REV.
NTS	B240	02	42	000	1191	2

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HEAT EXCHANGER FLUSHING AND DRAIN PLAN (REFER NOTE-14)

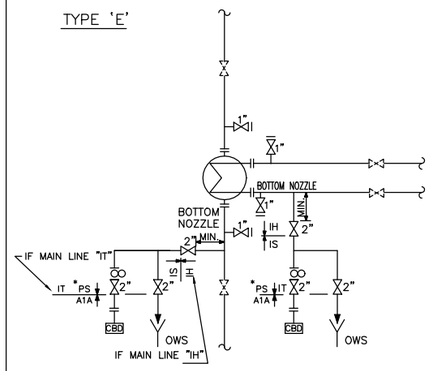
*PS : PROCESS SPEC

TYPE 'A'



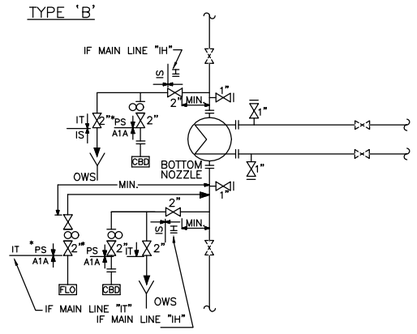
SERVICE : S/S & T/S CONGEALING HC

TYPE 'E'



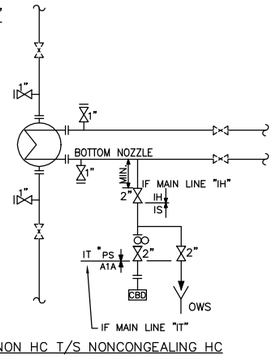
S/S & T/S NONCONGEALING HC

TYPE 'B'



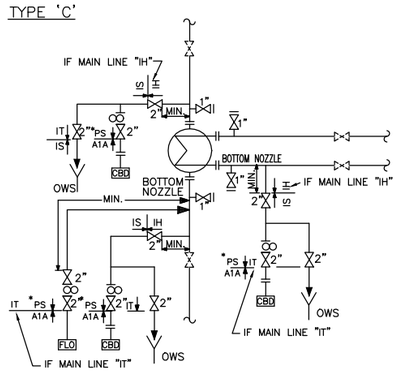
S/S CONGEALING HC, T/S NON HC

TYPE 'F'



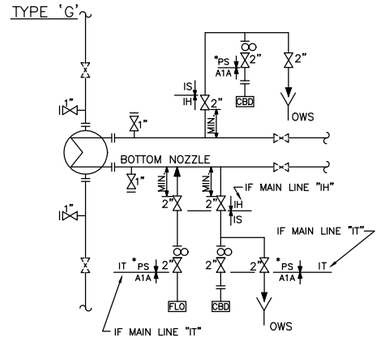
S/S NON HC T/S NONCONGEALING HC

TYPE 'C'



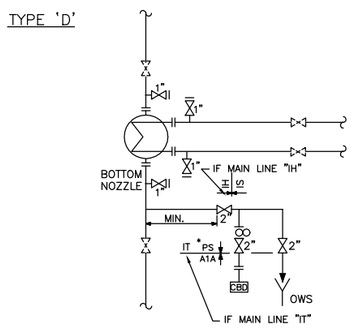
S/S CONGEALING HC, TS NONCONGEALING HC

TYPE 'G'



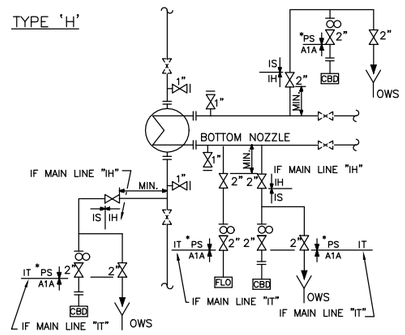
S/S NON HC T/S CONGEALING HC

TYPE 'D'



S/S NONCONGEALING HC, T/S NON HC

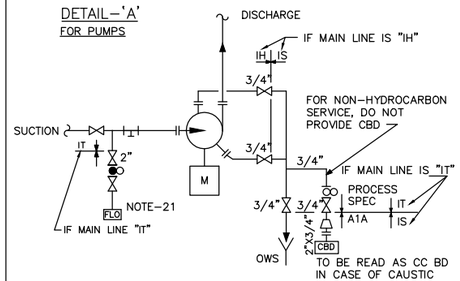
TYPE 'H'



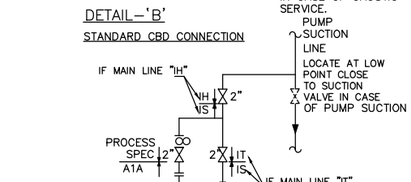
S/S NONCONGEALING HC T/S CONGEALING HC

PUMP VENT/DRAIN/BLEEDER CONNECTION DETAILS

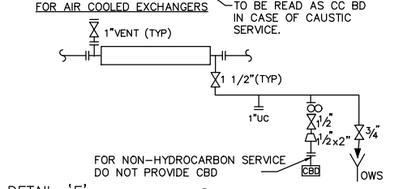
DETAIL-'A'
FOR PUMPS



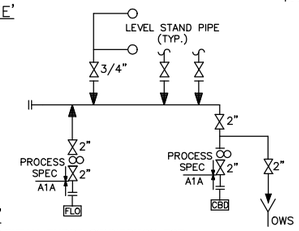
DETAIL-'B'
STANDARD CBD CONNECTION



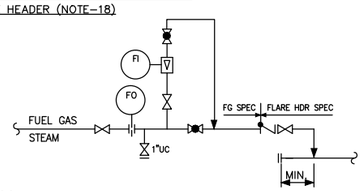
DETAIL-'C'
FOR AIR COOLED EXCHANGERS



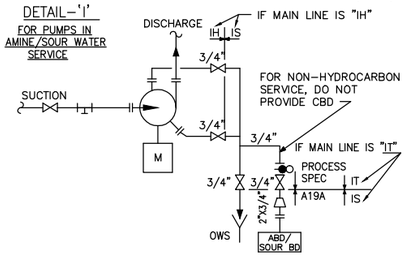
DETAIL-'E'



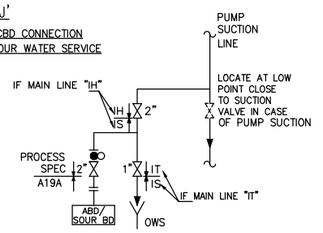
DETAIL-'F'
FUEL GAS / STEAM PURGE CONNECTION FOR UNIT FLARE HEADER (NOTE-18)



DETAIL-'I'
FOR PUMPS IN AMINE/SOUR WATER SERVICE

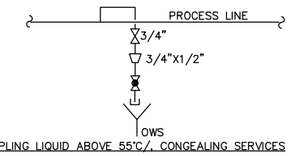


DETAIL-'J'
STANDARD CBD CONNECTION FOR AMINE/SOUR WATER SERVICE

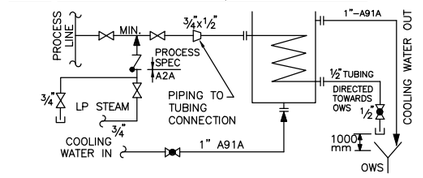


SAMPLE COOLER/COLLECTION DETAILS

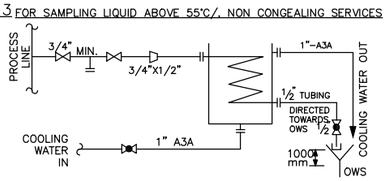
SC-1 FOR SAMPLING LIQUIDS AT OR LOWER THAN 55°C



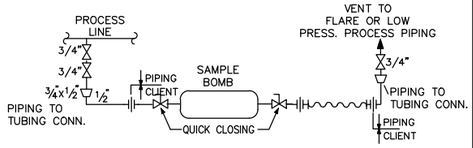
SC-2 SAMPLING LIQUID ABOVE 55°C/, CONGEALING SERVICES



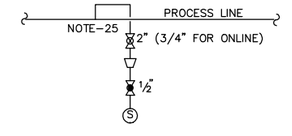
SC-3 FOR SAMPLING LIQUID ABOVE 55°C/, NON CONGEALING SERVICES



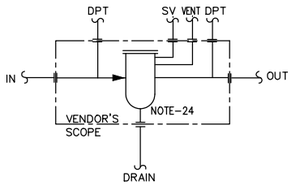
SC-4 FOR HIGHLY VOLATILE LIQUIDS AND SOUR WATER



SC-5 FOR SAMPLING GASES AT OR LOWER THAN 55°C



DETAIL-G
FOR FILTER SCOPE



NOTES:-

1. ALL INDICATED ELEVATIONS ARE WITH REFERENCE TO GRADE LEVEL WHICH IS 0.0MM.
2. ALL INSTRUMENT TAG NUMBERS TO BE PREFIXED BY UNIT NUMBER.
3. SIZES OF PUMP DRAIN/VENT SHOWN ARE TENTATIVE, WILL BE CONFIRMED BY PUMP VENDORS.
4. UNDESIGNATED PIPING AND VALVING ON EQUIPMENT SHALL FOLLOW THE CLASS AND INSULATION OF ASSOCIATED PIPING OF THE EQUIPMENT UNLESS STATED OTHERWISE.
5. VALVES AND MANIFOLDS ON INSTRUMENTS ARE NOT SHOWN IN P&ID'S AND SHALL BE AS PER ENGINEERING STANDARDS.
6. ALL PSV UPSTREAM PIPING SHALL BE FREE DRAINING TOWARDS VESSEL AND DOWNSTREAM TOWARDS BLOW DOWN HEADER.
7. ALL HYDROCARBON VENTS TO ATMOSPHERE SHOULD BE VENTED AT MINIMUM 3 METRES ABOVE THE NEAREST OPERATING PLATFORM EXISTING WITHIN A RADIUS OF 12 METRES. A 3/8" DIAMETER WEEP HOLE IN THE TAIL PIPE FOR DRAINAGE TO SAFE LOCATION AT LOW POINT OF LINE SHALL BE PROVIDED.
8. ALL STEAM VENTS TO ATMOSPHERE SHOULD BE VENTED AT MINIMUM 3 METRES ABOVE THE NEAREST OPERATING PLATFORM EXISTING WITH IN A RADIUS OF 8 METRES A 3/8" DIAMETER WEEP HOLE FOR DRAINAGE AT LOW POINT OF LINE SHALL BE PROVIDED.
9. THE INSTRUMENTATION SHOWN FOR VENDOR PACKAGE UNITS IS MINIMUM PROCESS REQUIREMENT. VENDOR TO PROVIDED ADEQUATE INSTRUMENTATION FOR SAFE OPERATION AND MACHINE SAFETY.
10. CBD/OWS DRAINS FOR EQUIPMENT LOCATED AT ELEVATED PLATFORMS CAN BE CLUSTERED AND ROUTED TO RESPECTIVE HEADERS.
11. HIGH POINT VENTS & LOW POINT DRAINS OF PIPING ARE NOT SHOWN IN THE P&ID.
12. PSV ISOLATION VALVES (UPSTREAM/DOWNSTREAM) SHALL BE OF FULL PORT SIZE.
13. ALL SAMPLE POINTS SHOULD BE CONVENIENTLY LOCATED AT GRADE LEVEL PREFERABLY NEAR BATTERY LIMIT & SHOULD BE APPROACHABLE THEY SHOULD BE CLOSE TO OILY WATER SEWER FUNNELS AS FOR AS POSSIBLE.
14. i) ISOLATION VALVES SHOWN DOTTED WILL BE PRESENT WHEN INDICATED IN P&ID WHERE EXCHANGER APPEARS.
    ii) DETAILS ARE APPLICABLE FOR INDIVIDUAL EXCHANGER ONLY WHEN SHELL SIDE AND TUBE SIDE ISOLATION VALVES ARE PROVIDED.
    iii) WHEN A BANK OF EXCHANGERS ARE ISOLATED BY TWO ISOLATION VALVES, THEN ONLY ONE FLUSHING OIL CONNECTION IS PROVIDED. HOWEVER DRAIN CONNECTIONS FOR PROCESS FLUIDS FROM BOTTOM NOZZLES WILL BE PROVIDED FOR ALL INDIVIDUAL EXCHANGERS.
    iv) WHEN EXCHANGERS ARE NOT PROVIDED WITH ANY ISOLATION VALVES, DRAIN CONNECTIONS FOR PROCESS FLUIDS AT BOTTOM NOZZLES WILL BE PROVIDED FOR EACH EXCHANGER. FLUSHING CONNECTION WILL BE PROVIDED AT ONLY ONE APPROPRIATE LOCATION.
15. DRAINS OF ALL LEVEL INSTRUMENTS, STAND PIPES IN HC SERVICE PROVIDED AT ELEVATED PLATFORMS SHOULD BE COLLECTED IN A COMMON 2" HEADER FOR ROUTING TO CBD/OWS (DETAIL-E). A 2" FLUSHING OIL CONNECTION SHOULD BE PROVIDED NEAR THE BLIND END OF THE DRAIN HEADER FOR FLUSHING. COMMON HEADER TO BE PROVIDED FOR EACH ELEVATED PLATFORM THIS WORK IS TO BE EXECUTED BY SITE CONTRACTOR PIPING TO TAKE CARE OF THIS REQUIREMENT IN MTO.
16. OPERATION OF ALL WARM UP LINES ON PUMPS (REQUIREMENT TO BE CONFIRMED FROM P&ID'S) SHALL BE SUCH THAT IF WARM UP LINE FLANGE OR VALVE GLAND LEAK OCCURS IT SHOULD NOT FALL ON CHECK VALVE & THE PUMP DISCHARGE VALVE.
17. BEARING COOLING WATER DRAINS TO BE ROUTED TO OWS.
18. STAND PIPES FOR ALL LEVEL INSTRUMENTS SHALL HAVE ISOLATION VALVES.
19. PROVIDE ISOLATION, VENT & DRAIN ARRANGEMENT FOR ALL INSTRUMENTS DURING DETAILED ENGG.
20. CONTROL VALVES ARE TO BE PREFERABLY LOCATED AT GRADE.
21. TO BE PROVIDED FOR CONGEALING SERVICE ONLY.
22. ALL GATE VALVES ON LINES LEADING TO FLARE HEADER (INCLUDING PSV ISOLATION VALVES) TO BE INSTALLED WITH STEM IN HORIZONTAL POSITION TO EXTENT POSSIBLE.
23. PROVIDE ONE SET OF UTILITY STATION ON PSV RACK.
24. MATCHING FLANGES FOR FILTER ARE IN VENDOR'S SCOPE.
25. SAMPLE POINT SHALL BE TAKEN FROM TOP FOR GAS SERVICE. REFER DETAIL-SC-5.

No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.
0	11.07.19	ISSUED FOR ENGG	Varun	GS	JKS	SS
A	28.02.19	ISSUED FOR COMMENTS	Varun	GS	JKS	SS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

GAIL (INDIA) LIMITED

GT COMPRESSOR PROJECT, GANDHAR

पाइपिंग एण्ड इंस्ट्रूमैन्टेशन डायाग्राम

PIPING AND INSTRUMENTATION DIAGRAM

GENERAL NOTES AND TYPICAL DETAILS

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
NTS	B240	02	42	000	1192	0

INSTRUMENT SYMBOLS

TEMPERATURE INSTRUMENTS

TG TEMPERATURE GAUGE
TI TEMPERATURE INDICATOR
TR TEMPERATURE RECORDER
TE TEMPERATURE ELEMENT
TIC TEMPERATURE INDICATOR CONTROLLER
DTIC DIFFERENTIAL TEMPERATURE INDICATING CONTROLLER
DTI DIFFERENTIAL TEMPERATURE INDICATOR
DTR DIFFERENTIAL TEMPERATURE RECORDER
TJI MULTIPOINT TEMPERATURE INDICATOR
TJR MULTIPOINT TEMPERATURE RECORDER
TW THERMOWELL
TA TEMPERATURE ALARM
TS TEMPERATURE SWITCH
TV TEMPERATURE CONTROL VALVE
TCV SELF ACTUATED TEMPERATURE REGULATOR

PRESSURE INSTRUMENTS

PG PRESSURE GAUGE
PT PRESSURE TRANSMITTER
PI PRESSURE INDICATOR
PR PRESSURE RECORDER
PIC PRESSURE INDICATOR CONTROLLER
PS PRESSURE SWITCH
PA PRESSURE ALARM
DPG DIFFERENTIAL PRESSURE GAUGE
DPT DIFFERENTIAL PRESSURE TRANSMITTER
DPI DIFFERENTIAL PRESSURE INDICATOR
DPIC DIFFERENTIAL PRESSURE INDICATING CONTROLLER
DPR DIFFERENTIAL PRESSURE RECORDER
DPV DIFFERENTIAL PRESSURE CONTROL VALVE
PV PRESSURE CONTROL VALVE
PCV SELF ACTUATED PRESSURE REGULATOR
DG DRAFT GAUGE

LEVEL INSTRUMENTS

LG LEVEL GAUGE
LT LEVEL TRANSMITTER
LI LEVEL INDICATOR
LR LEVEL RECORDER
LIC LEVEL INDICATOR CONTROLLER
LS LEVEL SWITCH
LA LEVEL ALARM
LV LEVEL CONTROL VALVE

FLOW INSTRUMENTS

FG FLOW GLASS
FE FLOW ELEMENT
FT FLOW TRANSMITTER
FI FLOW INDICATOR
FR FLOW RECORDER
FIC FLOW INDICATOR CONTROLLER
FrI FLOW RATIO INDICATOR
FrIC FLOW RATIO INDICATING CONTROLLER
FrR FLOW RATIO RECORDER
FA FLOW ALARM
FS FLOW SWITCH
FQ FLOW COMPUTER
FQI FLOW INTEGRATOR INDICATOR
FV FLOW CONTROL VALVE
FmR MASS FLOW RECORDER
FmI MASS FLOW INDICATOR
FmQ MASS FLOW INTEGRATOR
FcI CORRECTED FLOW INDICATOR
FcQ TOTALISED CORRECTED FLOW
FcAL CORRECTED FLOW ALARM LOW
FcAH CORRECTED FLOW ALARM HIGH

OTHER INSTRUMENTS

PSV PRESSURE SAFETY VALVE
TSV TEMPERATURE SAFETY VALVE
SOV SOLENIOD OPERATED VALVE
SDV SHUT DOWN VALVE
MOV MOTOR OPERATED VALVE
AV ACTUATED VALVE
RO RESTRICTION ORIFICE
RD RUPTURE DISK
AF FLAME ARRESTOR
HIC MANUAL LOADING STATION
HV HAND OPERATED VALVE
XV ON/OFF VALVE
PB PUSH BUTTON
AE ANALYSER ELEMENT
AT ANALYSER TRANSMITTER
AI ANALYSER INDICATOR
pHI pH INDICATOR
pHIC pH INDICATING CONTROLLER
pHR pH RECORDER
SS SELECTOR SWITCH
LSS LOW SIGNAL SELECTOR
HSS HIGH SIGNAL SELECTOR
ST SPEED TRANSMITTER
SR SPEED RECORDER
SI SPEED INDICATOR
XL INDICATION LAMP
I CURRENT INDICATOR
IA CURRENT ALARM
IR CURRENT RECORDER
LO LOCK OPEN
LC LOCK CLOSE
VSH VIBRATION SWITCH HIGH
VAH VIBRATION ALARM HIGH
ZSH POSITION SWITCH HIGH (VALVE OPEN)
ZSL POSITION SWITCH LOW (VALVE CLOSE)
ZLH POSITION LIGHT HIGH (VALVE OPEN)
ZLL POSITION LIGHT LOW (VALVE CLOSE)
BE FLAME SCANNER
DT DENSITY TRANSMITTER
DI DENSITY INDICATOR
DR DENSITY RECORDER
DX TRANSDUCER FOR SIGNAL FROM DENSITY INSTRUMENT
ESD EMERGENCY SHUT DOWN
XXA PIG DETECTOR INDICATOR
XXS PIG DETECTOR INDICATOR SWITCH
ZAL POSITION ALARM LOW (VALVE CLOSE)
HSH HAND SWITCH HIGH
HSL HAND SWITCH LOW
NIA INTERPHASE INDICATOR/ALARM
XLH INDICATION LAMP HIGH (ON POSITION)
XLL INDICATION LAMP LOW (OFF POSITION)
XAL INDICATION ALARM LOW (OFF POSITION)
XSL LOCAL/REMOTE SWITCH
XRL LOCAL/REMOTE INDICATION

OTHER INSTRUMENTS

ASH ANALYSER SWITCH HIGH
ASHH ANALYSER SWITCH HIGH HIGH
AAH ANALYSER ALARM HIGH
AAHH ANALYSER ALARM HIGH HIGH
CMS CORROSION MONITORING SYSTEM
WR MASS FLOW RECORDER
WQ MASS FLOW TOTALIZER
YR ENERGY RECORDER
YQ ENERGY TOTALIZER
BS HEAT DETECTOR
BSA HEAT DETECTOR ALARM
GE GAS DETECTOR
GA GAS DETECTOR ALARM

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No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.
0	13.06.19	ISSUED FOR ENGG.	Varun	GS	JKS	SS
A	28.02.19	ISSUED FOR COMMENTS	Varun	GS	JKS	SS

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भारत सरकार का उपक्रम
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GAIL (INDIA) LIMITED
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GT COMPRESSOR PROJECT, GANDHAR

पाइपिंग एण्ड इंस्ट्रूमैन्टेशन डायाग्राम
PIPING AND INSTRUMENTATION DIAGRAM

LEGEND AND GENERAL NOTES

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
NTS	B240	02	42	000	1193	0

EIL-0241-502-REV-0-A

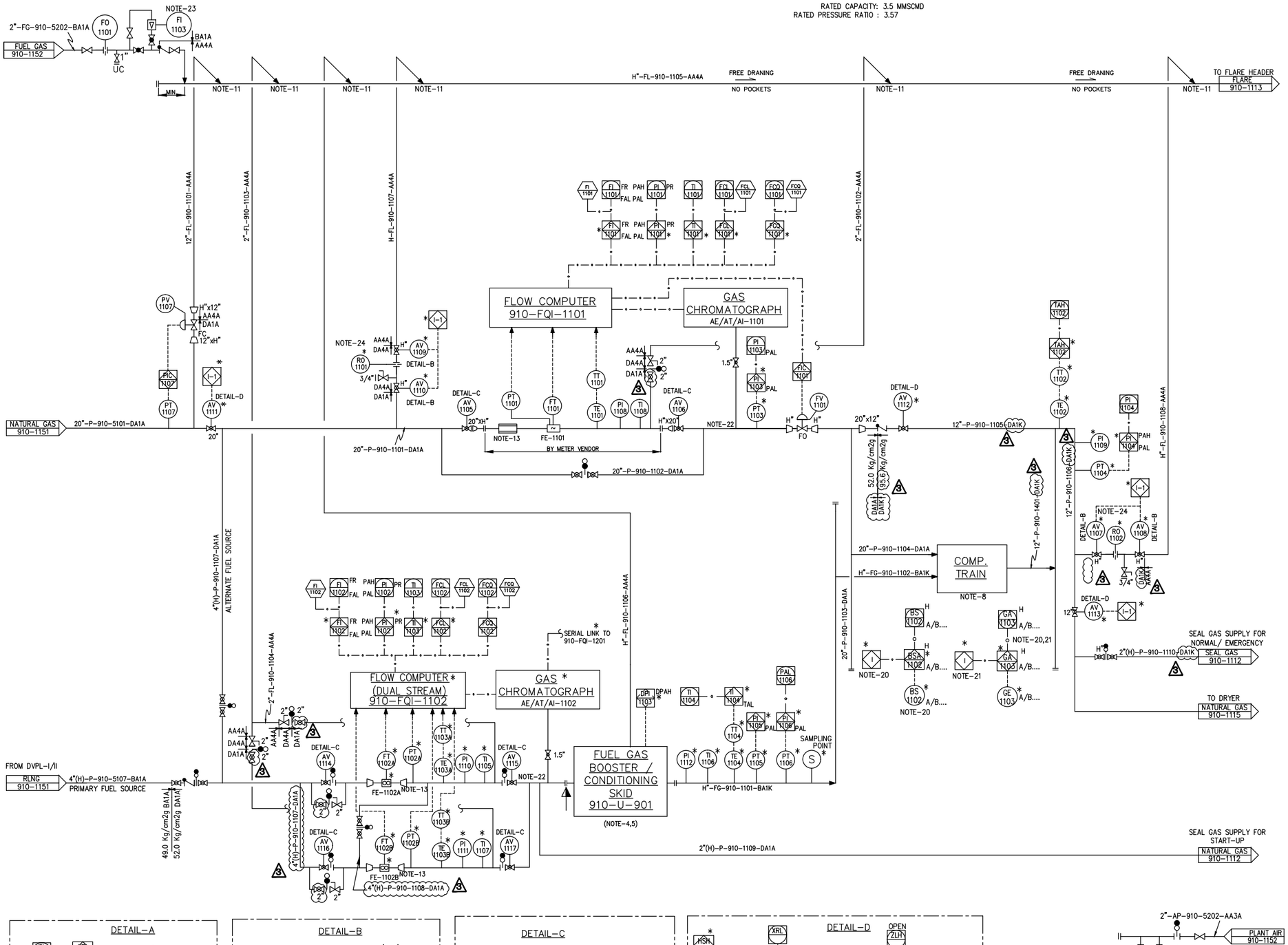
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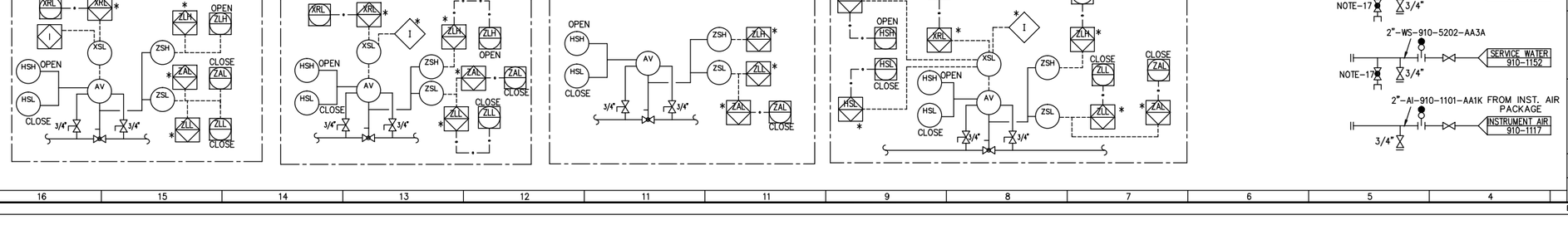
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910-U-901
FUEL GAS BOOSTER/CONDITIONING SKID

910-K-901
GAS TURBINE COMPRESSOR

RATED CAPACITY: 3.5 MMSCMD
RATED PRESSURE RATIO : 3.57





NOTES:

1. FOR GENERAL NOTES AND SYMBOLS REFER DWGS B240-02-42-000 -1191/1192/1193.
2. ALL INSTRUMENT TAG NOS. SHALL BE PROCEDED BY UNIT NO. 910.
3. ALL THE INDICATIONS/RECORDINGS OF INSTRUMENTS SHOWN IN THIS P&ID SHALL BE ON PLC. PANEL MOUNTED INSTRUMENTS WILL BE IN STATION COMMON PANEL.
4. TO BE SUPPLIED BY GTC VENDOR AND SHALL BE DESIGNED FOR COMPR. CONFIGURATION (1+0) CONSIDERING THE TOTAL FUEL GAS REQUIREMENT. VENDOR TO PROVIDE FLOW MEASUREMENT FOR COMMON FUEL GAS LINE GOING TO FUEL GAS CONDITIONING SYSTEM. FUEL GAS FLOW INDICATION TO BE PROVIDED IN THE CONTROL ROOM.
5. DELETED.
6. MASTER CONTROL IS FUNCTIONALLY SHOWN & INDICATIVE ONLY. FINAL SCHEME SHALL BE IMPLEMENTED AS PER SPECIFICATION BY COMPRESSOR VENDOR.
7. ESD BUTTON SHALL BE PROVIDED IN (SCADA) MCC, STATION COMMON PANEL.
8. REFER P&ID B240-02-42-910-1112/1113/1114/1115 FOR TYPICAL DETAILS OF COMPRESSOR TRAIN.
9. ALL TRANSMITTER SHALL BE SMART TYPE.
10. ESD PUSH BUTTON SHALL BE PROVIDED OUTSIDE THE COMPRESSOR SHED AT ATLEAST TWO LOCATIONS.
11. ALL PSV UPSTREAM PIPING/BLOWDOWN PIPING SHALL BE FREE DRAINING TOWARDS EQUIPMENT AND DOWNSTREAM TOWARDS FLARE HEADER. ALL VENTS/PSV DISCHARGE SHALL JOIN THE FLARE HEADER AT AN ANGLE OF 45° IN THE DIRECTION OF FLOW.
12. PROVISION OF BYPASS LINE WITH SPOOL PIECE FOR INSTALLATION OF FLOW METER DURING CALIBRATION.
13. STRAIGHT LENGTH AS PER INSTRUMENTION REQUIREMENT.
14. FLOW COMPENSATION SHOULD BE DONE IN FLOW COMPUTER.
15. ANTI SURGE CONTROL, PERFORMANCE CONTROL AND MASTER CONTROL FUNCTIONALLY SHOWN AND INDICATIVE ONLY. FINAL SCHEME SHALL BE IMPLEMENTED AS PER SPECIFICATION BY COMPRESSOR VENDOR.
16. SIGNAL TO SCADA SHALL BE THROUGH SEPARATE SERIAL LINK FROM STATION PLC & COMPRESSOR TRAIN UCP.
17. HOSE STATION CONSISTING OF PLANT AIR, SERVICE WATER, NITROGEN TO BE PROVIDED. HOSE TO BE FLANGED TYPE FOR NITROGEN. OTHER UTILITIES TO HAVE HOSE OF QUICK COUPLING TYPE.
18. ALL INDICATIONS, RECORDING OF INSTRUMENTS, STATUS, CONTROLS & ALARMS INDICATED IN THE P&ID SHALL BE IN COMMON FACILITY CONTROL PLC/PANEL. THE COMMON FACILITY PLC AND PANEL IS IN GTC PACKAGE VENDOR'S SCOPE.
19. DELETED.
20. ADEQUATE NO. OF HEAT DETECTORS (UV+IR) ARE TO BE PROVIDED AT DOWN WIND DIRECTIONS NEAR FILTERS, FLOW METERS, COMPRESSOR, FGC SKID & FAILURE PRONE EQUIPMENT PARTS,ACCESSORIES,VALVES & PIPES. COMPRESSOR/GAS TURBINE TO TRIP ON HEAT DETECTION.
21. ADEQUATE NO. OF GAS DETECTORS ARE TO BE PROVIDED AT DOWN WIND DIRECTIONS NEAR FILTERS, FLOW METERS, COMPRESSOR, FGC SKID & FAILURE PRONE EQUIPMENT PARTS,ACCESSORIES,VALVES & PIPES. COMPRESSOR/GAS TURBINE TO TRIP ON GAS DETECTION.
22. 20 D UPSTREAM STRAIGHT LENGTH TO BE CONSIDERED FOR INSTALLING GAS CHROMATOGRAPH.
23. METAL BODY ROTAMETER.
24. MAXIMUM BACK PRESSURE AT DOWNSTREAM OF RO-1101 AND RO-1102 TO BE CONSIDERED AS 4 KG/CM2g.

INTERLOCK LOGIC:-

INTERLOCK No.	ACTUATED BY	ACTION UPON
STATION ESD (910-I-1)	ESD PUSH BUTTON ON SCADA/ STATION COMMON PANEL/FIELD	TRIP THE COMPR. TRAIN 910-K-901 OPEN 910-AV-1107 910-AV-1108 910-AV-1109 910-AV-1110 AFTER ENSURING CLOSURE OF VALVES 910-AV-1111 910-AV-1113

ESD LOGIC SHOULD NOT RESET UNTILL AND UNLESS ALL DESIRED ACTIONS ARE ACHIEVED.

LEGEND:

- GTC VENDOR SCOPE / EIL
- EXISTING LINE
- NEW LINE
- * GTC VENDOR SCOPE.
- H : HOLD

No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.
3	04.09.19	REVISED AND REISSUED FOR ENGG.	Varun	GS	JKS	SS
2	11.07.19	HAZOP RECOMMENDATIONS INCORPORATED	Varun	GS	JKS	SS
1	13.06.19	ISSUED FOR HAZOP	Varun	GS	JKS	SS
0	22.04.19	ISSUED FOR ENGG	Varun	GS	JKS	SS
A	20.02.19	ISSUED FOR COMMENTS	Varun	GS	JKS	SS

संख्या | तिथि | संशोधन | ड्रॉन द्वारा | जाँच | अनुमोदित

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GAIL (INDIA) LIMITED
गैल (इन्डिया) लिमिटेड

GT COMPRESSOR PROJECT, GANDHAR

पाइपिंग एण्ड इंस्ट्रूमैन्टेशन डायाग्राम
PIPING AND INSTRUMENTATION DIAGRAM
GANDHAR NEW INSTALLATION
GANDHAR COMPRESSOR STATION

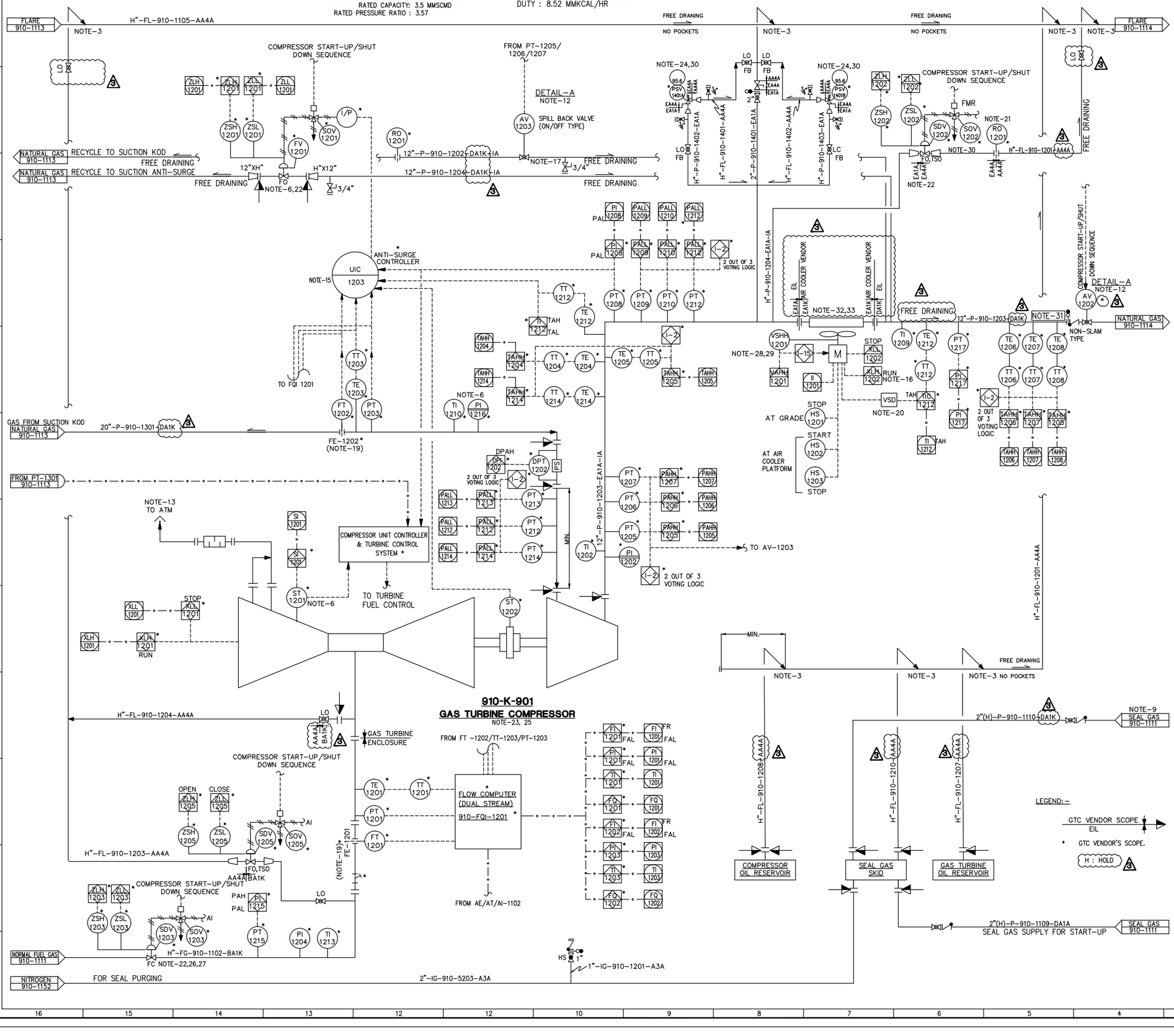
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NTS	B240	02	42	910	1111	3

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910-K-901
GAS TURBINE COMPRESSOR
RATED CAPACITY: 3.5 MMSCMD
RATED PRESSURE RATIO : 3.57

910-EA-901
COMPR. AFTER COOLER
DUTY : 8.52 MMKCAL/HR



NOTES:

1. FOR GENERAL NOTES AND SYMBOLS REFER P&ID. NO. B240-02-42-000-1191/1192/1193.
2. COMPRESSOR TO HAVE FACILITY FOR START/STOP FROM FIELD & STOP FROM SCADA CONTROL CENTER, UCP & CONTROL ROOM.
3. ALL PSV UPSTREAM PIPING/BLOWDOWN PIPING SHALL BE FREE DRAINING TOWARDS EQUIPMENT AND DOWNSTREAM TOWARDS FLARE HEADER. ALL VENTS/PSV DISCHARGE SHALL JOIN THE FLARE HEADER AT AN ANGLE OF 45° IN THE DIRECTION OF FLOW.
4. COMMON TRIP ALARM FOR COMPRESSOR TO BE TELEMETERED TO SCADA.
5. EMERGENCY SHUT DOWN PUSH BUTTON FOR COMPR. TRAIN SHALL BE PROVIDED IN MCC, UCP, STATION COMMON PANEL & LOCAL AT EACH SKID.
6. TO BE LOCATED AT HIGH POINT.
7. ALL INSTRUMENT TAG NOs. SHALL BE PRECEDED BY UNIT NO-910.
8. THE INSTRUMENTATION AND CONTROLS INDICATED FOR COMPRESSORS ARE MINIMUM REQUIRED FROM PROCESS. VENDOR TO PROVIDE ADDITIONAL INSTRUMENTATION CONTROL AND TRIPS REQUIRED FOR MACHINE SAFETY.
9. NORMAL/EMERGENCY SEAL GAS SUPPLY WILL BE TAKEN FROM COMPRESSOR DISCHARGE. VENDOR TO PROVIDE FLOW INDICATION AND ALARM IN SEAL GAS SUPPLY LINE. PRESSURE REDUCTION FACILITY, IF ANY REQUIRED IN SEAL GAS SYSTEM SHALL BE PROVIDED BY COMPRESSOR VENDOR.
10. ALL THE INDICATIONS, RECORDING OF INSTRUMENTS AND ALL ANNUNCIATORS INDICATED IN THIS P&ID SHALL BE IN UNIT CONTROL PANEL AND SHALL BE REPEATED IN GTC TRAIN PLC PLC IS IN GTC PACKAGE'S SCOPE.
11. ACOUSTIC INSULATION SHALL BE PROVIDED ON FOLLOWING LINES.
    - COMPR. MIN. FLOW LINES AND SPILL BACK FLOW LINE.
    - COMPR. SUC. LINE FROM SUCTION VALVE TO SUCTION NOZZLE.
    - COMPR. DISCHARGE LINE FROM DISCHARGE NOZZLE TO AFTER COOLER.
12. FOR DETAILS REFER P&ID No. B240-02-42-910-1111.
13. VENT SHALL BE LOCATED AT A SAFE HEIGHT (3 METER ABOVE THE HIGHEST WORKING PLATFORM) WITH RAIN CAP.
14. FUEL GAS FLOW SHALL BE INTEGRATED FOR COMPRESSOR TRAIN & SHALL BE TELEMETERED TO SCADA.
15. VENDOR SHALL HAVE THE OPTION OF TAKING COMPENSATED OR UNCOMPENSATED FLOW FOR UNIT COMPRESSOR CONTROLLER.
16. TYPICAL INSTRUMENTATION FOR A COOLER FAN IS SHOWN.
17. AV-1203 IS A SPILL BACK VALVE ACTUATED BY SIGNAL FROM ATLEAST TWO OUT OF THREE PT/PAHH AT THE COMPRESSOR DISCHARGE. THE VALVE SHALL BE ON/OFF TYPE.
18. SIGNAL TO SCADA WILL BE BY SEPARATE SERIAL LINK FROM EACH PLC.
19. STRAIGHT LENGTH AS PER INSTRUMENTATION REQUIREMENT.
20. 50% OF FAN MOTORS IN COMPRESSOR AFTER COOLER SHALL BE PROVIDED WITH VARIABLE SPEED DRIVE (VSD) TO SAVE ENERGY & DISCHARGE TEMPERATURE WILL BE CONTROLLED THROUGH VSD.
21. SDV-1202 & RO-1201 SIZE ACCORDING TO COMPRESSOR MANUFACTURER DEPRESSURISATION REQUIREMENTS.THE FLARE BACKPRESSURE IS 5.0 KG/CM2A.
22. ALL THE INSTRUMENT AIR OPERATED VALVES TO BE PROVIDED WITH VOLUME BOTTLE FOR ATLEAST 3 VALVE STROKES OPERATION DURING INSTRUMENT AIR FAILURE.
23. REFER COMPRESSOR VENDOR P&ID FOR INSTRUMENTATION SCOPE & DETAILS.
24. MAXIMUM RELIEF RATE SHOULD BE POSSIBLE WITH ONE PSV OUT OF SERVICE (N WORKING+ 1 STAND BY).
25. THE COMPRESSOR SHALL BE PROVIDED WITH SHUT DOWN AND DEPRESSURISATION IN THE EVENT OF FAILURE OF SEALS.
26. SDV-1203 TO BE LOCATED AT MIN. 15 METERS AWAY FROM COMPRESSOR SHED.
27. SDV-1203,(1202 & 1205) SHALL BE FIRE SAFE AND THEIR ASSOCIATED ACCESSORIES LIKE ACTUATOR,CABLES,ETC. ARE FIRE-SAFE/FIRE PROOF.
28. TYPICAL FOR EACH FAN AND THESE SHALL BE AIR COOLER VENDOR SCOPE OF SUPPLY. VIBRATION SWITCH SHALL BE PROXIMITY TYPE.
29. VIBRATION HIGH-HIGH ALARM AN TRIPPING OF FAN SHALL BE SIMULTANEOUS. VENDOR SHOULD PROVIDE A CONTACT SIGNAL FOR EACH VSHH FOR ALARM IN DCS.
30. MAXIMUM BACK PRESSURE AT DOWNSTREAM OF RO-1201 & PSV-1401A/B TO BE CONSIDERED AS 4 KG/CM2g.
31. SLUG FLOW EXPECTED IN TWO PHASE FLOW LINES. ADEQUATE SUPPORT TO BE PROVIDED.
32. SYMMETRICAL PIPING TO BE PROVIDED FOR AIR COOLER INLET AND OUTLET.
33. TOTAL NO. OF FANS = 4. PROVIDE AMPERAGE INDICATION FOR EACH FAN IN DCS.

INTERLOCK LOGIC:-

INTERLOCK No.	ACTUATED BY	ACTION UPON
910-I-2	PT/PALL-1212/13/14 (2 OUT OF 3) PT/PALL-1209/10/12 (2 OUT OF 3) PT/PAHH-1205/06/07 (2 OUT OF 3) TT/TAHH-1204/05/14 (2 OUT OF 3) TT/TAHH-1206/07/08 (2 OUT OF 3)	OPEN 910-FV-1201 TRIP 910-K-901. OPEN 910-AV-1203 UPON PAHH-1205/06/07 NOTE-17
910-I-15	910-VAHH-1201	TRIP RESPECTIVE RUNNING FAN OF 910-EA-901

PROVIDE TRIP BYPASS FOR START UP FOR PT/PALL-1214/1212/1213.

No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.
3	04.09.19	REVISED AND REISSUED FOR ENGG.	Varun	GS	JKS	SS
2	11.07.19	HAZOP RECOMMENDATIONS INCORPORATED	Varun	GS	JKS	SS
1	13.06.19	ISSUED FOR HAZOP	Varun	GS	JKS	SS
0	22.04.19	ISSUED FOR ENGG.	Varun	GS	JKS	SS
A	20.02.19	ISSUED FOR COMMENTS	Varun	GS	JKS	SS

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GT COMPRESSOR PROJECT, GANDHAR

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PIPING AND INSTRUMENTATION DIAGRAM

GANDHAR NEW INSTALLATION

TYPICAL COMPRESSOR DETAILS FOR COMPRESSOR TRAIN

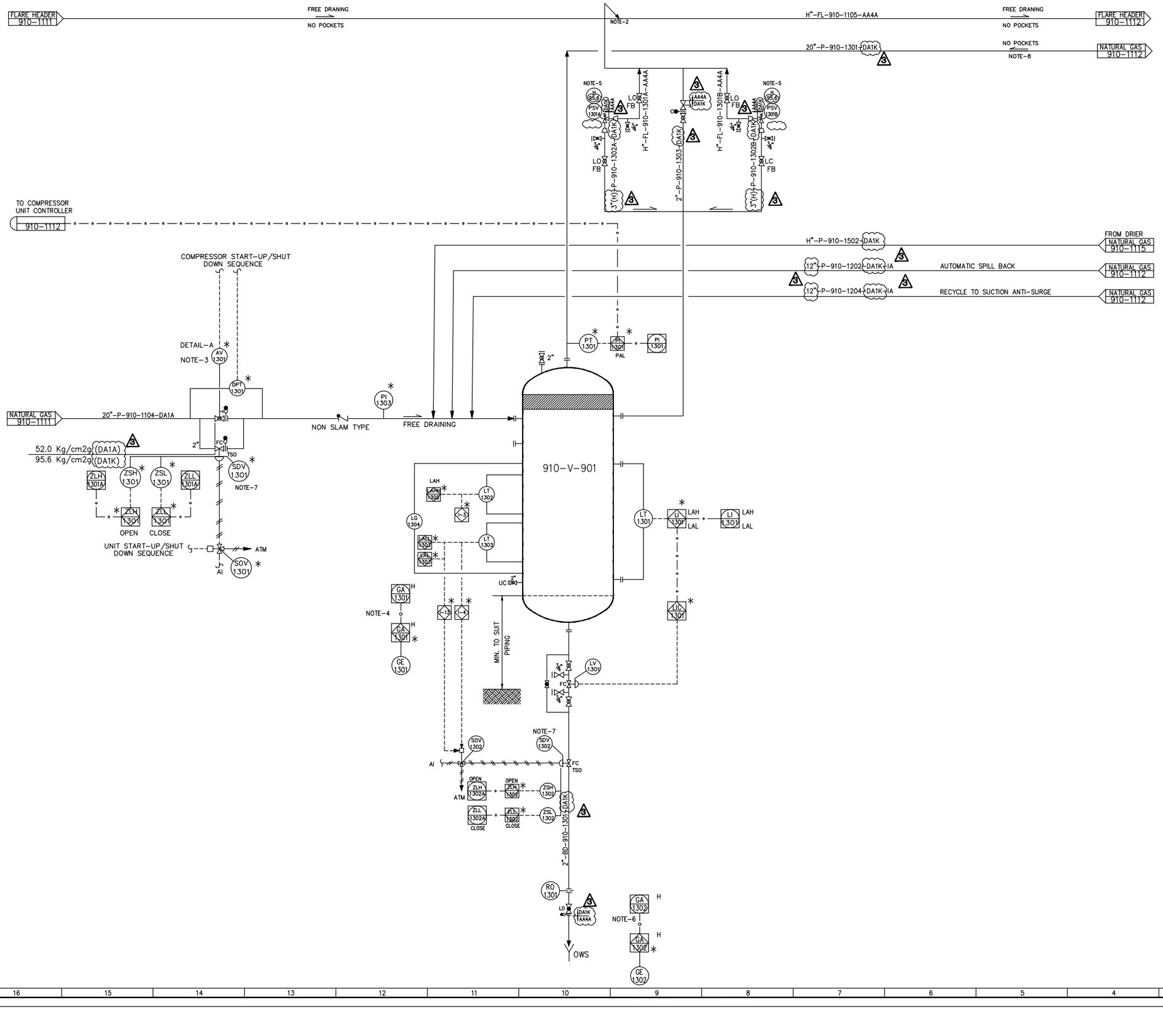
SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
NTS	B240	02	42	910	1112	3

EIL-0241-502-REV-0-A

DISTRIBUTION CODE

910-V-901
NATURAL GAS COMPRESSOR
SUCTION K.O. DRUM

SIZE : DIA 2000mm, HEIGHT :5100mm



NOTES :-

1. FOR LEGEND AND GENERAL NOTES, REFER P&ID DWG. NO. B240-02-42-000-1191/1192/1193.
2. ALL PSV UPSTREAM PIPING SHALL BE FREE DRAINING TOWARDS EQUIPMENT AND DOWNSTREAM TOWARDS FLARE HEADER. PSV DISCHARGE SHALL JOIN THE FLARE HEADER AT AN ANGLE OF 45° IN THE DIRECTION OF FLOW.
3. FOR DETAILS REFER P&ID NO. B240-02-42-910-1111.
4. GAS DETECTORS ARE TO BE PROVIDED AT DOWN WIND DIRECTIONS NEAR SUCTION KO DRUM. ALARM SIGNAL FROM GAS DETECTOR WILL BE TAKEN TO SMCS AND CONTROL ROOM.
5. MAXIMUM RELIEF RATE SHOULD BE POSSIBLE WITH ONE PSV OUT OF SERVICE (1 WORKING + 1 STAND BY).
6. GE-1302 GAS DETECTOR TO BE PROVIDED NEAR OWS FUNNEL.
7. SDV-1301 & SDV-1302 & (AV-1301) SHALL BE FIRE SAFE AND THEIR ASSOCIATED ACCESSORIES LIKE ACTUATOR,CABLES,ETC. ARE FIRE-SAFE/FIRE PROOF. (3)
8. PIPE FROM SUCTION KOD TO COMPRESSOR SHALL HAVE NO POCKETS, LINE SHALL BE FREE DRAINING TOWARDS KOD.
9. FIRE WATER SPRINKLER SYSTEM TO BE PROVIDED FOR KOD 910-V-901. (3)

INTERLOCK LOGIC:-

INTERLOCK NO.	ACTUATED BY	ACTION UPON
910-I-3	LAHH-1302	TRIP THE COMPRESSOR 910-KA-101
910-I-4	LALL-1303	CLOSE SDV-1302
910-I-13	LAL-1303	OPEN SDV-1302

LEGEND:-

* GTC PACKAGE VENDOR'S SCOPE.

H : HOLD (3)

No.	DATE	REVISIONS	DRN	CHKD	APPD.
3	04.09.19	REVISED AND REISSUED FOR ENGG.	Varun	GS	JKS	SS
2	11.07.19	HAZOP RECOMMENDATIONS INCORPORATED	Varun	GS	JKS	SS
1	13.06.19	ISSUED FOR HAZOP	Varun	GS	JKS	SS
0	22.04.19	ISSUED FOR ENGG.	Varun	GS	JKS	SS
A	20.02.19	ISSUED FOR COMMENTS	Varun	GS	JKS	SS

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GAIL (INDIA) LIMITED
गैल (इन्डिया) लिमिटेड
GT COMPRESSOR PROJECT, GANDHAR

पाइपिंग एण्ड इंस्ट्रूमेन्टेशन डायाग्राम
PIPING AND INSTRUMENTATION DIAGRAM
NATURAL GAS COMPRESSOR
SUCTION K. O. DRUM

अनुमाप SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG. No.	संशो. REV.
NTS	B240	02	42	910	1113	3

EIL-0241-502-REV-0-A

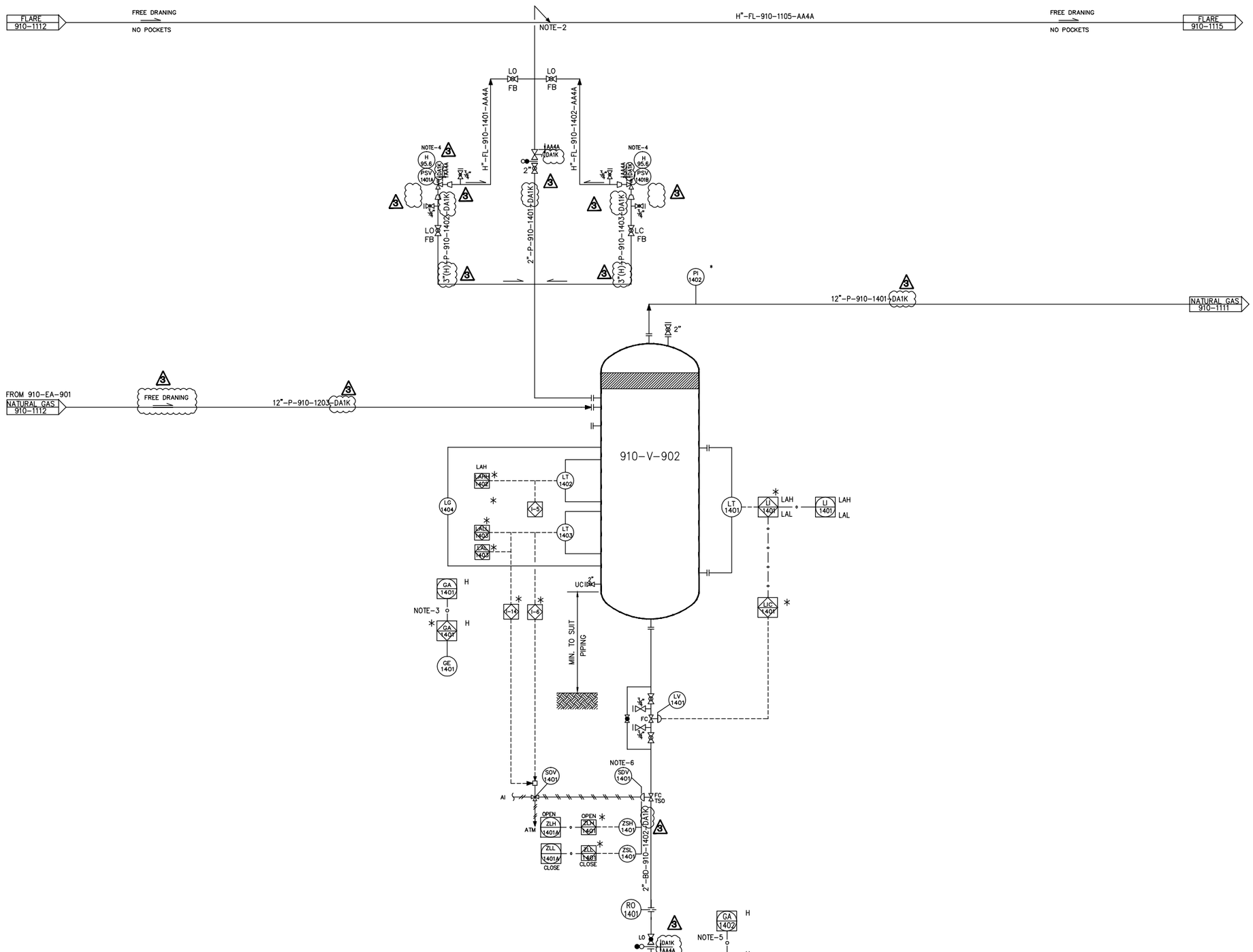
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910-V-902
NATURAL GAS COMPRESSOR DISCHARGE K.O. DRUM

SIZE : DIA 1800mm, HEIGHT : 4600mm



NOTES:

1. FOR LEGEND AND GENERAL NOTES REFER TO P&ID NO. B240-02-42-000-1191/1192/1193.
2. ALL PSV UPSTREAM PIPING SHALL BE FREE DRAINING TOWARDS EQUIPMENT AND DOWNSTREAM TOWARDS FLARE HEADER. PSV DISCHARGE SHALL JOIN THE FLARE HEADER AT AN ANGLE OF 45° IN THE DIRECTION OF FLOW.
3. GAS DETECTORS ARE TO BE PROVIDED AT DOWN WIND DIRECTIONS NEAR DISCHARGE KO DRUM. ALARM SIGNAL FROM GAS DETECTOR WILL BE TAKEN TO SMCS AND CONTROL ROOM.
4. MAXIMUM RELIEF RATE SHOULD BE POSSIBLE WITH ONE PSV OUT OF SERVICE (N WORKING+ 1 STAND BY).
5. GE-1402 GAS DETECTOR TO BE PROVIDED NEAR OWS FUNNEL.
6. SDV-1401 SHALL BE FIRE SAFE AND THEIR ASSOCIATED ACCESSORIES LIKE ACTUATOR,CABLES,ETC. ARE FIRE-SAFE/FIRE PROOF.

INTERLOCK LOGIC:-

INTERLOCK NO.	ACTUATED BY	ACTION UPON
910-I-5	LAHH-1402	TRIP 910-KA-101
910-I-6	LALL-1403	CLOSE SDV-1401

LEGEND:-

* GTC PACKAGE VENDOR'S SCOPE.

H : HOLD ③

No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.
3	04.09.19	REVISED AND REISSUED FOR ENGG.	Varun	GS	JKS	SS
2	11.07.19	HAZOP RECOMMENDATIONS INCORPORATED	Varun	GS	JKS	SS
1	13.06.19	ISSUED FOR HAZOP	Varun	GS	JKS	SS
0	22.04.19	ISSUED FOR ENGG.	Varun	GS	JKS	SS
A	20.02.19	ISSUED FOR COMMENTS	Varun	GS	JKS	SS

संख्या तिथि संशोधन REVISIONS ड्रॉन द्वारा DRN BY जाँच CHKD अनुमोदित APPD.

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GT COMPRESSOR PROJECT, GANDHAR

पाइपिंग एण्ड इंस्ट्रूमेन्टेशन डायग्राम
PIPING AND INSTRUMENTATION DIAGRAM
NATURAL GAS COMPRESSOR
DISCHARGE K.O. DRUM

अनुमाप SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG. No.	संशो. REV.
NTS	B240	02	42	910	1114	4

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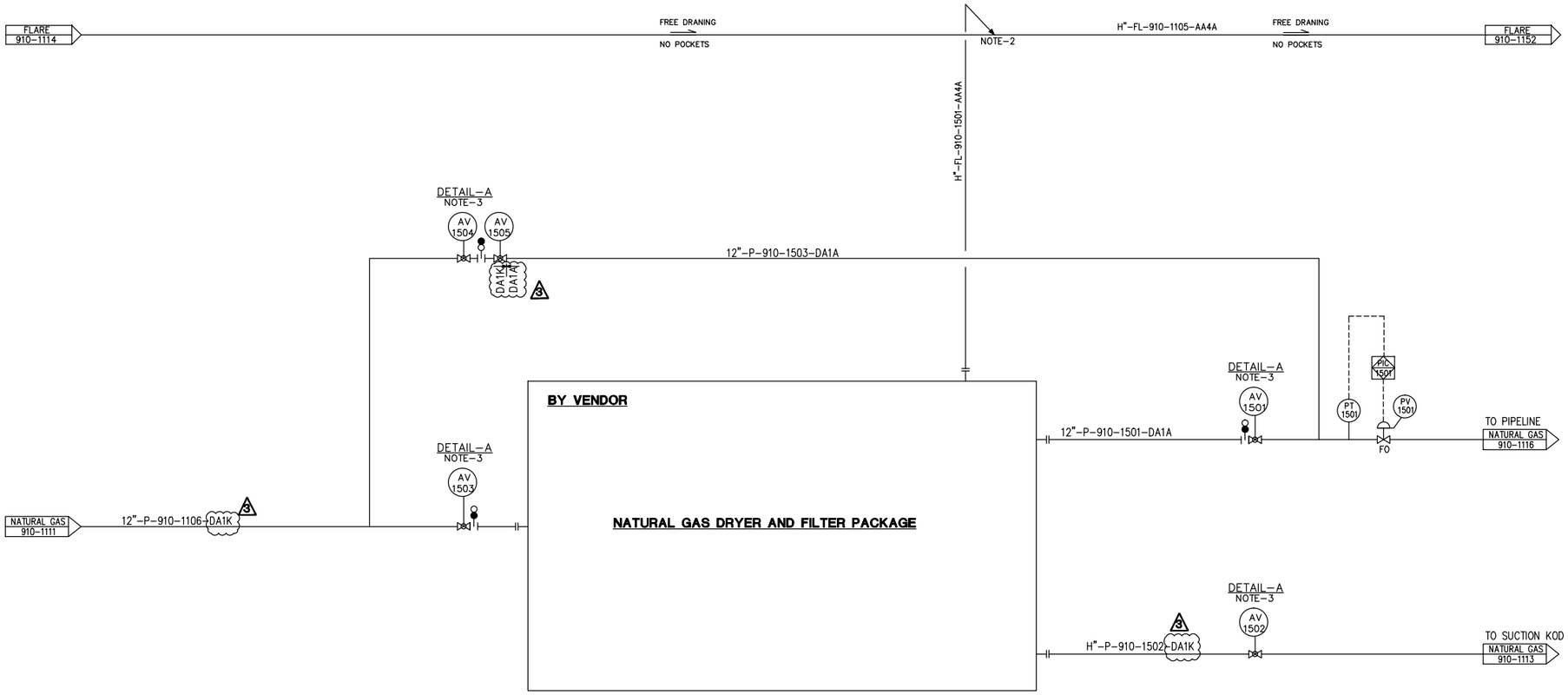
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910-LZ-001

NATURAL GAS DRYER AND FILTER PACKAGE

TYPE: MOLECULAR SIEVE BED (1 OPERATING + 1 REGENERATION MODE)



NOTES:

1. FOR LEGEND AND GENERAL NOTES REFER TO P&ID NO. B240-02-42-000-1191/1192/1193.
2. ALL PSV UPSTREAM PIPING SHALL BE FREE DRAINING TOWARDS EQUIPMENT AND DOWNSTREAM TOWARDS FLARE HEADER. PSV DISCHARGE SHALL JOIN THE FLARE HEADER AT AN ANGLE OF 45° IN THE DIRECTION OF FLOW.
3. FOR DETAILS REFER P&ID NO. B240-02-42-910-1111.

No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.
3	04.09.19	REVISED AND REISSUED FOR ENGG.	Varun	GS	JKS	SS
2	11.07.19	HAZOP RECOMMENDATIONS INCORPORATED	Varun	GS	JKS	SS
1	13.06.19	ISSUED FOR HAZOP	Varun	GS	JKS	SS
0	22.04.19	ISSUED FOR ENGG.	Varun	GS	JKS	SS
A	20.02.19	ISSUED FOR COMMENTS	Varun	GS	JKS	SS

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गैल (इन्डिया) लिमिटेड

GT COMPRESSOR PROJECT, GANDHAR

पाइपिंग एण्ड इंस्ट्रूमेन्टेशन डायग्राम
PIPING AND INSTRUMENTATION DIAGRAM

GANDHAR NEW INSTALLATION

NATURAL GAS DRYER AND FILTER PACKAGE

अनुमाप SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG. No.	संशो. REV.
NTS	B240	02	42	910	1115	3

EIL-0241-502-REV-0-A

DISTRIBUTION CODE

JOB SPECIFICATION (ELECTRICAL)

GAS TURBINE COMPRESSORS

(MR No. – B240-910-KA-MR-5010)

PROJECT : INSTALLATION OF GAS TURBINE COMPRESSOR AT GPU GANDHAR

OWNER : M/s GAIL

JOB NO. : B240

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
A	08.04.2019	ISSUED WITH MR	DK	SH	ANPS

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1. **Site Conditions**

Maximum Ambient Temp.	:	47^0C
Minimum Ambient Temp.	:	6^0C
Relative Humidity	:	90 %
Equipment design Temp.	:	40^0C

2. System voltage and frequency

2.1. Utilization voltage

1. 415V (nominal) 3 phase 4 wire solidly earthed neutral: This voltage shall be used for all motors above 0.37kW & upto and including 160KW as well as all other three phase loads.

2. 240V (nominal) 1 phase 3 wire 50Hz earthed: This voltage shall be used for low power single phase loads such as lighting, small power sockets, motors rated below 0.37KW etc.

2.1. Voltage and frequency variation

The following maximum variation shall be considered for equipment design:

a) Voltage : Differing from its nominal value by not more than ±10%.

b) Frequency: Differing from its nominal value by not more than ±5%.

3. Brief Description of Electrical system

3.1. Purchaser will provide 2 no power supply from Owner's EPMC for feeding the GTMCC supplied by bidder along with power cables.

3.2. Purchaser shall provide 110V AC UPS feeder for feeding the UPS distribution board at control room for feeding the Instrumentation loads (Refer elsewhere for load details).

3.3. Any other voltage required for the operation of GT system loads shall be derived by vendor.

3.4. Control cabling for local push button station/local control panel to MCC and MCC to PLC/DCS interface shall also be provided by Purchaser.

3.5. The system shall be complete in all respects with required interlocks for the desired sequence of operation and controls, selections, indications and alarms etc.

4. **WORKS EXCLUDED**

The following works / item are excluded from the scope of the bidder:

4.1. Supply of 415V feeders upstream of GT MCC.

4.2. Supply, laying and termination of power and control cables from the Owner's switchboards in Substation to the electrical loads installed at the Compressor skid.

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4.3. Supply, laying and termination of interface cables between Owner's switchboards in Substation and Instrumentation panels for DCS interface.

4.4. Supply, laying and termination of UPS power cables upto UPS Distribution board in control room.

4.5. All cable trays / trenches for owner's cables outside Skid.

5. AREA CLASSIFICATION & EQUIPMENT SELECTION

5.1. Area classification for the compressor shall be as under:

Sl. No	Equipment	Type of enclosure protection
1.	910-K-151	Ex-de , Zone-2, IIA/IIB, T3

5.2. The minimum enclosure protection shall be:

Sl. No	Equipment	Type of enclosure protection
1.	Auxiliaries for 10-K-151	
	i) MV Motors & Heaters	Flame proof, Ex-de, Gas group - IIA/IIB, Temp class T3
	ii) LCS/LCP	Flame proof, Ex-d, Gas group - IIA/IIB, Temp class T3
	iii) DC motors if any	
	iv) Lighting panel/ Fixtures as reqd.	

5.3 Flameproof Ex d equipment shall meet the requirement of IS/IEC: 60079-1. All indigenous flameproof equipment (Ex d type) shall be manufactured under BIS license.

5.4 All electrical equipment for use in hazardous areas shall be certified by CIMFR, PTB, Baseefa, UL, FM or equivalent independent testing agency for the service and the area in which it can be used and shall be approved by PESO/CCOE. Copies of Hazardous area test certificates & PESO/ CCOE approval shall be furnished. As per statutory requirement in India, the approval from PESO/CIMFR must be submitted for equipment to be installed in hazardous area.

6. ENGINEERING AND JOB SPECIFIC REQUIREMENTS

6.1. Bidder shall ensure that all electrical equipment comply to site and system conditions, rating and other technical requirement as specified in the MR.

6.2. Bidder shall use this specification, datasheet, and OWNER/ EIL's standard specifications for various equipment.

6.3. The equipment shall in general conform to latest revision of statutory regulations, Indian Standards, IEC / Other international standards applicable for the country of origin of the equipment.

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6.4. All equipment shall be subjected to routine and acceptance tests as per applicable specifications.

6.5. Besides these, the following requirements as detailed out in respective clauses for the equipment shall also be considered:

6.6. MV MOTOR

6.6.1. MV motors (415 V) shall conform to EIL Specification for high efficiency motors 6-51-0064, relevant clauses of EIL specification for MV VFD, 6-51-0038 (VFD Driven only), as applicable, and MV Motor data sheet no. B240-010-16-50-DS-5010/11.

6.6.2. Motors in general shall be asynchronous squirrel cage type having synchronous speed of 1500 rpm.

6.6.3. All MV motors shall be of high energy efficiency type IE2 as per IS-12615.

6.6.4. All outdoor motors shall be provided with FRP canopy.

6.6.5. Exact cable sizes of power and control cables shall be finalized during detailed engineering. Provisions, as required in Vendor's equipment for termination of the same, shall be made accordingly without any cost & time implications to Owner. Vendor shall supply accessories such as cable glands, lugs, etc. for the furnished cable size. In case of limitation of cable size for termination of power cables, required Flameproof Junction box suitable for Gas group IIA/IIB, Temperature class: T3 shall be provided without any cost & time implications to Purchaser.

6.6.6. Variation / Clarifications against the standard specification of MV Motor 6-51-0064, shall be as per the MOU agreed with EIL by respective motor manufacturer. No further deviations shall be entertained.

6.6.7. The VFD controlled motors shall be designed considering cooling at lowest operating speed as defined in pump data sheet. Compliance with this aspect shall be established by the bidder during detailed engineering/drawing review stage. In this regard, bidder shall furnish combined test certificates for temperature rise in the motor surface (Identical) for the complete range of speed variation. In case, valid type tests are not available, the tests shall be conducted by the bidder without any time and cost implication. Combined test shall be applicable for identical rated VFD & motor (i.e. kw rating. Model, make of job VFD & tested VFD shall be same & in case of motor, kw rating, make & frame size shall be same). In case of combined test to be performed on job VFD & job motor, VFD panels shall be shipped to motor manufacturer's works.

6.6.8. Motor frame size shall be selected based on the lowest operating speed as per process requirement.

6.7. MV SWITCHBOARD

6.7.1. MV switchboard/MCC supplied for feeding the various loads of Gas Turbine Compressor shall be located in MCC room/nearest Substation. The MV switchboard shall be compartmentalized and draw-out type.

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6.7.2. Variation / Clarifications against the standard specification of MV Switchboard 6-51-0018, shall be as per the MOU agreed with EIL by respective motor manufacturer. No further deviations shall be entertained.

6.7.3. MV Switchboard shall have two incomers and 1 No. bus coupler. Ratings of outgoing feeders and their configuration shall be inline with the hardware datasheet document no. B240-910-16-50-DS-5014, Component datasheet document no. B240-910-16-50-DS-5015 and other EIL specifications attached.

6.7.4. Incomer at GT MCC shall be suitable for fault level of 50 kA (for 1 sec.). At least 20% spare outgoing feeders, subject to a minimum of 1 of each type shall be provided in GT MCC switchboard. For FVNR/FVR feeders, type and rating designation (e.g. FVNR-15, FVR-15, FVNR-15 HD etc. as per M.V. switchboard data sheet) shall be considered for working out number of spares. For switch fuse feeders, switch rating shall be considered for working out number of spares. Feeders in MCC shall be rated suitably considering 20% margin.

6.7.5. Bidder shall furnish a list of control cables to be provided by owner for signals exchanged between Bidder supplied equipment at substation and Bidder supplied field equipment as well as PLC along with Offer.

6.7.6. Bidder shall furnish the maximum operating power demand of GTC MCC for which owner's incoming cable has to be sized along with Offer.

6.8. DC SYSTEM

6.8.1. DC system envisaged shall meet the technical requirements of Datasheet no. B240-16-50-DS-5016 and EIL standard specification for DC System document no. 6-51-0019 and Inspection test plan 6-81-1019.

6.8.2. DC system shall be redundant system with 1 x 100% batteries as per Option-I of EIL specification for DC System document no.6-51-0019.

6.8.3. Batteries shall be Ni-Cd type with sufficient backup time. Backup time shall be decided by bidder based on the GT requirement. This time shall be adequately sufficient for Machine safety requirements.

6.8.4. All interconnecting cables among battery, Charger and DCDB shall be in bidder's scope.

6.8.5. DC System including DCDB shall be located in MCC room/ switchgear hall of nearest substation and their batteries shall be located in the battery room of nearest substation/ MCC Room. Distance between battery and charger shall be around 100m. Exact length shall be worked out during detailed engineering.

6.9. VARIABLE FREQUENCY DRIVE PANEL

6.9.1. The VFD system having converter input voltage rated 415V shall conform to EIL specification 6-51-0038 and datasheet no. B240-010-16-50-DS-5012.

6.9.2. Operator console on VFD (external port will be provided) shall have facility/port to connect external hardware such as Laptop etc. Console shall have facility for upload and download all parameter settings from one drive to another identical drive for start up and operation. All the load parameters shall be visible at this operator console. In addition to that, manual alteration of load parameter can also be possible through this operator console.

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6.9.3. Bidder shall ensure that, entire VFD module & its components (i.e. rectifier, inverter etc.) shall be procured from OEM only.

6.9.4. Following mentioned facilities/provision (min.) shall be provided in offered VFD panels:-

Interface with LCS

- Local start push button
- Local stop push button
- Local/remote selection switch with locking facility
- Run indication lamp
- Speed increase push button
- Speed decrease push button
- Trip indication lamp
- Ready to start indication lamp
- Ammeter (range: 0 to 150% of full load current of motor)

Interface with PLC/DCS

- Start/stop
- Start permissive.
- Speed setpoint.
- Current feedback.

Accordingly, control schematic of VFD panel shall be prepared.

6.9.5. Following indications/controls are to be provided in the facia panel of VFD

a) Emergency STOP
b) One no. emergency push button with locking arrangement to trip upstream feeding breaker
c) Other control/metering/indication requirements as mentioned in EIL specification (6-51-0038)

6.9.6. For VFD panel, owner shall not provide any auxiliary power supply. Whatever is required shall be derived with in VFD only. Quantum of UPS control supply (110V) if any required shall be furnished with Offer.

6.9.7. VFD shall be suitable for operation in non-air-conditioned environment at rated design ambient temperature. VFD shall be located in MCC Room/nearest substation. Distance between VFD to Motor shed shall be of the order of 250m approx.

6.9.8. Requirement of dedicated clean earth for VFD system (if any) and separate protective earthing is not envisaged. Vendor to confirm.

6.9.9. 240V, 1-Phase power supply to the motor space heater shall be derived from VFD. Necessary arrangement for these supplies shall be made available by vendor in VFD panels.

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6.10. LOCAL CONTROL STATIONS

6.10.1. Flameproof control stations (IP-55) for all motors, emergency stop push buttons for motors as required for plant operation and safety etc., shall be provided by the vendor in accordance with standard specification no. 6-51-0006.

6.10.2. Outdoor area Local control stations shall have FRP canopies for additional weather protection.

6.10.3. Following facilities shall be provided as a minimum on LCP/LCS:

i). Start/Stop push buttons for all motors

ii). Ammeters for motor above 5.5kW. Field ammeter shall be analogue type with mark of full load current (FLC) and 150% overload.

iii). L-O-R (Local-Off-Remote) Selector switches as required Lockable type with key.

iv). Field RPM meter shall be suitable for 0-110% of rated speed.

6.11. MISCELLANEOUS

6.11.1. Equipment like Lube oil filling pump, lubricating oil centrifuge, gas turbine washing system, trolley mounted pumps etc. shall be complete with flame proof motors and their flameproof starters suitable for use in Zone-2, Gas group (as applicable), Temp class T3, with armored copper conductor trailing cable. Motor starter shall have motor protections, other hardware such as switch, fuse, contactor and BMR etc.

6.11.2. Trolley mounted pumps shall be powered from a nearby 5 pin socket to be supplied by bidder.

6.11.3. Equipment earthing shall be done at 2 points and both earth connections shall be brought to an earth plate to be provided on the skid by the bidder. Further, Purchaser shall connect from skid earth plate to main plant earth grid.

6.11.4. All motors shall be earthed by two different connections using flexible braided GI wires with proper lugging as per Equipment earthing schedule.

6.11.5. All electrical equipment including cables, lighting fixtures etc. inside the turbine enclosure shall be suitable for the maximum temperature inside the turbine enclosure.

6.11.6. Gas turbine enclosure shall be provided with interior flameproof lighting fixtures wired to a switch mounted outside the enclosure. Flameproof 15A (SPN+E) power receptacles (Plug and socket) shall also be provided. Lighting fixtures shall be LED Type with mechanical protection and other accessories. Armoured cables shall be used inside the enclosure.

6.11.7. All imported equipment must be of reputed make and the equipment must have been operating satisfactorily for atleast 8000 hours and must have been supplied and in operation at minimum 2 installations.

6.11.8. Lux level for lighting design shall be as follows;

a. Instt and control faces: 300 Lux (Locally mounted on skid)

b. Turbine enclosure: 150 Lux.

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6.11.9. Single point power supply (415V AC supply) shall be considered for oil filling pump, Lubrication oil centrifuge, gas turbine washing system. Further distribution to skid mounted electrical equipment shall be within the skids.

6.11.10. All material for aviation lights and lightning protection of all tall structures (stacks etc.) shall be included in bidder's scope.

6.11.11. Vendor shall supply Nickel plated brass double compression cable glands and tinned Cu crimping type lugs for equipment supplied by them. No cost / time implication shall be applicable on account of this). For outdoor equipment, double compression type Nickel plated brass flameproof cable glands shall be supplied. The size of cable glands supplied shall be appropriate to the size of cable.

6.11.12. All cable glands/ adapters/ blocking plugs for hazardous area equipment shall meet the requirements of IS/IEC: 60079-0.

6.11.13. All nuts and bolts shall be of stainless steel SS-304.

6.11.14. Prefabricated FRP canopy shall be provided for all outdoor equipment.

6.11.15. All hardware necessary for interfacing control system signals with Purchaser's motors starters shall be in bidder's scope. Bidder shall furnish a sketch for the signals to be exchanged between Purchaser's motor starters and bidder's local control panels (if any).

6.11.16. Bidder shall furnish a list of control cables to be provided by Purchaser for signals exchanged between Purchaser's motor starters and Bidder supplied field equipment and control room equipment.

6.11.17. All interconnecting cables between bidder's electrical equipment within bidder's scope shall be provided along with cable supporting materials like cable glands, lugs, cable supports, cable tags, ferrules, etc.

6.11.18. Exact cable sizes of power and control cables shall be finalized during detailed engineering. Provisions, as required in Vendor's equipment for termination of the same, shall be made accordingly without any cost & time implications to Owner.

7. INSPECTION AND TESTING AT MANUFACTURER'S WORKS

All major electrical equipment and material shall be subject to inspection by owner/ EIL/TPIA or authorized representative at manufacturers' works. Contractor/Vendor/ Sub-Vendor shall furnish all necessary information concerning the supply to owner/ EIL.

Type, routine and acceptance tests to be conducted on all equipment shall include all tests as specified in standard specifications, data sheets and ITPs enclosed with the MR.

All the equipment offered shall have valid type test certificates of recognized testing house such as CPRI, CMRI, BASEEFA or equivalent and valid CCOE approval.

8. Makes of Electrical Equipment/Component

The make of all electrical equipment shall be as below:-.

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	Equipment	Acceptable makes
1	AC MV VFD	ABB Limited, Asea Brown Bovery Ltd (Abb Ltd), Baldor Electric Company Cg Power & Industrial Solutions Ltd. Danfoss Industries Pvt Ltd, Eurotherm Del India Pvt Ltd, Hitachi Hirel Power Electronics Pvt Ltd, Karl E Brinkmann Gmbh, L & T, Mediensha Corp, Nidec Asi Spa, Rockwell Automation India Pvt Ltd, Siemens Ag, Siemens Ltd Siemens Allis Energy Products, Toshiba Corp, Vacon Controls & Drives Pvt Ltd, Vacon Oyj
2	MV Motor (Indigenous)	ABB Limited, Bharat Bijlee Limited Crompton Greaves Ltd, Laxmi Hydraulics. Pvt Ltd, Kirloskar Electric Co Limited Marathon Electric Motor I Ltd
3	MV Motor (Imported)	Asea Brown Bovery Ltd (Abb Ltd), Nidec Asi Spa, Cemp Srl, Ge Power Conversion France Sas, Ge Canada Hitachi Ltd, Hyundai Heavy Industries Ltd Jeumont Sa / Framatone Anp, Lloyd Dynamowerke Gmbh & Co Ltd, Loher Gmbh. Siemens Ag, Toshiba Corporation, Toshiba Mitsubhishi Electric Ind Co System, Weg Equipamentos Eletricos S.A, Weg Euro Idndustria Electrica Sa
.4	Flameproof control stations/Junction box/Plugs/Sockets	Baliga Lighting Equipments (P) Limited. Flexpro Electricals Pvt Ltd. Flameproof Equipment pvt.Ltd. Fcg Power Industries Pvt Ltd. Fcg Flamproof Control Gears P. Ltd. Petroleum Safety Products Ind. Pvt. Ltd. Kaysons Techno Equipment P Ltd. Pepperl & Fuchs Manufacturing (India) Pvt Ltd Sudhir Switchgears Pvt Ltd.
.5	MV Switchboard	ABB india Ltd, Controls & Schematics, GE Industrial Pvt Ltd. L & T Schneider Electric India Pvt Ltd. Siemens Ltd.

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	Equipment	Acceptable makes
.6	DC System	Amara Raja Power Systems Borri Spa Chhabi Electricals Pvt Ltd. Chloride Power Systems And Solutions Dubas Engineering Pvt Ltd. Hbl Power System Ltd Masstech Controls Pvt Ltd. Universal Instrument Mfg Co Pvt Ltd
.	Battery Ni-Cd	Amco SAFT India LTD HBL Power System Ltd
.	Flameproof Lighting Fixture	Baliga Lighting Equipments (P) Limited. Bajaj Electricals Ltd Flexpro Electricals Pvt Ltd. Flameproof Equipments Pvt.Ltd. Fcg Power Industries Pvt Ltd. Fcg Flamproof Control Gears P. Ltd. Petroleum Safety Products Ind. Pvt. Ltd. Kaysons Techno Equipment P Ltd. Pepperl & Fuchs Manufacturing (India) Pvt Ltd Sudhir Switchgears Pvt Ltd.

NOTES:

a) Bidder may procure material from any of the Owner/EIL approved vendors. However, current validity and range of approval as per EIL enlistment letter, work-load, stability and solvency needs to be verified by the bidder before placement of order.

b) Makes of items not covered above shall be subject to Owner/EIL's approval.

c) Bidder may procure material from any of the Owner/ EIL approved vendors. However current validity and range of approval as per EIL enlistment letter, work load, stability and solvency needs to be verified by the bidder before placement of order. Intimation for the same shall be furnished along with PTR.

d) Equipment shall be procured from OEM only. Channel partner/system house shall not be acceptable.

9. LIST OF ATTACHMENTS:

SlNo.	Title	Document No.	Rev.
1.	Data Sheet – MV Motors (DOL)	B240-910-16-50-DS-5010	A
2.	Data Sheet – MV Motors (VFD)	B240-910-16-50-DS-5011	A
3.	Data Sheet – MV VFD	B240-910-16-50-DS-5012	A
4.	Data Sheet – MV Switchboard	B240-910-16-50-DS-5013	A
5.	Data Sheet for MV Switchboard Hardware	B240-910-16-50-DS-5014	A

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SlNo.	Title	Document No.	Rev.
	Datasheet		
6.	Data Sheet – Load Data Format	B240-910-16-50-DS-5017	A
7.	Data Sheet Component Datasheet	B240-910-16-50-DS-5015	A
8.	Data Sheet Battery & Charger	B240-910-16-50-DS-5016	A
9.	Vendor Data Requirement	B240-910-16-50-VR-5010	A
10.	Specification for Flameproof Control stations	6-51-0006	5
11.	Specification for MV Switchboard	6-51-0018	5
12.	Specification for battery charger	6-51-0019	5
13.	Specification for MV Voltage Variable Frequency Drive System	6-51-0038	2
14.	Specification for stationary nickel cadmium batteries	6-51-0047	3
15.	Specification for MV Induction Motors	6-51-0064	1
16.	Specification for field inspection, testing and commissioning of electrical installations	6-51-0087	3
17.	Inspection & Test Plan for Flameproof Control stations	6-81-1006	3
18.	Inspection & Test Plan for MV Switchboard	6-81-1018	3
19.	Inspection & Test Plan for battery charger	6-81-1019	3
20.	Inspection & Test Plan for MV Motors	6-81-1032	5
21.	Inspection & Test Plan for MV Variable Frequency Drive System	6-81-1038	2
22.	Inspection & Test Plan for battery(Nickel Cadmium)	6-81-1047	2

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Project	PMC Services for Installation of GTC at GAIL, Gandhar		**Client**	GAIL - NOIDA	
Unit	New Comprssor area at Gandhar-GPU	**Location**	**Job No.**	B240	**Unit No.** 910

PURCHASER'S DATA

A.	**Site Conditions**		
1.	Maximum Ambient Temperature	°C	47
2.	Minimum Ambient Temperature	°C	6
3.	Design Ambient Temperature	°C	40
4.	Relative Humidity	%	90
5.	Altitude	mm	<1000
6.	Environment:		Humid & Highly corrosive
B.	**Technical particulars**		
1.	Motor Tag no.:		LATER
2.	Driven Equipment name:		
3.	Voltage:	V	415 +/- 10 %
4.	Phase:		Three
5.	Frequency:	Hz	50 +/- 3 %
6.	Fault level:	kA	50
7.	Method of starting:		D.O.L
8.	Winding Connection:		Delta
9.	No of Terminals:		6
10.	Cable size:	mm²	LATER
11.	Cable type:		
12.	Temperature rise:	°C	75
13.	Cooling:		IC411
14.	Insulation class:		F
15.	Temperature rise Limited to insulation class		B
16.	Hazardous area classification:		Zone2
17.	Dust classification		NA
18.	Gas group:		IIA/IIB
19.	Dust Group		
20.	Type of explosion protection:		Ex(d)
21.	Prestart purging for Ex(n) motor		Not Required
22.	Type of ingress protection:		IP 55
23.	Color shade:		632 as per IS 5
24.	Thermisters:		Not Required
25.	RTD:		Not Required
26.	BTD:		Not Required
27.	RTD/BTD monitoring device:		Not Required
28.	Applicable specification:		6-51-0064
29.	Efficiency:		IE 2

DRIVEN EQUIPMENT MANUFACTURER's DATA

1.	Suggested motor rating:	kW	
2.	Manufacturer:		
3.	BkW at Full load:	kW	
4.	kW:at end of Curve	kW	

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Project	PMC Services for Installation of GTC at GAIL, Gandhar			**Client**	GAIL - NOIDA
Unit	New Comprssor area at Gandhar-GPU	**Location**		**Job No.** B240	**Unit No.** 910

5.	Speed:	RPM	
6.	Rotation of eqpt. from coupling end:		
7.	Driven equipment:		
8.	Coupling type:		
9.	Torque required starting	mkg	
	Torque required Maximum	mkg	
10.	GD2 of eqpt including flywheel	kgm²	
	excluding flywheel:	kgm²	
11.	thrust Up:	kg	
	thrust Down:	kg	
12.	Starting condition:		

MOTOR MANUFACTURER's DATA

1.	Rating:	kW	
2.	Manufacturer:		
3.	No. of poles:		
4.	Frame designation:		
5.	Full load speed:	RPM	
6.	Mounting:		
7.	Full load torque (FLT):	mkg	
8.	Starting torque:	% of FLT	
9.	Break down or pull out torque:	% of FLT	
10.	Full load current (FLC):	A	
11.	Starting current at 100% voltage:	% of FLC	
12.	Rotation viewed from coupling end:		
13.	Starting time at 75% voltage:	sec.	
	100% voltage:	sec.	
14.	Locked rotor withstand time (cold/hot) at,		
	75% voltage	sec.	
	100% voltage:	sec.	
15.	Time (Te) for Increased Safety Motor at 100% Voltag	sec.	
16.	Heating/Cooling Time Const. (min.)	min	
17.	Space heater - voltage & power:		
18.	Efficiency at 75% Load:	%	
	100% Load: voltage:	%	
19.	Power factor at 75%/ Load:		
	100% Load:		
	starting		
20.	Moment of inertia, GD2:	kgm²	
21.	NDE bearing type & no		
22.	DE bearing type & no.:		
23.	Type of lubrication:		
24.	Weight of motor:	kg	

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Project	PMC Services for Installation of GTC at GAIL, Gandhar			**Client**	GAIL - NOIDA
Unit	New Comprssor area at Gandhar-GPU	**Location**		**Job No.** B240	**Unit No.** 910

25.	Thermisters, quantity	no.	
	make: type:		
26.	RTD, quantity:	no.	
	make: type:		
27.	BTD, quantity	no.	
	make: type:		
28.	Shaft voltage:	V	
29.	Critical speed, 1st/2nd stage:	RPM	
30.	Canopy:		

Notes

1 Recommended list of maintenance spares for two years operation shall include the following as minimum: (a) Bearing DE/NDE one set, (b) Terminal box coverwith screws, (c) Fan, (d) Terminal block
2 Cable glands to be supplied with motors shall meet all requirements as pe IS/IEC-60079.
3 For Approved makes of motors refer else where in the MR..
4 Starting time calculations shall be based on operating conditions specified on Material Requisition eg. open valve ccondition/closed valve condition, at no load/full load, as applicable.
5 Temperature class shall be T3.

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इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

Medium Voltage Squirrel Cage Induction Motor Datasheet

Project	PMC Services for Installation of GTC at GAIL, Gandhar		**Client**	GAIL - NOIDA	
Unit	New Comprssor area at Gandhar-GPU	**Location**	**Job No.**	B240	**Unit No.** 910

PURCHASER'S DATA

A.	**Site Conditions**		
1.	Maximum Ambient Temperature	°C	47
2.	Minimum Ambient Temperature	°C	6
3.	Design Ambient Temperature	°C	40
4.	Relative Humidity	%	90
5.	Altitude	mm	<1000
6.	Environment:		Humid & Highly corrosive
B.	**Technical particulars**		
1.	Motor Tag no.:		
2.	Driven Equipment name:		
3.	Voltage:	V	415 +/- 10 %
4.	Phase:		Three
5.	Frequency:	Hz	50 +/- 3 %
6.	Fault level:	kA	50
7.	Method of starting:		V.S.D
8.	Winding Connection:		Delta
9.	No of Terminals:		6
10.	Cable size:	mm²	LATER
11.	Cable type:		
12.	Temperature rise:	°C	75
13.	Cooling:		IC411
14.	Insulation class:		F
15.	Temperature rise Limited to insulation class		B
16.	Hazardous area classification:		Zone2
17.	Dust classification		NA
18.	Gas group:		IIA/IIB
19.	Dust Group		
20.	Type of explosion protection:		Ex(d)
21.	Prestart purging for Ex(n) motor		Not Required
22.	Type of ingress protection:		IP 55
23.	Color shade:		632 as per IS 5
24.	Thermisters:		Required
25.	RTD:		Not Required
26.	BTD:		Not Required
27.	RTD/BTD monitoring device:		Not Required
28.	Applicable specification:		6-51-0064
29.	Efficiency:		IE 2

DRIVEN EQUIPMENT MANUFACTURER's DATA

1.	Suggested motor rating:	kW	
2.	Manufacturer:		
3.	BkW at Full load:	kW	
4.	kW:at end of Curve	kW	

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Project	PMC Services for Installation of GTC at GAIL, Gandhar			**Client**	GAIL - NOIDA
Unit	New Comprssor area at Gandhar-GPU	**Location**		**Job No.** B240	**Unit No.** 910

5.	Speed:	RPM	
6.	Rotation of eqpt. from coupling end:		
7.	Driven equipment:		
8.	Coupling type:		
9.	Torque required starting	mkg	
	Torque required Maximum	mkg	
10.	GD2 of eqpt including flywheel	kgm²	
	excluding flywheel:	kgm²	
11.	thrust Up:	kg	
	thrust Down:	kg	
12.	Starting condition:		

MOTOR MANUFACTURER's DATA

1.	Rating:	kW	
2.	Manufacturer:		
3.	No. of poles:		
4.	Frame designation:		
5.	Full load speed:	RPM	
6.	Mounting:		
7.	Full load torque (FLT):	mkg	
8.	Starting torque:	% of FLT	
9.	Break down or pull out torque:	% of FLT	
10.	Full load current (FLC):	A	
11.	Starting current at 100% voltage:	% of FLC	
12.	Rotation viewed from coupling end:		
13.	Starting time at 75% voltage:	sec.	
	100% voltage:	sec.	
14.	Locked rotor withstand time (cold/hot) at,		
	75% voltage	sec.	
	100% voltage:	sec.	
15.	Time (Te) for Increased Safety Motor at 100% Voltag	sec.	
16.	Heating/Cooling Time Const. (min.)	min	
17.	Space heater - voltage & power:		
18.	Efficiency at 75% Load:	%	
	100% Load: voltage:	%	
19.	Power factor at 75%/ Load:		
	100% Load:		
	starting		
20.	Moment of inertia, GD2:	kgm²	
21.	NDE bearing type & no		
22.	DE bearing type & no.:		
23.	Type of lubrication:		
24.	Weight of motor:	kg	

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Project	PMC Services for Installation of GTC at GAIL, Gandhar			**Client**	GAIL - NOIDA
Unit	New Comprssor area at Gandhar-GPU	**Location**		**Job No.** B240	**Unit No.** 910

25.	Thermisters, quantity	no.	
	make: type:		
26.	RTD, quantity:	no.	
	make: type:		
27.	BTD, quantity	no.	
	make: type:		
28.	Shaft voltage:	V	
29.	Critical speed, 1st/2nd stage:	RPM	
30.	Canopy:		

Notes

1. Recommended list of maintenance spares for two years operation shall include the following as minimum: (a) Bearing DE/NDE one set, (b) Terminal box coverwith screws, (c) Fan, (d) Terminal block
2. Cable glands to be supplied with motors shall meet all requirements as pe IS/IEC-60079.
3. For Approved makes of motors refer else where in the MR..
4. Starting time calculations shall be based on operating conditions specified on Material Requisition eg. open valve ccondition/closed valve condition, at no load/full load, as applicable.
5. Temperature class shall be T3.

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DATA SHEET FOR A.C. VARIABLE FREQUENCY DRIVE SYSTEM

(New Comprssor area at Gandhar-GPU)

PROJECT : PMC Services for Installation of GTC at GAIL, Gandhar

OWNER : GAIL

JOB NO. : B240

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DATA SHEET

PART – I (PURCHASER'S DATA)

RATING AND JOB REQUIREMENTS

1.	Reference standards	:	EIL Spec. 6-51-0049
2.	Rated output capacity	:	*
3.	Rated output voltage	:	415V, 3 phase, 50Hz
4.	Motor Details		
	a) Drive system	:	Single/~~Multiple~~
	b) Type of motor	:	Sq-Cage induction motor
	c) KW rating	:	*
	d) No. of motors	:	1 No. for each Drive (As per motor data sheet)
	e) Starting condition	:	Soft start
	f) Frequency range	:	*
	g) Voltage range	:	*
	h) Full load current	:	*
	i) Full load PF		
	At lowest KW	:	*
	At Highest KW	:	*
	j) Starting current	:	*
	k) Load torque details	:	Vendor to Furnish
5.	**SITE CONDITIONS**:		
	a) Amb. Temperature	:	47 deg C max. , 5deg C min. (VFD to be designed for 45 deg C)
	b) Altitude	:	Less than 1000 m above MSL
	c) Humidity	:	87%
	d) Storage temperature	:	-
	e) Indoor/Outdoor	:	Indoor (In substation) VFD shall be suitable for continous operation at design ambient of 45 deg C
	f) Installation area	:	Substation 1

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***** **Vendor to furnish**

5. INPUT POWER SUPPLY SYSTEM CONDITIONS

a)	No. of phases	:Three (4 wires)
b)	AC input voltage	:415 V
c)	Voltage fluctuation	:±6%
d)	Rated frequency	:50Hz
e)	Frequency fluctuation	:±3%
f)	System fault level	:NA

6. SYSTEM REQUIREMENTS

a)	Speed range required	:	*
b)	Adjustment of speed	:	Auto/Manual/Both
c)	Speed Reference by measurement of the stator voltage frequency through voltage transformer	:	*
d)	Reference Signal		
	4-20 mA	:	Yes
	0-10 V	:	-
e)	Soft start feature	:	Yes
	Starting current	:	100-150 %
f)	By pass bkr. or Starter	:	Required
g)	Acceleration time Deceleration time	: :	* *
h)	Short time voltage dip	:	80%
i)	Harmonic limit on input	:	As per spec.
j)	Fault diagnostic	:	Required
k)	Braking	:	*

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l)	Regeneration	:	*
m)	Any other requirement	:	Distance between VFD and motor shall be considered as 800m.

NOTES:

1. 240V, 1-Phase power supply to the motor space heater shall be taken from VFD. Necessary arrangement for these supplies shall be made available in VFD panels.

2. Vendor to furnish the duly filled-in data sheet for each type / rating of VFD for post order review.

3. Testing of motor for use with offered make of VFD Controller shall confirm to EIL spec. 6-51-0038 .

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PART - II

TECHNICAL DATA FROM MANUFACTURER

1.	Manufacturer's reference Model No.	:	
2.	Rating	:	
3.	Applicable code/standards	:	
4.	Speed range	:	
5.	Speed reference	:	
6.	Input power supply ratings	:	
	Voltage	:	± %
	Frequency	:	± %
7.	Overload capability	:	
	a) 125% In for	:	minutes
	b) 150% In for	:	secs.
	c) Inrush current 250% In for	:	secs.
8.	Overall efficiency	:	
9.	Overall power factor at	:	
	a) 100% load	:	
	b) 75% load	:	
	c) 50% load	:	
	d) 25% load	:	
10.	AC Output		
	a) Output voltage	:	
	b) Voltage accuracy	:	
	c) Rated frequency range	:	
	d) Frequency	:	
	e) Voltage unbalance	:	

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f) Field supply voltage :

g) Max. field current :

11. Transient voltage :

a) fluctuation ratio :

b) Its recovery time :

12. Transient Torque

12.1 Max. Transient air gap torque/ duration :

12.2 Max. Transient torque/ duration :

Same shall be furnished at the coupling of VSDS, accounting for the motor and the driven equipment in the case of a two and a three phase short-circuit at the motor terminal.

13. Wave form distortion factor (% harmonics) in output/ Input waveform. :

(Number of harmonics and magnitude of each harmonic generated shall be furnished).

14. Output short ckt. Capability and duration. :

15. Deration of motor at :

a) Maximum speed :

b) Minimum speed :

16. Permissible No. of starts

Hot : Uniformly distributed
Cold : in one hour

17. Controls

a) System Start :

b) System Stop :

c) Speed Raise :

d) Speed Lower :

e) Drive frequency setting :

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f) Auto/manual operation :

i) At panel :

ii) At remote control :

g) Local/ remote operation for controls :

i) At panel :

ii) At remote :

h) Jog mode :

i) Reversing :

j) Dynamic brake :

k) Remote bkr. Trip :

l) Motorised potention for reference value selection :

m) Electronic Ramp function :

n) Speed and current controller :

18. Rectifier/ Inverter

a) Make :

b) Type/Model No. :

c) i) Diodes/GTOs configuration :

ii) Total No. of Diodes/GTOs :

d) i) Overall converter efficiency for complete range :

Plot of efficiency Vs. speed shall be furnished. :

ii) Converter efficiency at 100%, 75%,50% load and unity power factor. :

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iii) Efficiency of Inverter: at 100%, 75%,50% load at unity power factor

e) Overall P.F. of complete system plot of P.F. Vs speed shall be furnished. :

f) Cooling system

i) Type :

ii) Redundancy in cooling Units :

g) Type of feed back for speed control :

h) Speed control accuracy :

i) List of controls provided at the front of panel :

j) List of status measuring devices provided at the front of Panel :

k) List of status indication and Annunciation provided :

19. Type of Electronic Card mounting arrangement. :

20. **DIMENSION**

a) Length :

b) Height :

c) Depth :

d) Weight of cubicle :

(Dimensional details of all panels shall be furnished).

21. Degree of protection for enclosure. :

22. Paint shade :

23. Heat output of Panel :

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24.	Whether Air Conditioning is required for these panels.	:	
25.	Control supply voltage and Aux. Power requirement	:	
26.	**Main Transformer**	:	
	a) Make	:	
	b) Type of Transformer	:	~~Oil Filled~~/ Dry Type/Cast resin type
	c) KVA Rating	:	
	d) Voltage ratio	:	
	e) Vector group	:	
	f) Impedance	:	
	g) Overall dimension (L&BXH)	:	
27.	DC Reactor		
	a) Make	:	
	b) Type	:	
	c) Rating	:	
	d) Type of cooling	:	
	e) Overall Dimensions	:	
	f) Heat output	:	
	g) Inductance of the reactor	:	
	h) Air Core/Iron Core	:	
	i) Efficiency	:	
28.	Local control panel Required as per spec.	:	No
29.	Any other requirement	:	

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Project	PMC Services for Installation of GTC at GAIL, Gandhar		**Client**	GAIL - NOIDA	
Unit	New Comprssor area at Gandhar-GPU	**Location**	**Job No.**	B240	**Unit No.** 910

PURCHASER'S DATA

A.	**Site Conditions**		
1.	Maximum Ambient Temperature	°C	47
2.	Minimum Ambient Temperature	°C	6
3.	Design Ambient Temperature	°C	40
4.	Relative Humidity	%	90
5.	Altitude Above MSL	m	<1000
6.	Environment		Humid & Highly corrosive
B.	**Operating Conditions**		
1.	Voltage	V	415 +/- 10 TPN
2.	Frequency	Hz	50 +/- 3 %
3.	No of phases		Three
4.	System fault level	kA	50
5.	System earthing		Solidly Earthed
6.	Auxiliary supply		
	AC	V	240 +/- 10 % SPN
	DC	V	110 +/- 10 % DC
7.	Power supply for spring charging motor	V	110 DC
C.	**Electrical Data**		
1.	Short circuit withstand capacity for 1 sec.	KA	50
2.	Busbar current rating inside panel at specified ambient		As per SWBD data sheet
3.	Busbars		Heat shrunk PVC sleeved
4.	System breaking capacity	kA	50
5.	System making capacity	kA(peak)	105
6.	Circuit breaker		
	Type		ACB
	Duty cycle		0-3 min-co-3 min-co
	Rating		800
7.	Incoming power entry		Cable
8.	Cable entry (I/C & O/G)		Bottom
9.	Bus duct entry		NA
10.	Cable gland/lugs		Included
11.	Painting/paint shade		RAL-7032
12.	Feeder arrangement & Execution		Double Front, Drawout type
13.	Minimum motor starter module size		Vendor standard
14.	Minimum switchfuse module size		Vendor standard
15.	Floor fixing		Integral base frame and tack welding to floor channel
16.	Seperate bolted removablegland plate		Reqd.(Gland Plate Drilled at side)
17.	Minimum MCCB module		Not Applicable

MANUFACTURER'S DATA

A.	**Switchboards**	
1.	Tag no.:	
2.	Make	
3.	Type designation	

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Project	PMC Services for Installation of GTC at GAIL, Gandhar		**Client**	GAIL - NOIDA	
Unit	New Comprssor area at Gandhar-GPU	**Location**	**Job No.**	B240	**Unit No.** 910

4.	Degree of protection	
5.	CB panel	
	Overall weight	
	Incomer	
	Outgoing	
	Overall dimensions	
	Length*Depth*Height	
6.	Overall dimensions of MCC/ contactor controlled feeder panel	
	Length*Depth*Height	
7.	Overall dimensions of each PCC	
	Length*Depth*Height	
8.	Overall dimensions of each PMCC/ EPMCC	
	Length*Depth*Height	
9.	Overall dimensions of each MCC	
	Length*Depth*Height	
10.	Overall dimensions of each ASB	
	Length*Depth*Height	
11.	Overall dimensions of each LDB	
	Length*Depth*Height	
12.	Largest shipping section:	
	Max. overall weight	
	Length*Depth*Height	
13.	Recommended clearances for SWBD	
	Front*Rear*Above	
14.	Shock loading on foundation	
15.	Max. size/no. of cables that can be terminated	
	with rear extension	
	without rear extension	
16.	Size of rear extension panel	
17.	Clearance in air	
	Phase to Phase	
	Phase to Earth	
18.	Main horizontal bus bar	
	Bus bar current rating at	
	design ambient temp.	
	Main bus bar size	
	Main bus bar material	
	Main bus bar location	
19	Vertical bus bars	
	Bus bar current rating at	
	design ambient temp.	
	Bus bar size	
	Bus bar material	
	Bus bar location	
20.	Insulating material	

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Project	PMC Services for Installation of GTC at GAIL, Gandhar		**Client**	GAIL - NOIDA	
Unit	New Comprssor area at Gandhar-GPU	**Location**	**Job No.**	B240	**Unit No.** 910

21.	Earth bus bar size	
	Material	
22.	1min power freq voltage	
23.	Short circuit	
	1 second	
	Peak dynamic	
24.	Whether adaptor panel required	
	between PCC/MCC panel	
	If Yes, furnish dimensions	
B.	**Circuit breaker**	
1.	Type designation	
2.	Make	
3.	Mounting	
4.	No. of poles/phases	
5.	Current rating (in air)	
6.	Current rating (inside panel	
	at design temperature)	
7.	Short time rating (1 sec)	
8.	Sym breaking capacity	
	% DC component	
9.	Peak making capacity	
10.	Power frequency withstand	
11.	Impulse withstand voltage	
12.	Duty cycle	
13.	Total opening time	
14.	Total closing time	
15.	Power requirement	
	Opening	
	Closing	
	Spring charge motor	
16.	Time for spring charging	
17.	Breaker is trip free	
18.	Closing mechanism	
19.	Provision of manual spring charging	
20.	Tripping mechanism	
21.	Mechanical trip PB provided	
22.	Mechanical ON/OFF indicator provided	
23.	Operation counter provided	
24.	Time taken for spring charging	
25.	No. of auxiliary contacts	
26.	Derating required for capacitor switching	
C.	**Contractor**	
1.	Type designation	
2.	Make	
3.	Rated Voltage	
4.	Rated current	

Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By
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Project	PMC Services for Installation of GTC at GAIL, Gandhar	**Client**	GAIL - NOIDA
Unit	New Comprssor area at Gandhar-GPU	**Location**	
Job No.	B240	**Unit No.**	910

	AC-3 Duty	
	AC-4 Duty	
5.	Thermal rating	
6.	Making capacity	
7.	Breaking capacity	
8.	Switching frequency	
9.	Life	
	Electrical	
	Mechanical	
10.	Coil consumption	
	Pick up	
	Hold on	
11.	Closing time	
12.	Opening time	
13.	No of aux. contacts	
14	Maximum permitted back up fuse rating	
D.	**Switch**	
1.	Rated voltage	
2.	Rated current	
3.	AC 23 rating	
4.	Rated making capacity	
5.	Rated breaking capacity	
6.	Rated short circuit withstand current with	
	max. permissible rated fuses	
7.	Mechanical life	
8.	Maximum permitted back up fuse rating	
E.	**Thermal Overload Relay**	
1.	Make	
2.	Type	
3.	Setting range	
4.	Single phasing preventor	
5.	Type of operation	
6.	Maximum permitted back up fuse rating	
F.	**Fuses**	
1.	Make	
2.	Type	
3.	Current rating	
G.	**Electronic Motor protection relay**	
1.	Make	
2.	Type	
3.	Setting range	
4.	Single phasing preventor	
5.	Type of operation	
6.	Maximum permitted back up fuse rating	
7.	Earth fault protection available	
H.	**MCCB/MCB**	
1.	Make	

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Project PMC Services for Installation of GTC at GAIL, Gandhar **Client** GAIL - NOIDA

Unit New Comprssor area at Gandhar-GPU **Location** **Job No.** B240 **Unit No.** 910

2.	Type	
3.	Rated voltage	
4.	Rated current	
5.	Rated frequency	
6.	No. of poles	
7.	Derating factor for operation under site conditions	
8.	Rated 10 sec short time rating	
9.	Rated breaking capacity at service voltag	
10.	No. of operations at full fault	
11.	No. of operations at partial fault	
12.	No. of guaranteed mech. operations	
13.	1 min dry p.f with stand voltage	
14.	Shunt trip feature (for MCCB only)	
15.	Operating voltage range for MCCB shunt trip	

Eil Notes

1 Vendor shall furnish dimensions of various switchboards, CB panels and dummy/adaptor panels separately.

2 Switchboard offered shall be of proven design and shall have been successfully type tested. Type test certificates for an exactly identical design of offered switchboard shall be furnished by bidders. These test reports shall be not more than 5 yeas old, as on the final bid opening date. In case these type tests have not been conducted during the last 5 years, bidder shall conduct these type tests on the offered design of switchboard before despatch without any extra cost and delivery impact.

3 Vendor shall furnish technical particulars of various switchboards separately.

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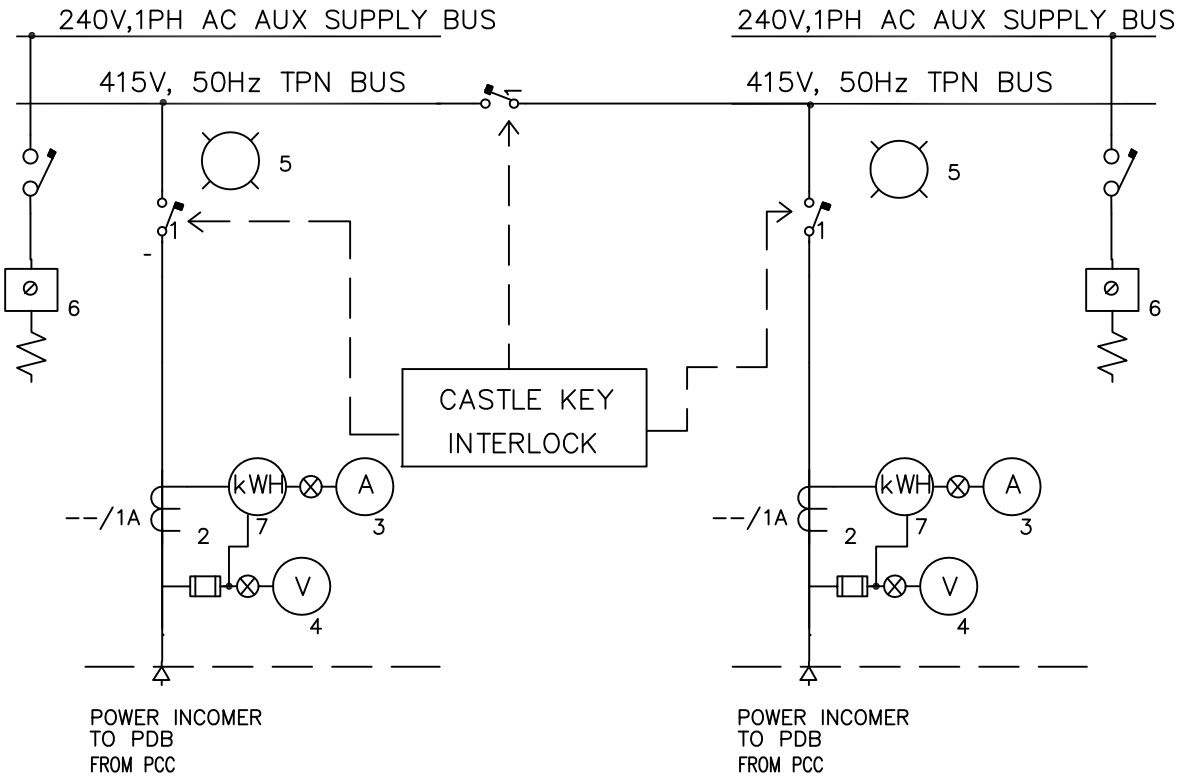
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PROJECT: PMC SERVICES FOR INSTAL-LATION OF GTC AT GAIL, GANDHAR CLIENT: M/S GAIL GANDHAR	REV	DATE	PURPOSE	BY	CHKD	APPRV
	A	09.04.2019	ISSUED WITH MR	DK	SH	ANPS

EQUIPMENT DATA(FOR EACH INCOMER)

ITEM NO.	NEMA NO.	QTY.	DESCRIPTION
1	–	1	ISOLATOR (TPN) SUITABLE FOR 50 KA (1SEC)
2	–	3	METERING CT, CL-1, 10VA
3	–	1	AMMETER WITH 4WAY SELECTOR SWITCH.
4	–	1	VOLTMETER WITH 4WAY SELECTOR SWITCH & FUSE
5	–	3	R Y B INDICATING LAMPS – LED TYPE
6	–	1	PANEL SPACE HEATER WITH MCB AND THERMOSTAT
7	–	1	kWH METER



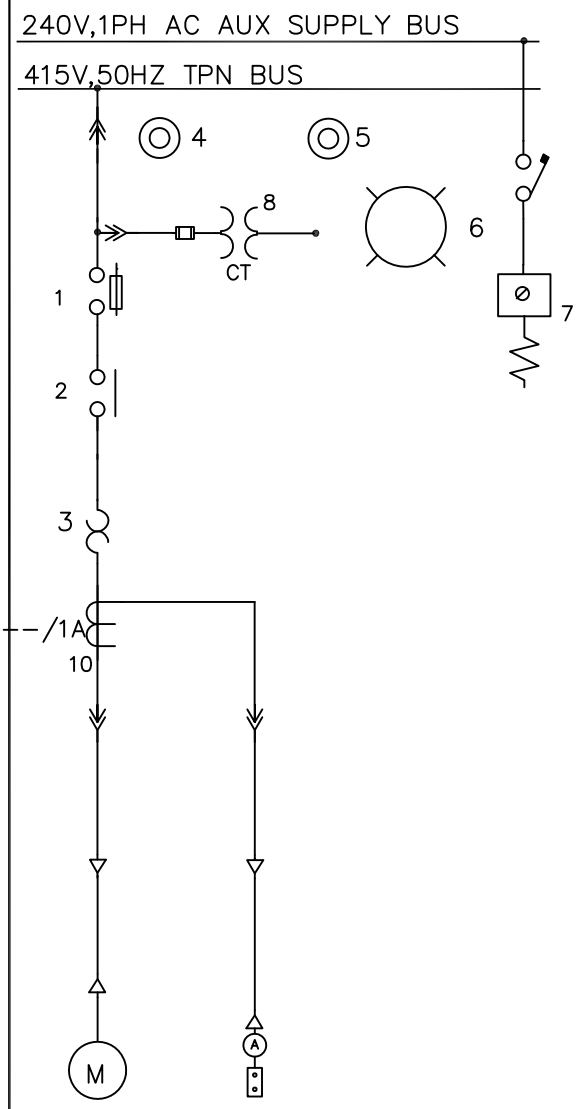
NOTES

1. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE . ALL THE ITEMS "EQUIPMENT DATA" AND IN SPECIFICATION 6-51-0018 SHALL BE IN VENDOR'S SCOPE.
2. MCCB FOR GTMCC SHALL BE SUITABLE FOR THE SYSTEM FAULT LEVEL 50KA(1SEC)
3. KWH METER SHALL BE PROVIDED FOR EACH INCOMER OF PDB IRRESPECTIVE OF RATING.
4. FOR THE OTHER REQUIREMENTS OF RELAYS AND METERS, INCLUDING SEPARATE METERS AND MULTIFUNCTION METER,

ENGINEERS INDIA LIMITED NEW DELHI	M.V. SW. BD. DATA SHEET GTMCC INCOMER	DATA SHEET	REV
		B240-910-16-50-DS-5014 SHEET 1 OF 5	A

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PROJECT:PMC SERVICES FOR INSTALLATION OF GTC AT GAIL, GANDHAR CLIENT: M/S GAIL GANDHAR	REV	DATE	PURPOSE	BY	CHKD	APPRV
	A	09.04.2019	ISSUED WITH MR	DK	SH	ANPS



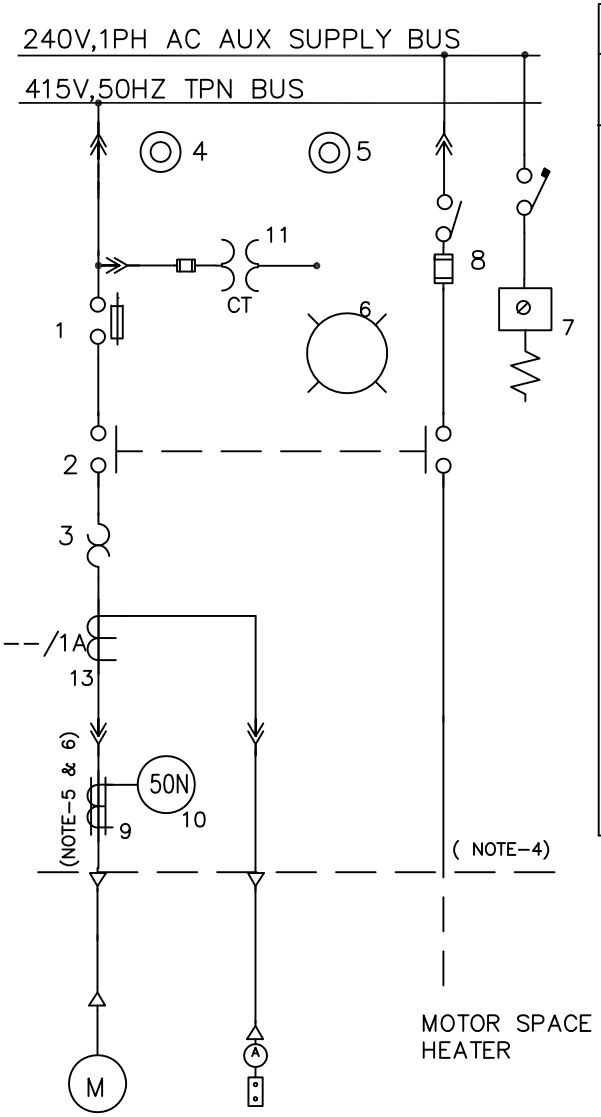
EQUIPMENT DATA

ITEM NO.	NEMA NO.	QTY.	DESCRIPTION
1	—	1	MOTOR DUTY FUSE SWITCH (DUTY AC-23)
2	—	1	AIR BREAK CONTACTOR, DUTY-AC3 WITH 2NO+2NC AUXILIARY CONTACTS.
3	49	1SET	THERMAL O/L RELAY WITH INHERENT PROTECTION AGAINST SINGLE PHASING
4	—	1	STOP PUSH BUTTON
5	—	1	RESET PUSH BUTTON FOR BIMETAL RELAY
6	—	AS REQD	INDICATING LAMPS – LED TYPE
7	—	1	PANEL SPACE HEATER WITH MCB AND THERMOSTAT
8	—	1	415/240V, CONTROL TRANFORMER
9	—	AS REQD	AUX.CONTACTORS WITH MIN.2NO+2NC CONTACTS
10	—	1	METERING CT CL-1.0, 15VA

NOTES:

1. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN SPECIFICATION 6-51-0093 SHALL BE IN VENDOR'S SCOPE.
2. COMPONENT RATING SHALL BE AS PER DATA SHEET
3. NO. OF CONTROL TERMINALS PROVIDED SHALL INCLUDE 20% SPARE TERMINALS SUBJECT TO A MINIMUM 24 TERMINALS.
4. METERING CT SHALL BE PROVIDED FOR MOTORS ABOVE 5.5 KW.

PROJECT: PMC SERVICES FOR INSTALL-ATION OF GTC AT GAIL, GANDHAR CLIENT: M/S GAIL, GANDHAR	REV	DATE	PURPOSE	BY	CHKD	APPRV
	A	09.04.2019	ISSUED WITH MR	DK	SH	ANPS



EQUIPMENT DATA

ITEM NO.	NEMA NO.	QTY.	DESCRIPTION
1	–	1	MOTOR DUTY FUSE SWITCH DUTY AC23
2	–	1	AIR BREAK CONTACTOR, DUTY–AC3 WITH 2NO+2NC AUXILIARY CONTACTS.
3	49	1SET	THERMAL O/L RELAY WITH INHERENT PROTECTION AGAINST SINGLE PHASING
4	–	1	STOP PUSH BUTTON
5	–	1	RESET PUSH BUTTON FOR BIMETAL RELAY
6	–	AS REQD	INDICATING LAMPS – LED TYPE
7	–	1	PANEL SPACE HEATER WITH MCB AND THERMOSTAT
8	–	1	DP SWITCH & FUSE FOR MOTOR SPACE HEATER
9	–	1	CORE BALANCE CURRENT TRANSFORMER
10	50N	1	EARTH LEAKAGE RELAY 'AREVA' TYPE CTUM–15 SETTING RANGE (1–16%) WITH BUILTIN TIMER
11	–	1	415/240V, CONTROL TRANFORMER
12	–	AS REQD	AUX.CONTACTORS WITH MIN.2NO+2NC CONTACTS
13	–	1	METERING CT CL–1.0, 15VA

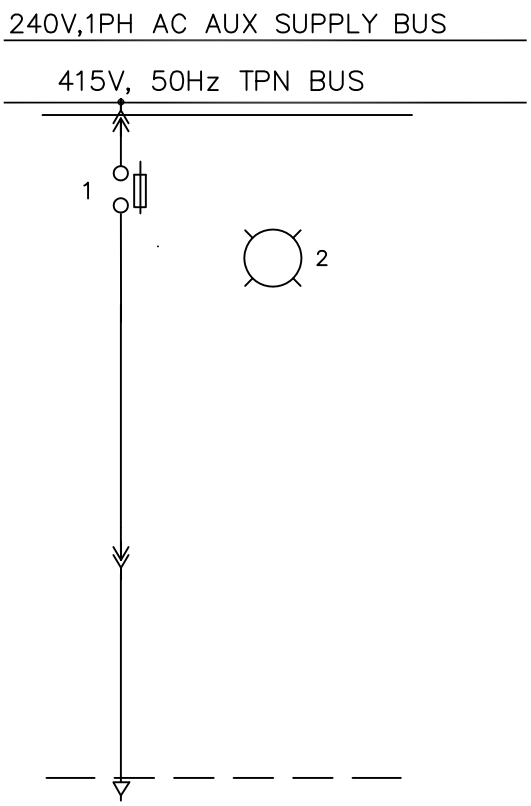
NOTES:

1. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN SPECIFICATION 6–51–0018 SHALL BE IN VENDOR'S SCOPE.
2. COMPONENT RATING SHALL BE AS PER DATA SHEET
3. NO. OF CONTROL TERMINALS PROVIDED SHALL INCLUDE 20% SPARE TERMINALS SUBJECT TO A MINIMUM 24 TERMINALS.
4. MOTOR SPACE HEATER CKT. TO BE PROVIDED FOR MOTORS RATED 30kW AND ABOVE.
5. CBCT AND ELR SHALL BE PROVIDED FOR MOTORS RATED MORE THAN 30 KW.
6. AREVA RELAYS ARE INDICATED FOR TYPE REFERENCE ONLY.

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PROJECT: PMC SERVICES FOR INSTALLATION OF GTC AT GAIL GANDHAR CLIENT: M/S GAIL GANDHAR	REV	DATE	PURPOSE	BY	CHKD	APPRV
	A	09.04.2019	ISSUED WITH MR	DK	SH	ANPS



EQUIPMENT DATA

ITEM NO.	NEMA NO.	QTY.	DESCRIPTION
1	–	1	HEAVY DUTY SWITCH FUSE UNIT (DUTY AC 22)
7 2	–	3	INDICATING LAMPS – LED TYPE

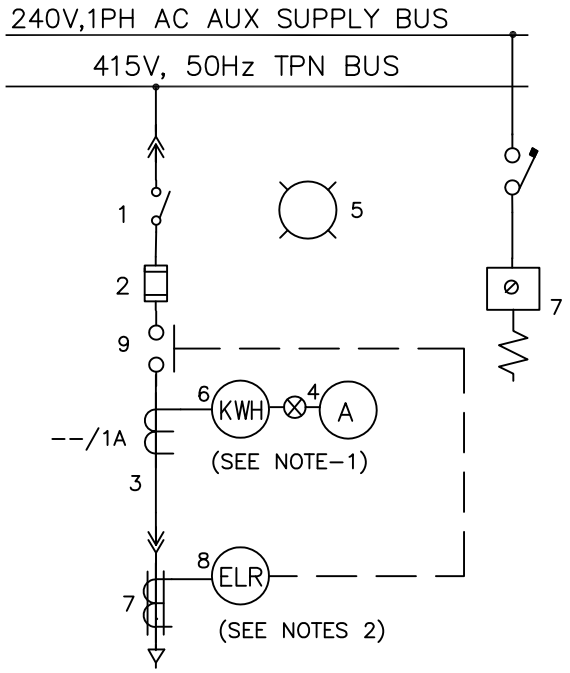
NOTES:

1. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN SPECIFICATION 6-51-0018 SHALL BE IN BIDDER'S SCOPE.
2. FOR THE OTHER REQUIREMENTS OF RELAYS AND METERS INCLUDING SEPARATE METERS AND MULTIFUNCTION METER, REFER JOB SPECIFICATION.

ENGINEERS INDIA LIMITED NEW DELHI	M.V. SW. BD. DATA SHEET SWITCH FUSE FEEDER	DATA SHEET	REV
		B240-910-16-50-DS-5014 Sheet 4 OF 5	A

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PROJECT: PMC SERVICES FOR INSTALLATION OF GTC AT GAIL, GANDHAR CLIENT: M/s GAIL GANDHAR	REV	DATE	PURPOSE	BY	CHKD	APPRV
	A	09.04.2019	ISSUED WITH MR	DK	SH	ANPS



EQUIPMENT DATA

ITEM NO.	NEMA NO.	QTY.	DESCRIPTION
1	–	1	HEAVY DUTY SWITCH WITH NEUTRAL LINK
2	–	3	HRC FUSE WITH FUSE BASE
3	–	3	METERING CT, CL-1, 10VA
4	–	1	AMMETER WITH 4WAY SELECTOR SWITCH.
5	–	3	INDICATING LAMPS – LED TYPE
6	–	1	KWH METER WITH ACCURACY CL.1.0
7	–	1	CORE BALANCE CURRENT TRANSFORMER
8	–	1	EARTH LEAKAGE RELAY 'ALSTOM' TYPE CTUM-15 SETTING RANGE (1-16%) WITH BUILT-IN TIMER
9	–	1	CONTACTOR

NOTES:

1. CT, AMMETER AND KWH METER SHALL BE PROVIDED FOR SWITCH FUSE FEEDER RATED 250A & ABOVE.
2. CBCT, ELR AND CONTACTOR SHALL BE PROVIDED FOR FEEDERS RATED 250A AND ABOVE.
3. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN SPECIFICATION 6-51-0093 SHALL BE IN VENDOR'S SCOPE.

ENGINEERS INDIA LIMITED NEW DELHI	M.V. SW. BD. DATA SHEET SWITCH FUSE CONTACTOR FEEDER	DATA SHEET B240-910-16-50-DS-5014 SHEET 5 OF 5	REV A

FEEDER TYPE	MOTOR RATING KW	APPROX. CABLE SIZE	COMPONENT RATING (A)				
			FUSE/BMR	FUSE/BMR	CT RATIO	HEAVY DUTY SWITCH	CONTACTOR (AC3)
FVNR-15 FVR - 15 FVNR - 15HD	≤ 5.5	3*16	6/0.8-1.2 10/2.5-4 16/5.5-8 32/11-16	10/2-3.3 16/4.5-7.5 20/6-10 32/9-15	–	32	15
FVNR-30 FVR - 30 FVNR - 30HD	5.5 <KW≤ 11	3*35	32/11-16 63/30-45	32/9-15 63/14-23	30/1	63	30
FVNR-60 FVR - 60 FVNR - 60HD	11 <KW ≤ 22	3*70	63/25-40 80/30-45	63/20-33 100/30-50	60/1	125	60
FVNR-100 FVR - 100 FVNR - 100HD	22 <KW≤ 45	3*150	125/38-63 160/50-90 200/70-110	125/45-75 150/45-75 200/66-110	100/1	250	100
FVNR-150 FVR - 150 FVNR - 150HD	45 <KW≤ 55	3*185	200/70-110	200/66-110	150/1	400	150
FVNR-200 FVR-200 FVNR-200HD	55 <KW≤ 90	2*3*120	MOTOR PROTECTION RELAY (46, 50, 49, 50N & 51LR)		200/1	400	200
FVNR-300 FVR-300 FVNR-300HD	90 <KW≤ 132	2*3*185	MOTOR PROTECTION RELAY (46, 50, 49, 50N & 51LR)		300/1	400	300
FVNR-400 FVR-400 FVNR-400HD	132 <KW≤ 160	2*3*300	MOTOR PROTECTION RELAY (46, 50, 49, 50N & 51LR)		400/1	630	400
FVNR-600 FVR-600 FVNR-600HD	160 <KW≤ 250	2*3*300	MOTOR PROTECTION RELAY (46, 50, 49, 50N & 51LR)		600/1	630	600
SWF-32	_	3.5*50	32	32	_	32	_
SWF-63	_	3.5*50	63	63	_	63	_
SWF-100	_	3.5*120	100	100	_	100	_
SWF-125	_	2*3.5*120	125	125	_	125	_
SWFC-250	_	2*3.5*300	250	250	250/1	250	_
SWFC-63	_	3.5*50	63	63	_	63	63
MCCB-125	MCCB	2*3.5*120	MCCB WITH O/C, S/C & E/F RELEASES		–	–	125 (See note-2)
MCCB-160	MCCB	2*3.5*185	MCCB WITH O/C, S/C & E/F RELEASES		–	–	160 (See note-2)
MCCB-250	MCCB	2*3.5*300	MCCB WITH O/C, S/C & E/F RELEASES		250/1	–	250 (See note-2)
MCCB-400	MCCB	3*3.5*300	MCCB WITH O/C, S/C & E/F RELEASES		400/1	–	400 (See note-2)

Rev.	Date	Purpose	Prepared	Checked	Approved
A	08.04.2019	ISSUED WITH TENDER	DK	SH	ANPS

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NOTES:

1. CT for metering shall be provided for motor rated above 5.5kW .

2. Contactor with CBCT and earth leakage relay shall be provided for MCCB feeder rated more than 100A and upto 400A .

3. Major components are shown above, all other items as specified in equipment data sheet and specification: 6-51-0018 shall also be in vendor's scope.

4. Typical fuse rating and bimetal relay ranges are specified above. Final fuse rating and bimetal range shall be selected by the manufacturer meeting type-2 co-ordination as per IS-13947.

5. Number of cores for motor feeders shall be 3.

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Atmospheric condition
Humid & highly corrosive

Altitude
< 1000 m
> 1000 m

Location
Outdoor
Indoor

Voltage
3.3 kV
6.6. kV
11 kV

Voltage
±6%
±10%

Duty
Continuous

Fault level
20 kA
25 kA
40 kA
N.A.

Starting method
D.O.L.
V.S.D.
Star-delta
Auto transformer

Earthing
Direct
Resistance

No.of terminals
3
4
6

Insulation Class
B
F
H
C

Area Class
Zone 1
Zone 2
Divn. 1
Divn. 2

Gas group
IIA
IIB
IIC
IIB/IIC
A
B
C
D
C&D

Area Classification
Ex(n)
Ex(e)
Ex(d)

IP
IP 23
IP 44
IP 55

Std. Spec.
EIL spec. 6-51-0031

color
631 as per IS 5

RTD/BTD
Not applicable

Frequency
±3%
±5%

Frequency2
50 Hz
60 Hz

Cooling
IC401
IC511
IC611

Cable Type
Al. cond. XLPE insulated
Cu. cond. XLPE insulated

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Project PMC Services for Installation of GTC at GAIL, Gandhar **Client** GAIL - NOIDA

Unit New Comprssor area **Location** **Job No.** B240 **Unit No.** 910

PURCHASER'S DATA

A.	**Site Conditions**		
1.	Maximum Ambient Temperature	°C	47
2.	Minimum Ambient Temperature	°C	6
3.	Design Ambient Temperature	°C	40
4.	Relative Humidity	%	90
5.	Altitude Above MSL	m	<1000
6.	Environment		Humid & Highly corrosive
B.	**Technical particulars**		
1.	Battery		
a.	Type		Ni-Cd
b.	Plate construction		Tubular positive
c.	Discharge duty requirements		

Sl No.	Item no. as per MR	Nominal DC voltage	Duty cycle				No. of cells			End cell voltage		
			First 1 min.	First 28 min.	First 90 min.	Last 1 min.	Lead Acid	VRLA	Ni-cd	Lead Acid	VRLA	Ni-cd
1												1.16

d.	Boost charging time		10
e.	Electrolyte liquid in containers		Required
f.	Battery stand formation		DOUBLE ROW DOUBLE TIER
g.	Accessories (Per battery set)		
i.	Hydrometer (syringe type)		3 nos.
ii.	Thermometer		3 nos.
iii.	Cell testing voltmeter (3V-0-3V)		1 nos.
iv.	Rubber gloves		4 pairs
v.	Spanner		1 no.
vi.	Acid resistant jugs & funnels		2 nos. each
vii.	Wall mounting teakwood holder		1 no.
h.	Cable details between battery & charger Item no.		Cable Size
2.	Battery charger		
a.	System voltage	V	415 +/- 10 % TPN
b.	System frequency	Hz	50 +/- 3 %
c.	System neutral earthing		Solidly Earthed
d.	System fault level	kA	50
e.	Charger voltage range		
	Float charging voltage range/cell		Ni-Cd-1.3-1.45 V
	Boost charging voltage range/cell		Ni-Cd-1.42-1.7 V
f.	Cable entry		Top
g.	Mounting		Floor mounted
h.	Access		Front
i.	Earth Bus		25X6 mm2 Cu (Min)
j.	Separate bolted removable undrilled gland plate for cable entry		Required(Gland Plate shall be drilled at site)
k.	Cable glands and lugs		Required
l.	Painting		Shade 632 of IS-5
m.	Incoming cable details for battery charger Item no.		Cable Size

Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By
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Project PMC Services for Installation of GTC at GAIL, Gandhar **Client** GAIL - NOIDA

Unit New Comprssor area **Location** **Job No.** B240 **Unit No.** 910

3.	DC distribution board	
a.	Type	Compartmentalized
b.	Feeder requirements	

Sl No.	Item no. as per MR	Feeder type	Feeder rating	No. of feeders	Max. cable size	Rating of DC contactor for lighting
1						

4.	ECS Interface	
a.	Indication-Charger failure	Required
b.	Indication-Inverter failure	Required
c.	Indication-Battery discharged	Required
d.	Indication-Battery isolated	Required

MANUFACTURER'S DATA

A.	**Battery**	
1.	Item no. As per MR/PR	
2.	Tag. No.	
3.	Manufacturer's name	
4.	Type & Catalogue no. of cell	
5	Ampere hour capacity	
6	No. of cells	
7.	Nominal cell voltage	
8.	Cell voltage at the end of full discharge at 10 hrs/ 5 hrs rate	
9.	Specific gravity of electrolyte at the end of full charging at °C	
10.	Specific gravity of electrolyte at the end of full discharge at 10 hrs/5 hrs rate at °C	
11.	Quantity of electrolyte per cell	
12.	Weight of cell with electrolyte	
13.	Quick charging current	
	Max. safe quick charging rate	
	Permissible ripple content	
14.	Suggested quick charging rate	
15.	Quick charging voltage	
	Max. quick charging voltage/cell	
	Quick charging voltage/cell for constant voltage finish charging	
16.	Float charging voltage/cell	
17.	Float charging current	
	Float charging current range	
	Permissible ripple content	
18.	AH efficiency at 10 hrs/5 hrs rate	
19.	Short ckt current of battery bank	
20.	Short circuit withstand time	
21.	Max. allowable termp.of electrolyte the cells can withstand without injurious effects	
	Continuously	
	Short period	

Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By
A	05-JUL-2019	ISSUED WITH MR	KINDO DEEPAK KARTIC	SRIHARI S	SINGH ARVIND N P (MS)

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Project PMC Services for Installation of GTC at GAIL, Gandhar **Client** GAIL - NOIDA

Unit New Comprssor area **Location** **Job No.** B240 **Unit No.** 910

22.	Type of positive plate	
23.	Type of negative plate	
24.	No. of positive plates/cell	
25.	No. of negative plates/cell	
26.	Material & thickness of separators	
27.	Ampere hour capacity at min. amb.	
	10 hrs rate to end cell voltage	
	specified at s.no. 8 above	
	5 hrs rate to end cell voltage	
	specified at s.no. 8 above	
	2 hrs rate to end cell voltage	
	specified at s.no. 8 above	
	1 hr rate to end cell voltage	
	specified at s.no. 8 above	
	30 min. rate to end cell voltage	
	specified at s.no. 8 above	
28.	Dimensions of each battery rack	
	Width	
	Depth	
	Height	
29.	No. of battery racks	
B.	**Battery charger**	
1.	Item no. As per MR/PR	
2.	Tag. No.	
3.	Manufacturer's name	
4.	Rating	
	Charger rating	
	Output voltage	
	Output current	
5.	Nominal voltage	
	Float charging	
	Quck charging	
6.	Float charging voltage range	
7.	Quick charging voltage range	
8.	Min. efficiency of charger	
	at light load (40%)	
	at rated load	
9.	Power factor at rated voltage & load	
10.	Max. RMS ripple voltage at rated load	
	with battery connected	
	without battery	
11.	Method of volatege control	
	Float charging mode	
	Qulck charging mode	
12.	Method of current control	
	Float charging mode	
	Qulck charging mode	

Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By
A	05-JUL-2019	ISSUED WITH MR	KINDO DEEPAK KARTIC	SRIHARI S	SINGH ARVIND N P (MS)

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Project PMC Services for Installation of GTC at GAIL, Gandhar **Client** GAIL - NOIDA

Unit New Comprssor area **Location** **Job No.** B240 **Unit No.** 910

13.	Safety factor for component selection	
14.	Charger dimensions	
	Width	
	Depth	
	Height	
15.	Max. heat loss in watts	
16.	Degree of protection	
C.	**DCDB**	
1.	Item no. As per MR/PR	
2.	Tag. No.	
3.	Manufacturer's name	
4.	DCDB dimensions	
	Width	
	Depth	
	Height	
5.	Degree of protection	
D.	**Cell booster**	
1.	Item no. As per MR/PR	
2.	Tag. No.	
3.	Manufacturer's name	
4.	Current rating	
5.	Voltage range	
6.	Dimensions	
	Width	
	Depth	
	Height	

Eil Notes

1 All interconnecting cables of DC system is in scope of bidder. cable sizes/details shall be furnished by bidder for EIL review.
2 ECS Interface Normally Open (NO) potential free contacts shall be wired upto terminal strip for connection to ECS interface

Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By
A	05-JUL-2019	ISSUED WITH MR	KINDO DEEPAK KARTIC	SRIHARI S	SINGH ARVIND N P (MS)

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ELECTRICAL LOAD DATA
(New Compressor area at Gandhar-GPU)

A	08.04.19	ISSUED WITH MR	DK	SH	ANPS
REV	DATE	P U R P O S E	BY	CHECKED	APPROVED

ENGINEERS INDIA LIMITED NEW DELHI	**Project: PMC Services for Installation of GTC at GAIL, Gandhar** **Location: Gandhar** **Client: M/s GAIL**	**Electrical Load Data**	**DRAWING NO** **B240-910-16-50-DS-5017** **Sheet 1 of 2**	**Date** 08.4.19	**REV** **A**

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
S.no	Tag no.	Service	Nor-mal / Std.by	Type of eqpt.:Pump/Cent .comp./Recip.co mp./blower etc.	Manufacturer of equipment	Eqpt. Status	Mounting	Drive arrgmt.	Rated speed r.p.m.	GD□ of Rot. Part kg-m□	Desi-gn abs. Shaft kW	End of curve /max KW	Min Rec. kW of motor	Dri ver incl Yes /No	Mot. dir. of rot. (from nde)	Motor	
																Rated kW	Speed rpm

Legend for Equipment status: # : Based on offer @ : Based on formal data * : Estimated Sheet X of X

ENGINEERS INDIA LIMITED NEW DELHI	**Plant: PMC Services for Installation of GTC at GAIL, Gandhar** **Location: Gandhar** **Client: M/s GAIL**	**Electrical Load Data**	**DRAWING NO** **B240-910-15-50-DS-5017** **Sheet 2 of 2**	**Date** 08.04.19	**REV** A

VENDOR DATA REQUIREMENTS
FOR
ELECTRICS OF GAS TURBINE COMPRESSOR

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
A	10-APR-2019	ISSUED WITH MR	DK	SH	ANPS

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VENDOR DATA REQUIREMENTS

The following drawings/documents marked "✔" shall be furnished by the bidder.

BATTERY & BATTERY CHARGER

S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Vendor Drawing/ Document Submission Schedule (Format EIL-1641-1923)		✔		✔	
2.	List of deviations, if any, to MR requirements		✔			
3.	Data Sheets (Duly filled-in)		✔		✔	
4.	Dimensional/Assembly Drawings : GA Drawing for Charger Panels, Cell Boosters and DCDB		✔		✔	
5.	Dimensional/Assembly Drawings : Battery Rack Arrangement Drawing		✔		✔	
6.	Dimensional/Assembly Drawings : Sectional View Drawing			✔	✔	
7.	Dimensional/Assembly Drawings : Cubical Arrangement Drawing			✔	✔	
8.	Dimensional/Assembly Drawings : Installation Plan/ Mounting Details/ Cable Cutout Details			✔	✔	
9.	Dimensional/Assembly Drawings : Bill of Material			✔	✔	
10.	Electrical Wiring Drawings : Single Line Diagram		✔		✔	
11.	Electrical Wiring Drawings : Block and Logic Diagrams			✔	✔	
12.	Electrical Wiring Drawings : Control Schematics			✔	✔	
13.	Electrical Wiring Drawings : Wiring Diagram and Terminal Details			✔	✔	
14.	Electrical Wiring Drawings : Interconnection Diagrams			✔	✔	
15.	Calculations for : Battery Sizing			✔	✔	
16.	Calculations for : Charger Sizing			✔	✔	
17.	Calculations for : System Cables			✔	✔	
18.	QA Plan of Vendor		✔		✔	
19.	Inspection & Test Plan (ITP) -For review by Inspection Dept.		✔		✔	*Refer Note-'*'*
20.	Site Acceptance Test Procedure			✔	✔	
21.	Test Records			✔	✔	
22.	Type Test Certificates for similar equipment		✔		✔	
23.	Performance Curves of battery			✔	✔	
24.	List of Commissioning Spares		✔		✔	
25.	List of Maintenance Spares		✔		✔	

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S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
26.	List of Special Tools & Tackles		✔		✔	
27.	Data Books/ Manuals : Installation Manual		✔		✔	
28.	Data Books/ Manuals : Operating/ Maintenance Manual		✔		✔	
29.	Data Books/ Manuals : Catalogues/ Brochures		✔		✔	
30.	Equipment storage procedure at site		✔		✔	

FLAMEPROOF CONTROL STATIONS

S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Schedule of Vendor Documents		✔		✔	
2.	Dimensional/Assembly Drawings : GA Drawings (For control station and canopy)		✔		✔	
3.	Dimensional/Assembly Drawings : Installation and mounting details			✔	✔	
4.	Wiring Diagram And Terminal Details			✔	✔	
5.	Type Test Certificate from Independent Test Lab			✔	✔	
6.	Statutory approval certificate			✔	✔	
7.	BIS Licence			✔	✔	
8.	List of Maintenance Spares			✔	✔	
9.	List of Special Tools & Tackles			✔	✔	
10.	Inspection & Test Plan (ITP) -For review by Inspection Dept.		✔		✔	*Refer Note-'*'*
11.	Test Records				✔	
12.	Data Books/ Manuals : Installation Manual				✔	
13.	Data Books/ Manuals : Operating/ Maintenance Manual				✔	
14.	Data Books/ Manuals : Catalogues/ Brochures				✔	
15.	Equipment storage procedure at site				✔	

MEDIUM VOLTAGE SWITCHBOARD

S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Schedule of Vendor Documents		✔			

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S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
2.	Confirmation of Technical Compliance					
3.	Data Sheets (Duly filled-in)		✔		✔	
4.	Dimensional/Assembly Drawings : GA Drawings		✔			
5.	Dimensional/Assembly Drawings : Installation Plan/Mounting Details			✔	✔	
6.	Dimensional/Assembly Drawings : Cross Sectional View			✔	✔	
7.	Dimensional/Assembly Drawings : Bus Duct GA Drawing		✔		✔	
8.	Dimensional/Assembly Drawings : Bus Duct Termination Drawing			✔	✔	
9.	Dimensional/Assembly Drawings : Cubicle Arrangement Drawing			✔	✔	
10.	Dimensional/Assembly Drawings : Name Plate Drawing			✔	✔	
11.	Dimensional/Assembly Drawings : GA drawing of Data Concentrator, HMI			✔		
12.	Electrical Wiring Drawings : Single Line Diagram		✔		✔	
13.	Electrical Wiring Drawings : Block and Logic Diagrams		✔			
14.	Electrical Wiring Drawings : Control Schematics			✔		
15.	Electrical Wiring Drawings : Wiring Diagram and Terminal Details			✔	✔	
16.	Electrical Wiring Drawings : Interpanel Wiring Diagram			✔	✔	
17.	Electrical Wiring Drawings : System Architecture		✔			
18.	Bill Of Material			✔	✔	
19.	Relay Characteristic Curve			✔	✔	
20.	Auxiliary Power Requirement Data (AC & DC)		✔		✔	
21.	Test Records				✔	
22.	Inspection & Test Plan (ITP) -For review by Inspection Dept.		✔		✔	*Refer Note-'*'*
23.	Type Test Certificate for Panel, Breakers & Bus ducts				✔	
24.	List of Commissioning Spares				✔	
25.	List of Maintenance Spares				✔	
26.	List of Mandatory Spares		✔			
27.	List of Special Tools & Tackles				✔	
28.	Data Books/ Manuals : Installation Manual				✔	
29.	Data Books/ Manuals : Operating/ Maintenance Manual				✔	
30.	Data Books/ Manuals : Catalogues/ Brochures				✔	
31.	Relay Parameterisation			✔		

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S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
32.	Data Mapping Details			✔		
33.	ECS I/O List			✔		

MV MOTOR

S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Schedule of Vendor Documents		✔		✔	
2.	Confirmation of Technical Compliance					
3.	Data Sheets (Duly filled-in)		✔		✔	
4.	Dimensional/Assembly Drawings : GA Drawing For motors < 75kW			✔		
5.	Dimensional/Assembly Drawings : GA Drawing For motors >= 75kW		✔			
6.	Dimensional/Assembly Drawings : Installation Plan/Mounting Details			✔	✔	
7.	Dimensional/Assembly Drawings : Terminal Box Arrangement			✔	✔	
8.	Dimensional/Assembly Drawings : Name Plate Drawing			✔	✔	
9.	Performance Curves : Speed Torque Curves			✔	✔	
10.	Performance Curves : Speed-Current/Time Curves			✔	✔	
11.	Performance Curves : Thermal Withstand Curves (Hot & Cold)			✔	✔	
12.	Performance Curves : P.f. & Efficiency Curves			✔	✔	
13.	Inspection & Test Plan (ITP) -For review by Inspection Dept.		✔		✔	*Refer Note-'*'*
14.	Test Records				✔	
15.	Type Test Certificates for similar equipment			✔	✔	
16.	List of Commissioning Spares					
17.	List of Maintenance Spares					
18.	List of Mandatory Spares		✔			
19.	List of Special Tools & Tackles					
20.	Data Books/ Manuals : Installation Manual				✔	
21.	Data Books/ Manuals : Operating/ Maintenance Manual				✔	
22.	Data Books/ Manuals : Catalogues/ Brochures				✔	
23.	Equipment storage procedure at site				✔	

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MV VFD

S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Schedule of Vendor Documents		✔		✔	
2.	Confirmation of Technical Compliance					
3.	Dimensional/Assembly Drawings : GA Drawings		✔		✔	
4.	Dimensional/Assembly Drawings : Installation Plan/Mounting Details			✔	✔	
5.	Dimensional/Assembly Drawings : Terminal Box Arrangement			✔	✔	
6.	Dimensional/Assembly Drawings : Name Plate Drawing			✔	✔	
7.	Performance Curves : Speed Torque Curves			✔	✔	
8.	Performance Curves : Speed-Current/Time Curves			✔	✔	
9.	Performance Curves : Thermal Withstand Curves (Hot & Cold)			✔	✔	
10.	Performance Curves : P.f. & Efficiency Curves			✔	✔	
11.	Schemactic and Logic Diagram			✔	✔	
12.	Block Diagram/ Interconnection Diagram			✔	✔	
13.	Wiring Diagram			✔	✔	
14.	Inspection & Test Plan (ITP) -For review by Inspection Dept.		✔		✔	*Refer Note-'*'*
15.	Test Records				✔	
16.	Combined Test Certificate (For similar Motor & VFD)			✔	✔	
17.	List of Commissioning Spares			✔	✔	
18.	List of Maintenance Spares			✔	✔	
19.	List of Mandatory Spares		✔			
20.	List of Special Tools & Tackles			✔		
21.	Data Books/ Manuals : Installation Manual				✔	
22.	Data Books/ Manuals : Operating/ Maintenance Manual				✔	
23.	Data Books/ Manuals : Catalogues/ Brochures			✔	✔	
24.	Equipment storage procedure at site				✔	
25.	Filled up PTR format wherever applicable		✔			

PACKAGED EQUIPMENT

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S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Schedule of Vendor Documents		✔			
2.	Confirmation of Technical Compliance					
3.	Guaranteed max. Power Consumption			✔	✔	
4.	Single line diagram			✔	✔	
5.	Electrical load data			✔	✔	
6.	Area classification		✔		✔	
7.	Block Diagram- FA & PA		✔		✔	
8.	Equipment layout		✔		✔	
9.	Cable layout			✔	✔	
10.	Sizing calculation			✔	✔	
11.	Cable schedule			✔	✔	
12.	Interconnection diagram			✔	✔	
13.	Electrical interface with owner		✔		✔	
14.	Technical details/Data sheets for major equipment			✔	✔	
15.	Motor data sheet		✔		✔	
16.	GA and internal arrangement drawing for panels			✔	✔	
17.	Schematic/Logic diagrams			✔	✔	
18.	Interconnection/Wiring diagrams			✔	✔	
19.	Bill Of Material			✔	✔	
20.	List of Mandatory Spares		✔		✔	
21.	List of recommended maintenance spares			✔	✔	
22.	Type Test certificates			✔	✔	
23.	Inspection & Test Plan (ITP) -For review by Inspection Dept.		✔		✔	*Refer Note-'*'*
24.	Test certificates			✔	✔	
25.	Catalogues and brochures				✔	
26.	Installation manual				✔	
27.	Operation/maintenance manual				✔	
28.	Equipment storage procedure at site				✔	

Notes :

1. "TICK" denotes applicability.
2. Post order, drawing / document review shall commence only after approval of Document Control Index (DCI).
3. All post order documents shall be submitted / approved through EIL eDMS portal.
4. Final documentation shall be submitted in hard copy (Six prints) and soft (two CDs/DVDs) in addition to

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submission through EIL eDMS.
5. Refer - 6-78-0001: Specification for quality management system from Bidders.
6. Refer - 6-78-0002: Specification for documentation requirements from Contractors.
7. Refer - 6-78-0003: Specification for documentation requirement from Suppliers.
8. All drawings & documents shall be submitted in A4 or A3 paper sizes. Documents in higher paper size shall be submitted in exceptional circumstances or as indicated in the MR/Tender.
9. Post order- The schedule of drawing / data submission shall be mutually agreed between EIL & the bidder / contractor / supplier during finalization of Document Control Index (DCI).
10. "@" indicates submission of documents to Inspection Agency.
11. Bill of Material shall form part of the respective drawing.
12. Also refer other department's VDR :-
13. Instrumentation
14. Packaged Equipment
15. Rotating Equipment
16. '*' indicates the following:
a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.
b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval by EIL Inspection.
17. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.
18. '*' indicates the following:
a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.
b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval by EIL Inspection.
19. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.
20. '*' indicates the following:
a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.
b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval by EIL Inspection.
21. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.
22. '*' indicates the following:
a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.

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b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval by EIL Inspection.

23. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.

24. '*' indicates the following:

a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.

b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval by EIL Inspection.

25. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.

26. '*' indicates the following:

a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.

b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval by EIL Inspection.

27. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.

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INSTRUMENTATION

JOB SPECIFICATIONS

GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE

(MR No:B240-910-KA-MR-5010)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
A	18.04.19	Issued with MR	PS	SR	PKS

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4.0 INSTRUMENT AIR REQUIREMENT

5.0 CABLES AND CABLE GLANDS

6.0 JUNCTION BOXES

7.0 INSTALLATION REQUIREMENT

8.0 MISCELLANEOUS

9.0 SPARES

10.0 INSPECTION AND TESTING

11.0 OTHER NOTES

12.0 LIST OF ATTACHMENTS

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S. No.	Requirement	Description
1.0	**GENERAL**	
1.1	Location of field equipments/ instruments	Hazardous area
1.2	Area classification	As per Electrical Area Classification
1.3	Operational requirements	Local gauge board and Unit control panel in Control Room
1.4	Type of interlock & shutdown system	Programmable Logic Controller
1.5	Type of instrumentation	Electronic
1.6	Logic representation	ISA
1.7	Distance between field equipments and Control Room	Approx. 500 meters (However bidder shall calculate the exact cable laying distance as per indicative Plot plan and equipment layout drawings of Compressor Station attached elsewhere in this requisition)
1.8	Order of priority in case of any conflict between MR documents	In the event of any conflict between this specification, data sheets, standard specifications, related standards, codes etc: the following order of priority shall govern: a) Statutory Regulations b) Job Specifications c) Job Standard Specifications, Standard Specifications d) Codes & Standards However, Bidder shall inform EIL/ owner for any discrepancy for resolution before proceeding and Client's/PMC decision shall be final & binding.
2.0	**TYPE & LOCATION OF CONTROLS & INSTRUMENTS**	
2.1	Type of control system (For monitoring and control)	PLC based Integrated gas turbine compressor control system. Including panel mounted HMI and control room mounted HMI with colour monitor, mouse, along with all required software and configurations to make the HMI fully operational so that the necessary operations and functions such as configuration and viewing of compressor performance curves can be carried out from the HMI. The monitor shall be 21" TFT type. (Bidder's Scope)
2.2	Type of control system (For Interlock & shutdown)	PLC based Integrated gas turbine compressor control system including. (Bidder's Scope)
2.3	Signals to / from purchaser's Station PLC.	Hardwired for the main suction & discharge and depressurizing valves and

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S. No.	Requirement	Description
	Existing Purchaser control system(RTU/SCADA/DCS). All other signal shall be connected to DCS through serial link.	other signals required for Gas turbine compressor train startup, shutdown & depressurization sequence, as specified in P&ID, equipment data sheets and elsewhere in this MR. Also redundant serial link from GTC PLC to Station PLC shall be provided for repeat of all signals from GTC PLC to station PLC/RTU.
2.4	Status signals of drives from MCC	Shall be wired to UCP marshalling cabinet in control room.
2.5	Antisurge controller, Load sharing / Performance / Master Controller	~~A~~ntisurge controller for compressor along with a dedicated Load Sharing / Performance (if required) Master Controller mounted in unit control panel.
2.5.1	Location (Note1)	Anti surge controller/ Performance / Master / Load Sharing controller in UCP in Control Room.
	Note-1: Bidder to refer System Interface Schematic B240-910-16-51-SK-0001 and B240-910-16-51-SK-0002 attached with this specification.	
2.5.2	Transmitters	Only transmitters suitable for use with anti-surge controller shall be used
2.6	Vibration & temperature monitoring system	Required(Shall be provided as per Compressor datasheet attached elsewhere in the bid package. Refer B240-910-16-51-SK-0001 and B240-910-16-51-SK-0002 attached with this specification.
2.6.1	Monitors/ racks mounted in UCP	Located in Control Room
2.6.2	Display Unit	On UCP
2.6.3	Requirement of future Connectivity with Purchaser's Machine monitoring System	Bidder shall ensure the following for future Connectivity with Purchaser's System or equivalent in case required at later date by Purchaser: (i) Bidder shall provide hardware like communication processors in each rack. (ii) Individual monitors shall have provision for giving raw data to the Machine Monitoring system (iii) Enabling software required if any for connecting to Purchaser's Machine Monitoring system for acquisition of raw data from various monitors with respect to each sensor shall be provided by bidder.
2.6.4	Process instrument type for alarm/ shutdown	Transmitter (Switch action soft generated through control system. Process switches shall not be used, even though indicated in P&IDs).

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S. No.	Requirement	Description
2.6.5	Ingress protection for instruments and enclosures in field	Weatherproof to IP55 as a minimum. IP65 for transmitters, solenoid valves, junction boxes and field switches (wherever applicable)
2.8	Hazardous area protection for instruments (Note-2)	All electronic/electrical instruments and equipments shall be suitable for area classification as per IEC codes and shall be tested by any recognised authority like Baseefa, FM, PTB, CMRI etc. and shall be certified by Petroleum And Explosives Safety Organisation (PESO)/ Chief Controller of Explosives (CCE), Nagpur or Director General of Mines Safety (DGMS) in India. Intrinsically safe in general. Solenoid valves shall be flameproof.
	Note-2: Certification for use in hazardous area shall be as follows: All instruments shall be suitable to Area classification Zone-1 Gr IIC T3 (minimum requirement for instruments). For all intrinsically safe / explosion / flameproof equipment / instruments which are manufactured abroad and certified by any statutory authority like BASEEFA, FM, UL, PTB, ATEX, LCIE etc. should also have the approval of PESO(Petroleum Explosives safety organizer) / CCE(Chief Controller of Explosives),Nagpur. For all flame proof equipments manufactured locally (indigenously, the testing shall be carried out by any of the approved test house like CMRI / ERTL etc. The instruments shall in addition bear the valid approval from PESO(Petroleum Explosives safety organizer) / CCE(Chief Controller of Explosives), Nagpur. For all intrinsically safe equipment manufactured locally (indigenously, the testing shall be carried out by any of the approved test house like CMRI / ERTL etc. The equipment shall in addition bear the valid approval from PESO (Petroleum Explosives safety organizer) / CCE(Chief Controller of Explosives),Nagpur.	
2.9	Transmitters	
2.10	Monitoring and Control loops	Smart type with HART protocol
2.11	Interlock and shutdown system (PLC) loops	Smart type with HART protocol
2.11.1	Integral LCD type outputmeter	Required (Display output in user configurable engineering units) with each transmitter.
2.11.2	Temperature transmitter	Field mounted Smart type with HART protocol required for all temperature elements except for bearing temperature elements.

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S. No.	Requirement	Description
2.11.3	Level transmitters	Level transmitters shall be Radar type.
2.12	Smart transmitters offered by Bidder shall be suitable for calibration with Universal type Hand held Configurator (1 No to be supplied by bidder). Bidder shall supply suitable configurator (HHC-1 no). (Intrinsically safe with battery charger) of each type for configuration of the instrument	
2.13	Transmitter accuracy (PT, PDT, FT, DP LT)	As given below
2.13.1	For ranges of >=760 mm WC	±0.075% within a turndown of 1:10 of the offered span
2.13.2	For ranges < 760 mm WC	±0.15% within a turndown of 1:10 of the offered span
2.13.3	Dia. Seal type with ranges >= 500 mm WC	± 0.25% within a turndown of 1:10 of the offered span
2.13.4	Dia. Seal type with ranges < 500 mm WC	± 0.5% within a turndown of 1:10 of the offered span
2.14	Temp. Transmitter accuracy (with cold junction compensation with thermocouple element)	As given below
2.14.1	For temperature ranges above 0 to 150 °C and up to 0 °C to 350 °C	± 0.25% of URL
2.16.2	For temperature greater than between 0 °C to 50 °C and up to 0 °C to 150 °C	± 0.5% of URL
2.14.3	For temperature < 50 °C	± 1.25% of URL
2.15	Temp. Transmitter accuracy (with RTD element)	As given below
2.15.1	For temperature range > 350 °C	± 0.075% of full scale
2.15.2	For temperature range between 150 °C to 350 °C	± 0.15% of full scale
2.15.3	For temperature range < 150 °C	± 0.2% of full scale
2.16	Control valve & SMART positioner.	
2.16.1	Anti-Surge Control valve	Required.as per P&ID
2.16.2	SMART positioner	
a)	Type	Smart type with HART protocol (latest version). (Note-3)
	Note-3: Positioner shall be universal in nature to facilitate use with any type of pneumatic actuator like single acting and double acting for both sliding stem and rotary shaft valves. Positioner shall be supplied by Bidder from one of the following makes i.e. M/s Dresser,M/s Fisher, M/s Metso,M/s Samson and M/s Flowserve	
b)	Positioner enclosure	Metallic
2.17	Control valve limit switches	Proximity type, intrinsically safe
2.18	Pressure gauges	
a)	Case material	SS304

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S. No.	Requirement	Description
b)	Safety type, solid front case for pressure gauge	Required for toxic service or with ranges 0 to 100 kg/cm2g and above
2.19	Temperature gauges	
a)	Type	Generally Bimetallic type
b)	Case material	SS304
2.20	Thermocouple	
a)	Type	Generally K type
b)	Grounded/ ungrounded	Grounded type
2.21	RTD (wherever applicable)	PT-100, 3 wire, calibration as per IEC 60751
2.22	Thermowell and thermowell flange material	Minimum 316 SS or better for thermowells and thermowell flanges as per Piping Material Spec.
2.23	Air Filter Regulator filter size	5 micron
2.24	Solenoid valve insulation class	Class F
2.25	Terminal blocks	Internal terminal block for all instruments, anti-vibration type, suitable for terminating a minimum of 1.5 mm2 size cable conductors. Flying leads are not acceptable.
2.26	Terminals	Screw less clamp type
2.27	Barriers (wherever applicable)	Required
2.28	SS Tag plate	Required for all instruments, gauge boards, and local panel.
	Threaded end connections for instruments shall be to NPT as per ANSI B 1.20.1. Flanged end connections shall be as per ANSI B 16.5. All flanges and flanged valves shall have smooth surface finish (125 – 250 AARH) as per ASME B46.1.	
3.0	**POWER SUPPLY REQUIREMENT** (Note-4)	
3.1	Control system	110 V AC 50 Hz UPS
3.2	Interlock & shutdown system	110 V AC 50 Hz UPS
3.3	Interrogation voltage for contact input	24 V DC
3.4	Solenoid valve	24 V DC
3.5	Intrinsically safe transmitters (loop powered)	24 V DC
3.6	Proximity type limit switches	24 V DC
3.7	Panel lighting	230 V AC 50 Hz (Non-UPS)
	Note-4: Purchaser will provide one power feeder of 110VAC UPS to UCP in Control Room. Further distribution shall be by Bidder. Any other power required for Bidder supplied hardware shall be derived out of 110VAC, UPS and the same shall also be in Bidder's scope. Bidder shall indicate estimated power consumption for 110 V AC (UPS) & 230 V AC Non UPS along with bid.	
4.0	**INSTRUMENT AIR REQUIREMENT** (note-5)	

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S. No.	Requirement	Description
	Minimum Pressure	4.5Kg/cm2 g
	Normal Pressure	6 Kg/ cm2 g
	Design Pressure	9.5 Kg/ cm2 g
	Note-5: Purchaser will provide one instrument air connection at battery limit. Further instrument air distribution shall be by Bidder. Instrument air connection size shall be finalized during detail engineering after the analysis of exact consumption of instrument air.	
5.0	**CABLES & CABLE GLANDS**	
5.1	Type (single pair as well as mulipair)	1.5 mm² twisted in pair individually and overall shielded with aluminium Mylar tape with drain wire and armoured. Multipair cable shall be 6P(1.5mm2) or 12P(1.5mm2) type
5.2	Flame retardant+Low Smoke	Required, as per IEC 60332 Cat. A.
5.3	Cable glands	Nickel-plated brass, double compression type suitable for armoured cables. Cable glands shall be Exd/Flameproof type.
5.4	Slipper type PVC sleeves (cable shrouds)	Required (over cable glands for all cable entries in junction boxes).
6.0	**JUNCTION BOXES**	
6.1	Separate JBs for different type of signals	Yes Separate JBs for signals for Intrinsically safe & flameproof instruments, 4~20 mA signals, Contacts, Thermocouples, RTDs, Solenoid valves, Vibration & temperature monitoring signals for machine monitoring system
6.2	Type of JBs	Weather proof for IS instruments and flame proof for Ex-proof instruments
7.0	**INSTALLATION REQUIREMENT**	
7.1	Instrument impulse lines	Piping for - all hydrocarbon service , - high pressure service (>= 600#) (note-6) Tubing for - Utilities.
7.2	Piping material used in installation hook up	As per Piping Material specifications.
7.3	Tubing used in impulse line	Minimum SS 316L tube, ½" OD size
7.4	Instrument valve manifold	Integral type
7.5	Impulse line isolation valve (after first isolation valve)	Globe type
7.6	Impulse line vent & drain valves	Globe type
7.7	Instrument air isolation valve for each instrument	Ball valve of SS 316
7.8	Instrument connection sizes	As per 7-52-0001 and 7-52-0002 attached with Job Specification.

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S. No.	Requirement	Description
	Note-6: Remote type Installation Standards shall be followed.EIL installation standards are attached for reference. All the transmitters should have horizontal impulse entry only for easy interchangeability without impulse modification in future.	
7.9	Instrument air signal, air supply, steam tracing (where applicable) tubing	6 mm OD SS316 tube for instrument air supply tubing and 6 mm OD Copper tube for steam tracing.
7.10	Cable routing	Galvanized mild steel perforated trays of 2.5 mm thickness shall be used for branch cables / single pair cables from instrument to junction boxes. Ladder trays/duct shall be MS hot dip galvanized.
7.11	Spare space in cable trays	Cable trays shall have at least 50% spare space
7.12	Cable entry in junction box	From side or bottom
7.13	Ferruling inside JBs	Heat shrinkable printed sleeve type
7.14	Accessibility of instruments	Any instrument not accessible from grade/ platform shall be provided with accessing platform.
8.0	**MISCELLANEOUS**	
8.1	Proven track record	The instruments and systems as being offered / supplied should have been operating satisfactorily under similar process conditions for at least 4000 hrs. PTR for the offered control system shall be furnished as per the attached PTR format along with bid.
8.2	Vendor list	All Instrument items shall be from EIL approved vendors indicated in the attached vendor list.For items not from approved vendor list, Bidder shall furnish proposed sub-vendor list for purchaser's approval along with PTR of such sub-vendor.
8.3	Specialty services	For PLC based control system, Vibration & temperature monitoring system, master/performance/load sharing controller and Anti-surge control system bidder shall hire the single point specialist services from the respective sub-suppliers of all the above mentioned systems for design, detail engineering, supply of all component needed, installation & commissioning as detailed below: a) During engineering stage: To approve all applications related issues and configurations,

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S. No.	Requirement	Description
		networking, cabling & electrical design etc. b) During order execution stage: To participate in the machinery FAT/SAT and to oversee timely supplies of various components of the system envisaged. c) During installation & commissioning: To supervise & verify the installation and calibration on site of field instruments & system components being supplied and documentation of the complete installation. Testing & commissioning shall be done under supervision of respective manufacturer's specialists. Bidder to make specialists' services available during testing & commissioning. d) To optimise the overall system w.r.t. appropriate integration and interface with Purchaser's other system.
8.4	Painting requirements	Painting of installation material, instrument supports and structural supports shall be as per painting specification attached elsewhere in MR.
8.5	Logistic support	Logistic support certificate as per Annexure – I from the all major instrument supplier shall be provided by Bidder along with the offer.
8.6	Loop Checking	Bidder is responsible for loop checking in coordination with purchaser's contractor at site. Site activities for loop checking like laying, dressing, identification & tagging, ferruling, termination of cables, calibration for all the instruments shall be carried out by purchaser's contractor. However bidder shall supervise & provide all necessary assistance to the purchaser's field contractor for these site activities. However checking of interconnection between instruments / equipments inside control room and performing loop checking with the co-ordination of field contractor shall be in the scope of bidder. Before proceeding for loop checking the calibration results of individual instruments shall be recorded in the format, which shall be approved by EIL/Purchaser for correctness of

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S. No.	Requirement	Description
		installation/measurements and calibration results
8.7	Training requirements for PLC system	Required
		At Vendor works: 7 days for 2 person
		At Site works: 7 days, Two batches of 6 person
9.0	**SPARES (Note-7)**	
9.1	Mandatory Spares	Bidder shall provide Mandatory spares as per Mandatory spares list Doc no. B240-910-16-51-SS-5010 attached. Prices for mandatory spares shall be included in the base price.
9.2	Commissioning spares	Instrument commissioning spares shall be supplied as required for successful commissioning of the compressor. The same shall be included in Bidders offer. Vendor shall procure these spares as per recommendation of sub vendors/Suppliers and these shall be available at the time of commissioning. These shall include all instrumentation and control items including for sub-package items. Bidder shall note that in case any additional spare is consumed during erection and commissioning over and above the quoted erection and commissioning spares, the same shall be supplied by bidder without any time and cost implications. Also, if any spares are consumed during commissioning from mandatory spares, the same shall be replenished by bidder without any cost implication.
9.3	Installed spares	Bidder shall provide installed spares duly wired with barriers etc. (as applicable) as per details given below: I. For each Vibration Monitoring System: (i) I/O Level:- 20% (ii) Marshalling:- 20% II. For Panel Status lamps, switches, push buttons :- 20%
	Bidder shall ensure 20% additional spare space for marshalling and I/O modules for future in Vibration monitoring cabinet.	
9.4	2 years operation spares	Bidder shall furnish separate list of recommended spares for instruments / system for 2 years operation along with unit price.
9.5	Engineering Spares	Bidder to consider 30% Total I/O's as engineering spares. These are to be

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S. No.	Requirement	Description
		considered in addition to all other spares
	Note-7: Requirements of spares indicated in any other Standard specification shall not be considered.	
10.0	**INSPECTION & TESTING**	
10.1	Factory testing & inspection of all instrument items by Vendor's authorized representatives, EIL/Owner, unless specified otherwise	Yes

11 Other Notes:

11.1. Design Philosophy and other requirements:

11.1.1 The operation, monitoring & control of the Gas turbine compressor is envisaged via higher level operator interface (HMI) for control and monitoring of entire Gas turbine & compressor unit package through Programmable Logic Controller (PLC). Sequential start up / shutdown operation shall be implemented through sequential logic in Integrated Gas turbine and compressor control system based on PLC. Instruments and control shall be of fail-safe design.

11.1.2 Loops for Interlock / shutdown and alarm, indication / control shall be completely independent of each other including the field sensor / transmitter. There shall be no sharing of the loop components on the same line for a closed loop for control / indication / alarm and a loop for interlock or shutdown.

11.1.3 Loss of air-conditioning in the control room shall not result in malfunction or erratic behavior of instruments or shutdown of the system. The system shall be designed to operate for a minimum period of 2 hours without air conditioning.

11.1.4 All required push buttons and selector switches etc. for operation of various equipments shall be through soft keys in the consoles except for some critical operation like ESD etc., which shall be mounted on GTC Unit Control Panel in control room by the bidder.

11.1.5 Suitable bypass for interlock with annunciation / indication shall be provided for start up of Gas Turbine and Compressor in respective system.

11.1.6 All hardwired lamps for alarms; indication etc. shall have lamp test facility. Lamps used shall be of LED type. Screw less terminal blocks (cage clamp technology) are to be used in all panels, marshalling cabinets/ auxiliary panels etc

11.2 Operation, monitoring & controls and Interlock / Shutdown System

11.2.1 All operation, monitoring & controls and interlock & shutdown logic functions for the gas turbine & compressor package including its auxiliaries like lube oil, dry gas seal (as per API 682) & fire and gas detection etc. shall be executed by the bidder individually in the PLC based Integrated Turbine and compressor Control System for entire GTC train.
Bidder shall supply PLC based Integrated Turbine and compressor Control System.

11.2.2 PLC based control system with its individual MMI & printers and serial data interfaces shall be provided in accordance with the data sheet B240-910-YE-DS-5010 and the configuration diagram B240-910-16-51-0001 enclosed with this requisition. However bidder shall note that the configuration indicated in the enclosed drawing is indicative only. Bidder shall provide all

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the required hardware's and software's to meet the functional requirement as specified here and elsewhere in this document and shall also furnish the offered system configuration.

11.2.3 Bidder shall provide the interlock and shut down scheme for complete package to EIL / purchaser for approval, in the form of:

a) Write up.
b) Logic / Ladder diagram as per ISA S 5.2
c) Sequence of operation diagram of start-up / shutdown / normal operation.

11.2.4 All compressor and turbine related pre alarms shut down alarms and system alarms shall be displayed on HMI. There should be FIRST OUT string configured to display the very first alarm in case of trips along with PLC bit address or cross reference.

11.3 Gas Turbine Control System

11.3.1 Bidder shall provide fault tolerant, PLC based Integrated Gas Turbine and compressor Control System with fail-safe design and adequate redundancies, as per bidder standard, for continuous uninterrupted and safe operation of the machine.

11.3.2 Integrated Gas Turbine and compressor Control System shall be provided with colour graphic operator consoles (TFT type), one panel mounted and the other table mounted, in accordance with the configuration diagram B240-910-16-51-0001 & B240-910-16-51-0002 enclosed with this requisition for complete centralized man machine interface, monitoring and control. System shall be provided with displays complete with required hierarchies and alarm management for easy operation and control of the system. Display shall also include graphic mimics of train process P&ID's.

11.4 **Axial & Radial Vibration, Bearing & Winding Temperature Monitoring System**

11.4.1 Compressor shall be provided with individual monitoring system located in control room, which shall include monitoring for compressor as well as turbines.

11.4.2 The monitoring system shall be mounted on standalone racks supplied by bidder.

11.4.3 For data transfer to Machine monitoring system(MMS) shall be provided with individual communication processors (TDI) mounted in Unit Control Panel (UCP) which shall collect static as well as dynamic machinery data under steady state as well as start-up & shut-down conditions and shall be provided with serial link.

11.4.4 Serial communication link from Vibration and temperature monitoring system shall be provided by bidder for communication to GTC PLC through suitable protocol.

11.4.5 Special cables from probes to proximities / transducers to the monitoring system in control room and other serial link cables shall be in bidder's scope of supply.

11.4.6 Bearing & winding temperatures shall be measured at the points as specified elsewhere in this requisition. Sensor shall be RTD element, platinum, 100 ohms at $0^{o}C$, of three-wire type. Calibration shall be as per DIN 43760 standard.

11.4.7 Key Phasor

11.4.7.1 Bidder shall provide key phasor system or performing analysis of vibration signals to determine machine malfunctions. It shall consist of proximity probe, transducer, extension cable etc. and other accessories to make the system complete. Bidder shall provide necessary reference on the shaft to determine once-per-turn occurrence.

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11.5 Gas and Fire Detection System

11.5.1 Bidder shall provide separate Fire and Gas Detection System (including sensors & transmitters) for each Gas Turbine enclosure (LEL, Heat and Flame detectors). It shall be connected to compressor PLC provided by the bidder and located in control room.

11.5.2 Gas Detection

11.5.2.1 Bidder shall design and provide hazardous gas detection system (including sensors & transmitters) for alarm and shutdown for inside enclosures, combustion air intake plenum chamber, ventilation intake and exhaust of gas turbines so as to protect personnel and equipment from hazardous gas infiltration as per relevant NFPA standards and API recommended practices. Gas detection system shall meet all mandatory requirements specified by gas turbine manufacturer. The gas detector shall be Smart, IR type with 4-20 mA output. The detections shall have two levels of alarm and trip setting adjustable over the entire range (20%, 50% LEL typical) with reference to concentration of gases before the hazard level (100% LEL) is reached. All gas detectors transmitters and the cables located inside the turbine enclosure shall be suitable for a temperature of 200°C.

11.5.2.2 20% LEL, 50% LEL and malfunction alarms are to be generated in UCP PLC for annunciations and also audible alarm in local shall be provided. Coincident detection of 50% LEL in turbine enclosures shall close the main fuel valve, shutdown the compressor system, shutdown the ventilation system. However, in case of equipment surface temperature (inside enclosure is above 200°C) ventilation shall continue until temperature drops down to below 200°C. Single detection of 50% LEL shall provide only alarm.

11.5.2.3 In all locations where gas detection is required, at least two detectors along with transmitters shall be provided. Bidder shall decide location of gas detectors during detailed engineering.

11.5.2.4 The audible alarm and gas detection system (sensors/transmitters) shall be suitable for the area classification. Sealed conduits shall be provided for safe function in the event of hazard within the enclosure.

11.5.2.5 Detection system shall consist of gas detector / transmitter with 4-20 mA output connected to PLC in control room where further control scheme for the Gas Detection System shall be implemented to achieve the above specified functions.

11.5.3 Fire Detection

11.5.3.1 Bidder shall design and supply inside the GTC enclosures, a Fire Detection system as per the NFPA Standards and API Recommended practices.

11.5.3.2 Manifestation of fire shall be sensed by the following methods:

1. Ultraviolet (UV) Light Detectors arranged for coincident actuation

2. Thermal detectors for fixed temperature detection & rate of rise in temperature.

11.5.3.3 The self-checking type UV Light Detectors shall detect flash fires. They shall not be sensitive to direct or reflected sunlight or normal artificial lighting. They shall be provided with automatic optical integrity. Thermal detectors shall be provided to detect fixed temperature.

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11.5.3.4 The detectors along with transmitters shall be provided by bidder inside the turbine enclosure at appropriate locations. A Minimum of two UV detectors shall be provided in each location to facilitate co-incident activation.

11.5.3.5 Activation of coincident UV Light Detectors or coincident Thermal detectors (in the gas turbine enclosure) and / or single thermal detector shall sound a local alarm, as well as remote alarm located in Control Room; close the main fuel valve and cause emergency shutdown of the equipment. Any single UV detection or thermal detection shall sound local and remote alarm.

11.5.3.6 All the detectors and its transmitters shall be listed or approved by Factory Mutual or Underwriter's Laboratory Inc. for hazardous locations.

11.5.3.7 All the detection devices shall be wired in sealed conduit and NEMA7 / "EExd" enclosures, in order to function safely should hazard exist inside the enclosure. The total fire detection system shall be suitable for Zone-1 area. All the UV detectors/transmitters and cables located inside the turbine enclosure shall be suitable for a temperature of 200°C.

11.5.3.8 Thermal Detectors shall have stainless steel body construction and shall be Flame proof, rate compensated, fixed temperature type with 4-20 mA transmitters, which shall be connected to respective PLC.

11.5.3.9 Fire Suppression System shall be designed so that it can be activated automatically by receiving a signal from the PLC's after being activated by coincident signals received from fire detectors located inside the enclosures. It shall also possible to manually activate the fire suppression system in the event of a signal from any of the devices either from control room or from local gauge board.

11.5.3.10 A suitable time delay (approximately 30 seconds, adjustable), with audible and visible flashing red light alarm, shall be provided before the release of fire extinguisher to facilitate escape of the personnel. Fire Extinguisher Release alarm shall also be annunciated in control room.
Facility is to be provided to lock fire suppression system during maintenance period for both initial and reserve cylinders to avoid accidental release of fire suppression system.

11.6 Compressor / Capacity Control System: Master / Performance /Load sharing Controller & Anti-surge Controller:

11.6.1 The system in general shall be provided in accordance with the Instrument Job Standard Specification for Package Units" (6-52-0052 & Capacity control system configuration as per schematic B240-910-16-51-SK-0002 enclosed with this requisition and as per the indicative scheme as indicated in the enclosed P&ID's. However bidder shall note that the configuration indicated in the enclosed drawing is indicative only. Bidder shall provide all the required hardware's and software's to meet the functional requirement as specified here and elsewhere in this document and to achieve a fully automatic mode of operation.

11.6.2 The anti-surge controller **(as per API 670)**, emergency surge detectors shall be a separate dedicated controller for each stage of the compressor. The bidder shall supply this installed on individual compressor control panel located in control room.The bidder shall supply this installed on unit control panel located in control room.

11.6.3 Load Sharing / Performance Master Pressure Control

11.6.3.1 Bidder shall supply Load Sharing / Performance Master Pressure Control System of Gas compressor Units. The same shall be a separate dedicated standalone Controller System suitably interfaced with the UCP PLC for the Logic and Sequence control.

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11.6.3.2 The Bidder shall supply a fully integrated performance control system that provides dedicated high-speed control of the closely coupled process control loop(s). Integrated limiting loops shall be provided with the supplied performance control system in order to maintain the compressor and driver within the OEM and process defined safe limits. Provisions shall be included to move smoothly from speed or throttling control to process control based on modulation of the antisurge valve(s) at periods of reduced process demand and during fast moving or large process disturbances. Bidder's control system should include automatic tracking and mode switching between speed (fuel) control and the associated process and antisurge control loops. Speed and/or power limiting algorithms shall be designed for smooth transition in and out of process control loop tracking. A dedicated master performance control system shall be used for the primary process variable and limiting loops. This master controller shall work with the dedicated antisurge system associated with each compressor.

11.6.3.3 The System shall provide control of both discharge / suction pressures and flow in the Compressor by automatically varying Turbine's rotational speed which shall be consistent with the primary goal of preventing surge and provide regulation of the overall system capacity to accurately meet the discharge flow rate requirements.

11.6.3.4 The System shall calculate compressor operating point deviations in a manner that is invariant to changes in inlet conditions, including changes in inlet pressure, inlet temperature, gas composition (molecular weight and specific heat ratio), compressor polytrophic efficiency and rotational speed.

11.6.3.5 In response to bringing one compressor on-line or taking one off-line, the System shall re-establish steady-state operation with all units equally (within 1%) in no more than 30 minutes.

11.6.3.6 The System shall maximize energy efficiency within the compressor network by distributing the total load so as to maintain each compressor the same distance from surge, thus avoiding unnecessary recycle.

11.6.3.7 In the event of series load sharing, the compressors are to operate equidistant to surge when they are not recycling and with equalized recycle flow when they are. When the compressors are not recycling their mass flow rates must be the same.

11.6.3.8 The System shall provide automatic limitation of network throughput as required to avoid a variety of Turbine, Compressor, and process limits, such as maximum process pressures, rotational speeds, and turbine exhaust-gas temperatures.

11.6.3.9 Master/Overall Performance Control function of the System shall regulate the overall load distribution by influencing the outputs of the Antisurge and the individual secondary Performance Controllers.

11.6.3.10 The System of individual or the Secondary Performance Control function of the individual compressors shall regulate the throughput of its own compressor by manipulating its speed. It shall calculate its output in relation to the changes in the Master Performance Control function output and the compressor's distance from surge line (obtained by monitoring Anti surge Control function) for protecting the Compressors from surge, avoiding unnecessary recycling and providing the optimum performance.

11.6.3.11 The System's overall or the Master Performance Control / Load Sharing function shall regulate the Compressor train's discharge flow by indirectly manipulating the control elements of the Antisurge and Secondary Performance Control functions. When the Compressor is operating far from its surge limit, deviations shall be countered primarily by the Secondary Performance control functions with little or no change in the recycle rate.

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When the Compressor is operating near its surge limit the deviations shall be countered primarily by changing the recycle rate with little or no change in the Compressor throttling valves.

11.6.3.12 The System's Master Performance Control/Load sharing function shall calculate its output to provide the optimum response for ensuring the specified performance of the Compressor Control system. It shall provide limiting control of the Compressor train suction and discharge pressures using necessary control logic with user-configurable coefficients. When one of these variables is outside its user-selectable limit, the system response shall be such to restore the normal/optimum functioning of the system.

11.6.3.13 The System's Secondary Performance Control function shall provide limiting control of each Compressor's suction and discharge pressure using necessary control logic with user-configurable coefficients. When one of these variables is outside its user-selectable limit, the system response shall be such to restore the normal/optimum functioning of the system.

11.6.3.14 Each of the System's Secondary Performance Control function shall exchange information with all other Anti surge and Performance Control functions in order to implement optimum control responses for regulating the Compressor to increase the precision of the process control by reducing adverse loop interactions. This response shall also be added to the combined PID and Variable-Gain responses.

11.6.3.15 The System's Secondary Performance Control function shall incorporate features to automatically detect compressor start-up and shut-down based on the value of analog input and to ramp their output signals up and down in response to such changes.

11.6.3.16 In the event that a Secondary Performance Control function of the System fails to receive the requisite load-sharing information from the master control function, it shall revert to controlling one of its own input signals using a system specific control response that is fully configurable by the user.

11.6.3.17 The purpose of these controls is to maximize energy efficiency within the subject compressor network by distributing the total load so as to maintain each compressor at the same relative distance from surge, thus avoiding unnecessary recycle at times of reduced throughput.

11.6.4 Anti-surge Controllers (ASC)

11.6.4.1 Anti surge controller to be supplied of microprocessor based anti-surge controllers for new compressor package. Recycle valves are also to be supplied. Bidder shall provide surge control system supplier's confirmation on adequacy and suitability of the selected recycle valves for their system.

11.6.4.2 These shall be mounted and wired suitably by package supplier on the main compressor Unit Control Panel located in the control room.

11.6.4.3 These controllers shall have necessary digital displays and keyboard for monitoring operation, in addition to monitoring & operation through HMI, and data entry and provision of inter-connection to PLC.

11.6.4.4 These controllers shall have necessary digital displays and keyboard for monitoring operation, in addition to monitoring & operation through HMI, and data entry and provision of inter-connection to PLC.

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11.6.4.5 The controller shall be such that it shall allow compressor to operate as close as possible to the actual surge line @ 2% away from actual surge line safely.

11.6.4.6 The controller shall provide stable operation. It shall also be very sensitive to achieve correct/accurate opening of the antisurge (bypass) valve without hunting.
Even with upset conditions, it shall not allow surging. This shall be achieved by fast response transmitters and by pass valve as well as by special algorithms in software, to be used only for recycle valves.

11.6.4.7 Auto/manual station, inputs for bias and other settings as required for adjusting the surge control/safety line shall be provided.

11.6.4.8 A trip control algorithm as an overshoot limit control shall be provided. This feature will quickly open the recycle valve to a preset position, upon an external trip signal from the compressor shutdown system (or from other status signals indicative of a sudden reduction in flow rate).

11.6.4.9 Manual operation of recycle valve shall have override by anti-surge controller. Controller shall be capable of checking the input signal failure and taking action for safe operation with necessary indication on the panel.

11.6.4.10 Antisurge Control Requirements

11.6.4.10.1 Antisurge control loops shall continually calculate the distance between the operating point and surge limit line in a manner that is invariant to changes in inlet conditions, including changes in inlet pressure, inlet temperature, gas composition, molecular weight and specific heat ratio.

11.6.4.10.2 Multiple field proven antisurge algorithms shall be available in the supplied antisurge control system. These algorithms shall be accessible via user configuration for each antisurge control loop, such that any unexpected field modifications can be easily accommodated.

11.6.4.10.3 The antisurge system shall include a dedicated surge control algorithm for each compressor section. Dedicated antisurge control valves will also be used for each section unless otherwise indicated by the user approved piping and instrumentation diagram.

11.6.4.10.4 The antisurge system shall work in harmony with the closely coupled process control loops in order to provide for a smooth transition from speed or throttling control to performance control using the antisurge valve at lower process load levels.

11.6.4.10.5 The antisurge system shall be capable of recognizing transmitter failures and automatically switching to a fallback strategy allowing continuation of automatic control. Alarms should be provided to signal operator to any system fault.

11.6.4.10.6 The antisurge control algorithm shall incorporate a surge detector and surge cycle counter. Surge detection shall be based on comparing the rate of change of the flow and/or discharge pressure to user configurable limits. Provisions must also be made for recording and displaying the maximum observed rate of change for each of those variables, as an aid to configuring the detection system based on the results of a surge test on the given machine.

11.6.4.10.7 Should extraordinary conditions push any compressor section into surge, the system shall be designed to automatically break the surge cycle before the second cycle can occur. In addition, the system shall provide for automated recovery from surge without operator

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intervention. Also, upon surge detection, the surge control line shall be automatically readjusted for more antisurge control margin until an investigation of the circumstances of the event can take place.

11.6.4.10.8 The antisurge control algorithm shall incorporate standardized operating modes for forcing the antisurge valve fully open (normally when the compressor is shut down) and fully closed during purging operations. These states shall be selected on the basis of discrete inputs and/or the compressor's rotational speed, flow rate, or discharge pressure.

11.6.4.10.9 The System shall manipulate the Recycle Control Valve /Valves so as to maintain an adequate but not excessive margin of safety between its compressor section's operating point and surge limit, as described below. The Control System's response shall be such to quickly increase the recycle flow rate in the event of large and/or fast disturbances.

11.6.4.10.10 The System shall provide reliable anti-surge control and protection of each compressor stage in any operating mode, including start-up, purge, idling, and shutdown of the machine.

11.6.4.10.11 The System shall protect each stage of compressor from surge-induced compressor damage and process upsets with minimum recycle and minimize adverse interactions between the various control functions.

11.6.4.10.12 In the steady state, the deviation of the discharge pressure from its set point shall not exceed preferably ½%.

11.6.4.10.13 In response to full closure of network suction or discharge block valve, the System must not allow any compressor to surge. In response to the simultaneous closure of both valves, the system should not allow any compressor to surge more than once.

11.6.4.10.14 The set point of the anti surge control functional response shall be a user-configurable function for volumetric flow, thus compensating for changes in the rotational speed or guide vane geometry and shall be increased each time a surge cycle is detected. The above-referred set point shall also be increased when the rate at which the compressor operating point is moving toward its surge limit increases. Once an adequate margin of safety has been restored, this additional margin-of-safety shall be decayed at a user-adjustable rate.

11.6.4.10.15 The System shall also implement necessary responses to the changes in the master/ Performance Load Sharing Control functions' output when the compressor is operating near its surge limit.

11.6.4.9 Emergency surge detector

11.6.4.9.1 This detector shall be provided as back up to the anti-surge controller. In the event of failure of anti-surge controller/system, the emergency surge detector shall prevent machine damage due to surge by opening the recycle valve very fast on sensing the second surge cycle. Alarm shall be provided on first surge cycle.

11.6.4.10 Bidder shall be fully responsible for proper sizing, selection and supply of anti-surge control valve as per the recommendations of the anti-surge controller manufacturer. **The anti-surge controller manufacturer shall vet sizing calculations of anti-surge control valve** & it shall be submitted to EIL for information before procurement of the valve.

11.6.4.11 A maintenance notebook computer with the latest version of CCC's Engineering Utilities shall be supplied.

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11.7 PLC system

11.7.1 UCP PLC system for GTC train and operator consoles shall be as per PLC data sheet document no B240-910-YE-DS-5010 attached with this requisition.

11.7.2 This specification of PLC shall be read in conjunction with standard specification for PLC no 6-52-0040 enclosed with this MR.

11.7.3 The changeover of Dual Processor in PLC shall be bump less and the system shall be fail-safe. Redundancy shall be provided for complete Processor sub-system including CPU, Memory, communication and Power supply. And I/O's shall be non redundant.

11.7.4 In PLC redundant communication sub system, on failure of active device, the redundant device shall take over automatically without interrupting the system operation.

11.7.5 PLC operation shall be completely unaffected by a momentary power loss of the order of 20 milliseconds.

11.7.6 Field mounted type, vendor's standard design, remote I/O's for GTC PLC can also be accepted provided the same are field proven in similar application and certified for hazardous area application.

11.7.7 The PLC shall include GTC/station control as per P&ID attached with the MR.

11.8 OPERATOR CONSOLE

11.8.1 The PLC console (control room mounted) shall be used as operating cum engineering console. The UCP Panel mounted HMI shall be used as operator console only. The Engineering workstation shall be used for PLC Programming, MMI development, Program storage, and fault diagnostics in addition to the monitoring and Plant operation. The MMI software shall be from the original manufacturer of PLC and should not be third party software.

11.8.2 Operator console shall have data equalization and clock synchronization among each other. If alarm is acknowledged on one console then same shall be acknowledged automatically in other console.

11.8.3 Operator console shall be server grade industrial PC and hardware configuration shall be minimum with 21" color TFT LCD monitors with keyboard and optical mouse.

11.8.4 All alarm log printers shall be Laser type as per PLC data sheets. And one no. laser jet colour printer A3 size, shall be supplied.

11.9 Special Requirements

11.9.1 Interface from bidder supplied Control System PLC with Purchaser's Existing Plant Control Station/ /SCADA (RTU).

11.9.2 Bidder shall provide serial communication link along with interconnecting cables for all data transfer from bidder supplied package PLC to SCADA/DCS/PLC.

11.9.3 Bidder shall provide all necessary hardware, software etc. in bidder supplied systems and other details required for interfacing of their package PLC and from PLC to purchaser's PLC / SCADA (RTU). In addition to this, the communication software shall be supplied in electronic media (CD/DVD) for testing the communication link.

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11.9.4 Bidder shall be fully responsible for proper integration of their supplied system to purchaser's PLC/SCADA (RTU)/DCS and bidder supplied at site and bidder shall provide all necessary assistance to purchaser for establishing all the serial links with ~~station~~ PLC/SCADA (RTU) fully functional & operational.

11.10 Sequential Start-up and Shutdown Logic

11.10.1 The microprocessor based Gas Turbine Control system and Programmable Logic Controller (PLC) shall include an automatic sequential start-up and shutdown logic designed to provide reliable programmed starting, acceleration and full load operation of the unit and safe shutdown of the entire turbine compressor system. Separate interlock and logic system shall be provided for each train. Sequential logic shall reside in non-volatile memory.

11.10.2 Bidder shall ensure that unit will be shutdown safely in case of failure of microprocessor based Turbine control system and PLC. Bidder shall provide required back up through hardwired fast path relays for safe shutdown of the unit in case of such processor failure. In addition, safe shutdown should also, at least, cover the following:

a) Engine over temperature
b) Over speed of GT / PT
c) Fire & Gas Detection coincident logic.
d) ESD etc.

11.10.3 Sequence and interlock requirement of complete Gas Turbine Compressor Train shall be implemented in dedicated Turbine Compressor Control System and GTC Train PLC. This shall include the following as a minimum:

a) All shutdown / interlocking, sequential start-up and other auxiliary equipments shall be located with in the compressor unit control panel / PLC.
b) Start-up and shutdown of the entire compressor train (i.e. unit train valves, process gas after coolers, Knock out drums process interlocks etc.) shall be executed by these microprocessor based Turbine Compressor Unit control system and train PLC to centralize the train operation into single stream.
c) To avoid accidental operation, all important push button, switches etc. shall have one common flushed Master Control Button. Action shall take place when both the buttons are pressed together.
d) Operation mode selector switches, as required on compressor unit control panel / PLC console for mode of operation shall be provided.
e) Fuel gas Cut-Off valve leakage check through suitable logic and pressure sensor's between the fuel shut off valves shall be provided.

12.0 LIST OF ATTACHMENTS:

As per document No B240-910-16-51-LA-5010 attached elsewhere in this requisition.

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Mandatory Spares List
(To be supplied loose)

Discipline: Instrumentation

Mandatory spares shall be quoted and included in base price as per the following table:

Sl. No.	Part Description	Quantity Required
	Mandatory spares shall be quoted and included in base price as follows:	
1	**Field Instruments**	
	This includes all types of the following instruments excluding line-mounted instruments.	
I	Pressure gauges Temperature gauges	10%subject to minimum1No. of each type and size, range, rating and material wise whichever is higher.
II	Field transmitters for Pressure, Level, DP, Flow and Temperature etc.	10%subject to minimum1No. of each type and size, range, rating and material wise whichever is higher.
III	RTD/Thermocouple (with Thermowell), Thermowell etc.	10%subject to minimum1No. of each type and size, range, rating and material wise whichever is higher.
V	Gas detector, fire detector UV/IR Thermal/heat detectors with transmitter	10% subject to minimum 1 no of each type of sensor & transmitter, whichever is higher.
VI	Level gauge glasses	10% subject to minimum 1 no of glass of each size along with gasket set, whichever is higher.
VII	Instrument valve / 3-Way valve manifold / Tube fittings etc.	10% subject to minimum 1 no for each type/size, whichever is higher.
VIII	Speed transmitter probe	10% subject to minimum 1 no of each, which ever is higher.
IX	Beacons / Horns for gas detector	10% or minimum one number, whichever is higher.
2	**Line mounted instruments**	
I	Control valve, shutdown valve	a) 01No. seat plug assembly for each valve under cavitation and / or flashing and noise (for globe and angle valves).
		b) Grouping of balance valves with respect to size, rating, material & trim type and 10% subject to minimum 1 no. of plug & seat assembly of each group, whichever is higher (for globe & angle valves)
		c) Grouping of valves with respect to size, rating & material and 10% subject to min 1 no. ball & seat, for each group whichever is higher (for ball valves).

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Sl. No.	Part Description	Quantity Required
		d) Grouping of valves with respect to size, rating & material and 10% subject to min 1 no. of disk/rotary plug and seat of each group, whichever is higher (for rotary plug & butterfly valves).
		e) Grouping of all valves with respect to size, rating, material & trim type and 10% subject to minimum 1 no. whichever is higher of the following items group wise: - I. Gland packing II. Actuator Diaphragm. III. Valve positioner IV. Bonnet gaskets (for all type of valves) V. Quick exhaust Valve (if any) VI. Solenoid valves VII. Limit switches. VIII. Smart Positioner. IX. Air filter regulators
II	Pressure Relief valve and pilot valve of pilot operated PRV	
	a) Spring, Nozzle, Seat	5% of total quantity of identical pressure relief valves or minimum one number which ever is higher.
	b) Gasket set, O-Ring set	20% of total quantity of identical pressure relief valves or minimum one number whichever is higher.
	c) Complete Pilot of Pilot operated pressure safety valves	5% of total quantity of identical pilot operated pressure relief valves or minimum one number whichever is higher
III	Self actuated regulators	a) Grouping of valves with respect to size, rating, material & trim type and 10% subject to minimum 1 no. of the following items of each group, whichever is higher : - I. Plug & Seat Assembly II. Gland packing III. Actuator Diaphragm. IV. Bonnet gaskets (for all type of valves)
3	**PLC**	
I	Each type of modules used in PLC like I/O cards, processor cards, power supply cards, communication cards, interface cards, etc. as being offered by the system	5% of the total installed quantity subject to minimum one number, whichever is higher of each type.
II	IS isolator barriers	
	a) Analog input	5 % of total quantity
	b) Analog output	5 % of total quantity
	c) Digital input	5 % of total quantity
	d) Thermocouple / RTD	5 % of total quantity
III	Isolator/signal multiplier	5% of total installed quantity subject to minimum one number, whichever is

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Sl. No.	Part Description	Quantity Required
		higher of each type.
IV	IS mV/I converter	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
V	IS RTD/I converter	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
VI	Prefabricated cable	4 set with connecting plug for each type of peripheral and I/O hardware
VII	Keyboard	1 no of each type
VIII	Interposing relay	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
IX	Push button	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
X	Lamps	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
XI	Selector switch	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
XII	Switches	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
XIII	Alarm cards (receiver switches)	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
XIV	MCBs	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
XV	System cabinet air filter	100%
XVI	Annunciator	
	- Power supply module	4 nos
	- Flasher module	4 nos
	- Tone generator card	2 nos
	- Lamps	5 dozen
	- Fuses	2 dozens
XVII	Termination panel/patch card, series resistor, isolator (for safe area signal)	5 % of total quantity
XX	Fuses (of each type)	100 %
4	**Vibration and Temperature monitoring system**	
I	Each type of module used n machine monitoring system like I/O cards, processor cards, power supply cards, communication card, interface card etc as being offered for system	5% of total installed quantity subject to minimum one number, whichever is higher of each type.
II	Probe of each type (vibration, temp, axial displacement keyphasor, etc)	**Quantity shall be as mentioned in Rotating Equipment mandatory spares list attached elsewhere with the MR.**
III	Fuses of each type	100%
VIII	Selector switches	5% of total installed quantity subject to minimum one number, whichever is higher of each type.

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Sl. No.	Part Description	Quantity Required
5	**Compressor control system**	
I	Anti-Surge Controller(If applicable)	01 No.
II	Master /Performance Controller(If applicable)	01 No.
III	Load Sharing Controller (If applicable)	01 No.

Notes:

1. The word 'Type' means the make, model no., type, range, size/length, rating, material as applicable.
2. Whenever % is identified, contactor shall supply next rounded figure.
3. Mandatory spares shall include sub-package items also.
4. Mandatory spares shall be supplied loose for use by client in future.

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INSTRUMENTATION

SCOPE OF WORK

FOR

GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE
(MR No:B240-910-KA-MR-5010)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
B	19.08.2019	Revised & Issued with MR	PS	SR	PKS
A	18.04.2019	Issued with MR	PS	SR	PKS

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S.No.	DESCRIPTION	Bidder	Purchaser
1.0	**Scope of Design & Engineering**		
1.1	Design and detailed engineering including residual engineering (note-1) of instrumentation & controls of Gas turbine driven Centrifugal Compressor based on P&ID's and other technical requirements described in various documents attached with this MR. This shall include detailed engineering including preparation of engineering drawings/ documents, specification data sheets, sizing, selection of materials, review of vendor drawings / documents for all supply items and preparation of engineering drawings/ documents for UCP and PLC.	Yes	
1.1.1	All type of field instruments identified and marked as "*" on P&ID's on process gas suction & discharge, starting gas, fuel gas, seal gas, gas recycle and vent gas lines such as pressure, Flow(DP), temperature, differential pressure, temperature transmitters, pressure & temperature gauges, temperature elements and thermowells, all types of control valves & shutdown valves with accessories, pressure relief valves, anti surge control valves, suction flow elements, gas detectors etc. and any other instruments including skid mounted instruments, local gauge board mounted instruments, control panel mounted Instruments required to complete the job in all respect.	Yes	
1.1.2	Unit control panel with Programmable Logic Controller based control system to be located **existing** control room, for entire Gas turbine driven centrifugal compressor and associated auxiliaries and station control system as per P&ID's.	Yes	
1.1.3	All skid mounted instruments related to compressor package including Turbine, compressor, seal gas system, fuel gas system, starting gas systems, air intake system, gas after coolers, lube oil system and auxiliaries etc.	Yes	
1.1.4	All controls for entire gas turbine compressor train including process gas suction & discharge, starting gas, **fuel gas conditioning skid with metering system**, seal gas, gas recycle and vent gas lines instruments to be executed in dedicated PLC based control system of the compressor .	Yes	
1.1.5	Local Gauge boards	Yes	
1.1.6	Antisurge controllers, Performance/Master controller and load sharing controller (if required)	Yes	
1.1.7	Vibration, temperature and Displacement monitoring system including monitors.	Yes	

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S.No.	DESCRIPTION	Bidder	Purchaser
1.1.8	**Integration of Compressor control systems with existing DCS/PLC systems.**	Yes	
2.0	**Scope of procurement/ supply**		
2.1	Supply of all items related to instrumentation & control system of Gas turbine driven centrifugal compressor and other station facilities as indicated in P&IDs and technical documents attached elsewhere in MR. The scope of supply shall include but not limited to following:		
2.1.1	All field mounted instruments including pressure, Flow(DP), temperature, differential pressure, temperature transmitters, temperature elements & thermowells, pressure & temperature gauges, all types of control valves & shutdown valves with accessories, pressure relief valves, anti surge control valves, suction flow elements, gas detectors etc. as marked "*" Gas turbine driven centrifugal compressor vendor scope and other station facilities as per P&ID's and compressor data sheets attached elsewhere in this MR and any other instruments required to complete the job in all respect.	Yes	
2.1.2	All controls system instruments for entire Gas turbine driven centrifugal compressor including process gas suction & discharge, starting gas, fuel gas, seal gas, gas recycle and associated other facilities. All instruments to be executed in dedicated PLC based control system		
2.1.3	Supply of Unit Control Panels for compressor and gas turbine controls and monitoring, including anti-surge, performance / master controllers, load sharing controller (if required) and panel mounted operator console (HMI) etc. These shall be located in control room.	Yes	
2.1.4	One no. HMI (Desk top PC with 21" TFT monitors) mounted in control room for control, monitoring and configuration of Integrated gas turbine compressor control system including all subsystems such as vibration, temperature, displacement, anti surge, performance / master controls. The HMI shall have operator cum engineering functionality with engineering facility password protected.	Yes	
2.1.5	One no Laptop computer with all necessary hardware and software and anti virus software for programming configuration of bidder supplied control system.	Yes	
2.1.6	Supply of AC and DC power supply distribution cabinets as required for as required for Centrifugal Compressor control systems, PLC, vibration monitoring system etc. in the control room and field instruments in the field.	Yes	

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S.No.	DESCRIPTION	Bidder	Purchaser
2.1.7	Local gauge boards with all instruments and accessories, duly mounted on them, if any.	Yes	
2.1.8	Any other skid mounted (Lube Oil System, dry gas seal system etc.) or panel mounted instruments required to complete the job in all respect for satisfactory operation of Compressor and Ancillary systems.	Yes	
2.1.9	Vibration, Temperature & Displacement Monitoring system including monitors.		
2.1.9.1	Vibration, axial displacement, key phaser and temperature probes etc as per compressor data sheets attached elsewhere in this MR.	Yes	
2.1.9.2	UCP mounted Monitors/ racks located in control Room. Vibration and temperature points shall also be configured in HMI including direct and GAP voltages and temperature indications.	Yes	
2.1.9.3	Panel/ cabinet for monitors/ rack in control room including terminals, barriers, I/O cards, and dual redundant power supplies etc., duly mounted on panel / cabinet.	Yes	
2.1.10	Antisurge controllers for compressor along with a dedicated Performance / master Controller, load sharing controller (if required) including terminals, barriers, I/O cards, and dual redundant power supplies etc., duly mounted & prewired in a Unit control panel located in control Room.	Yes	
2.1.11	Programmable Logic Controller (PLC) with dual redundant processor, communication and power supply and single I/O as per PLC data sheet no B240-910-YE-DS-5010 attached with this MR.	Yes	
2.1.12	Supply of Fire and Gas detectors including Detectors & Transmitters for Gas turbine enclosure. Fire and gas detection system shall be configured in the Centrifugal Compressor system PLC. On line data shall be displayed on HMI showing approximate locations of sensors	Yes	
2.1.13	Alarms, signals & power Junction boxes for following:		
2.1.13.1	For interconnection between skid mounted instruments in field and UCP in control room	Yes	
2.1.13.2	For interconnection between instruments supplied loose in field to be located on process gas compressor suction & discharge piping, Knock out drums, fuel gas /startup gas lines, gas vent lines, recycle gas lines as shown in P&ID and marked as "*" to Control Room and other associated facilities.		Yes
2.1.14	Cables (signal, alarm, thermocouple extension, RTD,	Yes	

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S.No.	DESCRIPTION	Bidder	Purchaser
	power supply, serial communication) for following: (Note - 2)		
2.1.14.1	Between field instruments and skid mounted junction boxes	Yes	
2.1.14.2	Multi-pair cables between junction boxes and UCP in control room [6P or 12P 1.5mm2, For RTD and Gas detectors 8T(1.5mm2) cable to be used].Distance between field and control room to be considered as 500m approximately.	Yes	
2.1.14.3	Between field mounted sensors of vibration & temperature, displacement, key phasor monitoring system and monitors/ racks located in control room	Yes	
2.1.14.4	All system cables between various systems such as vibration & temperature monitoring system, antisurge controllers, performance/master controllers and UCP PLC and HMI.	Yes	
2.1.14.5	Special cable between speed sensor in field and Turbine Speed Controller in UCP in control room	Yes	
2.1.14.6	Any other special cables from field to UCP in existing control room for compressor control system.	Yes	
2.1.14.7	All Interconnection cables between instruments supplied loose in field to be located on process gas compressor suction & discharge piping, fuel gas /startup gas lines, gas vent lines, recycle gas lines as shown in P&ID and marked as "*" to Control Room		Yes
2.1.15	Installation & Erection Materials:		
2.1.15.1	All installation and erection materials such as impulse tubes, pipes, valves, fittings, manifolds etc. for installation of all bidder supplied instruments and junction boxes (on skid instruments and other off skid instruments) as per approved installation standards.	Yes	
2.1.15.2	Instrument stanchions, supports and all types of consumables and accessories for mounting all bidder supplied instruments and accessories, gauge boards etc.	Yes	
2.1.15.3	Cable glands, and PVC sleeves (cable shrouds) for different types of cables	Yes	
2.1.15.4	Cable trays along with supports from instruments to junction box for skid mounted instruments	Yes	
2.1.15.5	GI/ copper earthing strip & earthing cables for earthing of all instrumentation items including junction boxes, field instruments, etc.	Yes	
2.1.15.6	Supply & installation of all cable trays and accessories for routing the cables with the GTC skid.	Yes	
2.1.15.7	All piping and pipe fittings, tubes and tube fittings for	Yes	

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S.No.	DESCRIPTION	Bidder	Purchaser
	instrument air supply distribution for instruments supplied by Bidder.		
2.1.15.8	Insulation and painting of instruments and impulse lines, as applicable, in line with insulation and painting specifications attached elsewhere in MR.	Yes	
2.1.15.9	Installation material for junction boxes and power distribution boards.	Yes	
2.1.15.10	Any other installation material required for installation and commissioning of various instruments and systems supplied by Bidder.	Yes	
2.1.16	Start-up and Commissioning spares	Yes	
2.1.17	Mandatory spares	Yes	
2.1.18	Supply of drawings and documents as listed in Vendor Data Requirement	Yes	
2.1.19	Any special tools or tackles for instrumentation	Yes	
2.1.20	Any additional instrument required in the opinion of bidder for meeting functional requirements, safe and efficient operation, which are not listed specifically in this document.	Yes	
2.1.21	One heavy-duty dot matrix type printer as per PLC data sheets as alarm cum log printer shall be supplied. And one no. laser jet colour printer A3 size shall be supplied.	Yes	
3.0	**Factory testing & calibration**		
3.1	Carrying out/ witnessing shop testing and calibration of all instruments and system oriented items as per approved Inspection Test Plan / FAT procedure.	Yes	Yes
4.0	**Installation, field calibration/ testing and commissioning**		
4.1	Installation of all instruments, junction boxes, and accessories and auxiliary systems (e.g. lube oil) on equipment skid.	Yes	
4.2	Installation of loose supply instruments on gas compressor process lines.		Yes
4.3	UCP in control room		Yes
4.4	HMI's in control room		Yes
4.5	Installation of local gauge board (mounted on bidder supplied skid)	Yes	
4.6	Laying & termination of all cables from bidder supplied instruments& junction boxes on skids to Bidder supplied UCP in control room.		Yes
4.7	Instrument air distribution for all bidder supplied instruments on skids	Yes	
4.8	Installation of all junction boxes and power distribution boards on skids.	Yes	

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S.No.	DESCRIPTION	Bidder	Purchaser
4.9	Supervision of installation, hookup, testing and commissioning of various instruments, local gauge board, antisurge controllers, performance controller, turbine speed controller, vibration and temperature monitoring system etc. supplied by Bidder.	Yes	
5.0	**Coordination**		
5.1	Coordination with • Purchaser, • Purchaser's Plant Control Station • Purchaser's station PLC contractor for loop checking, field testing of all items, calibration of all instruments for successful commissioning of the compressor package.	Yes	
6.0	Insulation and painting of instruments and impulse lines, as applicable, in line with insulation and painting specifications.	Yes	

Notes:

1. Residual engineering includes instrument sizing, Thermowell Wake frequency calculation, utility consumption, specifying derived data in process data sheets, type and material selection of instruments wherever required. Residual engineering shall also include actual transfer/ implementation of the information provided in the form of notes in P&ID and instrument data sheets/ equipment data sheets and other documents provided in MR. Bidder to note that turbine control systems indicated in P&ID attached is indicative. Bidder shall develop the P&ID considering monitoring and controls from UCP PLC and its HMI and interface with Purchaser's Plant Control Station .

2. Approximate cable routing distance between skid in field and Unit control panel located in existing Control room shall be considered as 500 meters for all interconnecting cable estimate as part of base quote of the Package. However bidder shall calculate the exact cable laying distance as per indicative

3. Instruments not mounted on skid but to be located on process gas compressor suction & discharge piping, fuel gas /startup gas lines, gas vent lines, recycle gas lines shall be supplied loose along with all required installation materials as per approved installation standards finalized during detailed engineering.

4. Installation & cabling between bidders supplied off skid loose instruments including supply of cables, junction boxes, cable glands, trays etc shall be by purchaser.

5. EIL/Owner shall witness testing of any or all items at various stages during manufacture and/or final stage before shipment as per approved Inspection Test Plan. All system oriented items like Integrated Compressor & Turbine Control system, Anti Surge controllers,

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Vibration and Temperature Monitoring System, F&G system, performance/master controllers etc. shall undergo factory testing and integrated factory acceptance test. Testing shall be carried out as per approved procedure. No such item shall leave manufacturer's works without factory acceptance test.

6. For instruments and accessories outside skid, supervision of installation, erection & commissioning shall be in bidder's scope, on per diem basis.

7. All bidder supplied instruments and junction boxes on various skids of package shall be pre-installed including cabling & termination within the machine skid.

8. Bidder shall provide required assistance to Purchaser's instrumentation contractor during loop checking of all Compressor instruments (mounted within skid or outside skid).

9. Any activity specifically not listed in this document, does not absolve the vendor of their responsibility to include such activities in their scope of work, which otherwise is necessary, to complete instrumentation work for compressor.

10. All such activities shall be carried out by the vendor without any implication. Instrument Job Specification shall be read in conjunction with scope of work.

11. Any items not covered in this section, which form part of the vendor's standard package and are required for ease of operation, control safety and interlock requirement shall be supplied by Bidder without any implication.

12. In case compressor and turbine vendors are two different vendors then also all the engineering and engineering drawings/documents shall be prepared by the sole bidder for entire control system of turbine and compressor and also other system as per this requisition.

13. All indications, recording of instruments, status, control and alarms of Instruments **(which are NOT marked as * in attached P&IDs)** shall also be in common facility PLC supplied by GTC Package vendor. Vendor to size the PLC accordingly. B

14. Following are excluded from bidder scope of work:

- Installation of bidder supplied off skid loose instruments & junction boxes.
- Laying & termination of single pair cables supplied by the bidder, from bidder supplied loose instruments to the bidder supplied junction boxes ~~(if any)~~.
- Laying & termination of the single pair., multi-pair cables & special cables, supplied by the bidder, from machine skid junction boxes to respective control room.
- Installation of all bidder supplied Unit control panels / cabinets in control rooms.

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- Laying & termination of all interconnecting cables including power supply cables between bidders supplied unit control cabinets / panels with in the control room.

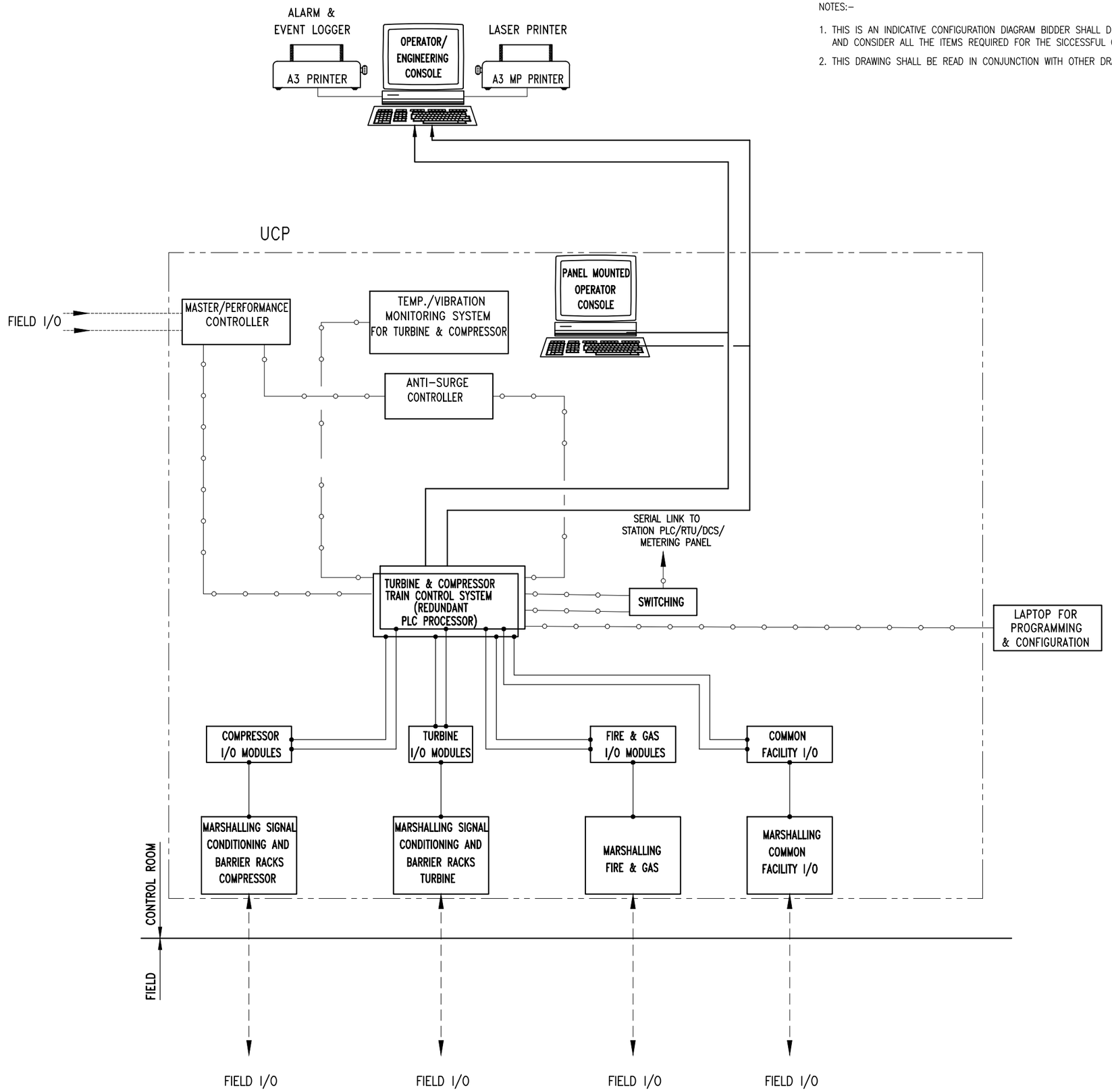
- These activities will be carried out by purchaser's field erection contractor and compressor package vendor shall coordinate with purchaser's field erection contractor and provide them necessary specifications, data, documents and drawings and any other information & assistance required for the above activities to complete the job within the agreed time schedule. Further bidder shall be fully responsible for proper commissioning of the package along with all associated instruments and control systems.

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NOTES:–

1. THIS IS AN INDICATIVE CONFIGURATION DIAGRAM BIDDER SHALL DEVELOP THE ACTUAL CONFIGURATION DIAGRAM AND CONSIDER ALL THE ITEMS REQUIRED FOR THE SICCESSFUL OPERATION OF THE COMPRESSOR.
2. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH OTHER DRAWINGS.



1	19.08.2019	REVISED AND ISSUED FOR PACKAGE MR	HVK	PS	SR	PKS
0	16.04.2019	ISSUED FOR PACKAGE MR	HVK	PS	SR	PKS
REV.	DATE	REVISION	BY	CHK	APPROVED	APPROVED

ENGINEERS INDIA LIMITED
NEW DELHI

PLANT – GAIL GANDHAR

CLIENT – GAIL

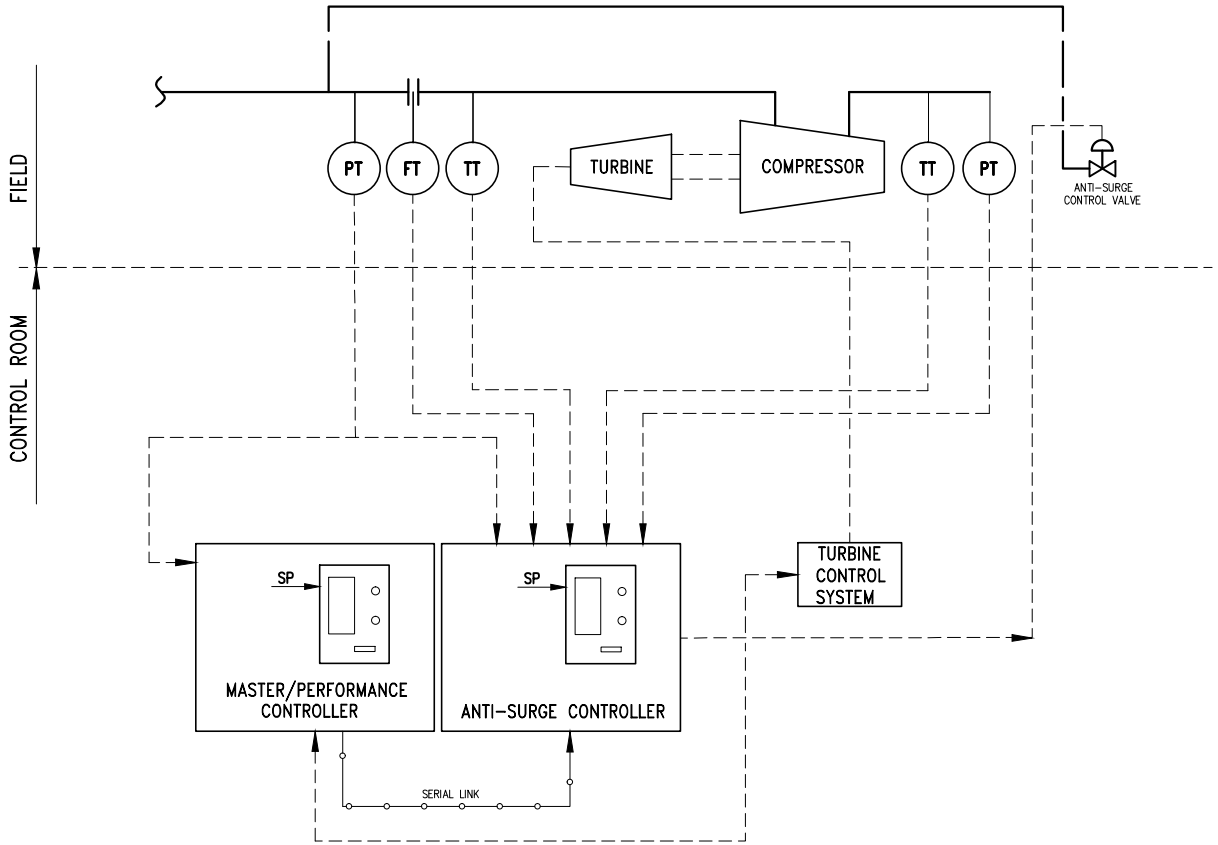
GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE

DRAWING NO.	REV.
B240–910–16–51–SK–0001	1

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NOTES: –

1. THE ITEMS/COMPONENTS SHOWN IN THIS SKETCH INDICATIVE ONLY. VENDOR TO CONSIDER ALL THE ITEMS REQUIRED FOR THE SUCCESSFUL OPERATION OF CAPACITY CONTROL SYSTEM.



ENGINEERS INDIA LIMITED NEW DELHI	PLANT – GAIL GANDHAR CLIENT – GAIL	0	16.04.2019	ISSUED FOR PACKAGE MR	HVK	PS	SR	PICS
		REV.	DATE	REVISION	BY	CHK	APPROVED	APPROVED

GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE

DRAWING NO.	REV.
B240–910–16–51–SK–0002	0

1–1641–0503 REV.0 A3–420x297

TECHNICAL COMPLIANCE

DISCIPLINE	**:**	**INSTRUMENTATION**
DOCUMENT NO.	**:**	**B240-910-16-51-5010**
PROJECT	**:**	**GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR**
PACKAGE	**:**	**GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR**
OWNER	**:**	**GAIL**
EIL JOB NO.	**:**	**B240**
BIDDER	:	

NOTES:

1. The Bidder shall indicate his reply in the space provided in the Technical Questionnaire. In case space provided is not adequate, the reply may be furnished separately under suitably numbered annexes/ attachments duly referred against the comment/ query.

2. The Compliance Statements/ Queries are required to be categorically confirmed / answered by the bidder and the completely filled in Tech Questionnaire shall be submitted together with the Bid.

Bidder's Signature and stamp	

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INSTRUMENTATION

Sr. No.	COMPLIANCE STATEMENT/QUERY	BIDDER'S CONFIRMATION/ ANSWER
	Please note that it is mandatory to furnish replies to the technical queries listed below, without which bidder's offer will be considered as incomplete and is liable for rejection.	
1.	Please confirm that deviation, if any, against the applicable specifications and codes/ standards shall be duly consolidated at one place (under Exceptions / deviations list). In case no deviations are furnished, it will be presumed that all requirements are fully met and complied with, by the bidder. Any deviations/ deletions/ corrections made by the bidder elsewhere will not be taken cognizance of and all such deviations shall deem to have been withdrawn by the bidder.	
2.	Please confirm categorical compliance to the scope of work, various technical specifications, drawings and documents for instrumentation & control, PLC system in the bid package. Also, confirm that all other equipment, materials and work not explicitly mentioned but nevertheless required to fulfill the functional requirements shall be deemed to be included in the scope of bidder with no additional cost and time implication to the owner.	
3.	Confirm that the all instrumentation items their accessories, items for Control System including their accessories, etc. supplied shall be of one of the approved makes given in the APPROVED VENDOR LIST attached with bid package.	
4.	Please confirm compliance to Drawings/ Documents requirements.	
5.	Please confirm compliance to Mandatory Spare Parts requirements.	

BIDDER'S SIGNATURE & STAMP

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DATA SHEET FOR

PROGRAMMABLE LOGIC CONTROLLER

FOR

GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE
(MR No:B240-910-KA-MR-5010)

Rev. No	Date	Purpose	Prepared	Checked	Approved
A	18.04.2019	ISSUED WITH GTC PACKAGE MR	PS	SR	PKS

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NOTES:

1. Information filled-in by Consultant / Owner and the columns marked [X] specifies the minimum system requirements. Bidder shall check the same with respect to the special requirements as per this package.
2. Bidder to note that all Information in columns marked ***** is to be filled by PLC vendor and furnish in the offer.
3. Bidder shall complete information against all items marked as "**" in the data sheets.
4. Vendor to note that information provided against all items marked as "**" and "*" must be such that system performance is not degraded.
5. Vendor shall categorically confirm all items marked as "#" in the data sheets. In case no specific confirmation is indicated, it shall be considered as vendor's unconditional compliance.
6. This data sheet shall be read in conjunction with Standard Specification for Programmable Logic Controllers, 6-52-0040. Vendor shall check the filled in column accordingly.
7. PLC system shall be sized as per the loading defined in this section. The loading here refers to the use of memory, CPU time and communication capacity etc. Loading shall consider the worst case of high system capacity, during this case, no degradation of system performance is allowed. Maximum loading on various subsystems shall be as follows:
   - 80% I/O capacity and other hardware.
   - 60% Processor, including user memory.
   - 40% Communication network (for deterministic protocol).
   - 30% Number of nodes.
8. Bidder shall supply PLC's as per details below for-compressor station.
   (i) One number PLC with console/Printer dedicated for compressor train.
9. Field mounted type remote I/O for GTC PLC can also be acceptable provided the same are field proven and certified for hazardous area application.

In addition bidder shall also supply One nos. laptop computer with all required licencensed software's with printer as programming / operator console.

PLC operation shall be completely unaffected by a momentary power loss of the order of 20 msecs.

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PROGRAMMABLE LOGIC CONTROLLER

MAKE: *_____ **Model:** *_____

1. Functional requirement GTC train Start Up, Shutdown and Interlocks, [X]

GTC Train Operation monitoring and Control [X]

2. System Configuration Type

2.1 # Single PLC

a) Redundant dual processor [ ]

b) Redundant dual processor with dual I/O [ ]
I/O auto-testing only [ ]
for interlock & shutdown and single I/O
for dual I/O for monitoring.

c) Redundant dual processor with single I/O [X]
I/O auto-testing]

d) Three processors with simultaneous logic execution (TMR) [ ] 2 of 3 vote output [ ]

I/O auto-testing [ ]

3.0 **Processor System:**

3.1**# Functional capability Logic Functions [X]

Timing Functions [X] Range : 0-99,999 sec

Least count : 0.01 Seconds

Regulatory Control Function [X]

Data Acquisition [X]

Sequencing [X]

Monitoring [X]

Data archival and retrieval [X]

*Other available as standard_____

3.2# Interfacing capability

I/O Racks	[X]	Anti-Surge	[X]
PLC Console	[X]	Flow Computer	[X]
Capacity/Performance controller	[X]		
Vibration & Temperature Monitoring racks	[X]		
For SCADA/RTU	[X]	Printer	[X]
Other	[X]		

Note: Printers shall be connected to all the PLC Consoles. Printer sharer for the same shall be supplied.

3.3* Memory capacity _____MB

3.4* Memory used _____MB

3.5* Spare memory available _____MB (also refer Spares Philosophy specified in std. Specification 6-52-40)

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3.6#	Memory type	Retentive	[X]	Volatile	[X]
	If Retentive	Erasive	[X]	Non-erasive	[ ]
		*Erasing by_____			
	If Volatile	Battery back-up			[X]
*Battery type_		*Battery life	One year		
		Chargeable			[X]
		Continuous trickle charge			[X]
		Configuration protection time 72 hours			[X]
		Battery drain indication			[X]
		Retentive memory back-up			[X]

Note: Battery type shall be size 'D' Lithium battery. Also spare battery shall be provided for one-year operation.

3.7.**	Maximum Scan Time(shutdown & interlock)	100 ms	[X]	Actual_____*____ms
	Maximum Scan Time (closed loops)	500 ms	[X]	Actual_____*___ms
	Maximum Scan Time (open loops--analog/digital)	01 sec	[X]	Actual _____*___ms
3.8.*	Power supply redundancy	Redundant Floating		[ ]
		Redundant per individual Processor & individual Rack		[X]
3.9.#	Outputs on processor system failure	Freeze	[*]	Open [*]
		Close	[*]	Engineer Configurable [*]
		Flunk	[*]	
3.10.*	Maximum distance between processor & console	As per control room layout (20 m approx) Allowable_____*_____m		

4.0 Algorithms**

Arithmetic Functions	Add / subtract, multiply, division, summation square root, average, bias, ramp function, rate of change, difference, absolute value, square, exponential, Logarithm. [X]
Logic Functions	AND/OR/NOR/NOT/XNOR/ON/OFF- DELAY/FLIP-FLOP/ PULSE [X]
Comparison Functions	Greater than, less than, greater equal to, lesser or equal to, equal, not equal [X]
Selector Functions	Low selector, High selector, Mean Value selector, Auto ranging for Dual transmitter, over ride mean value selector [X]

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Control Algorithms	PI, PID, Ratio control, PID with dead band, Error square PID, Adaptive gain, Proportional control [X]	
Basic Functions	Manual Loader, Cascade, Hi alarm limit, Ex high alarm limit, Low alarm limit, Ex low alarm limit, Rate of change alarm, deviation alarm [X]	
Limiter Functions	Low output limiter, HI out put limiter, Alarm limiter, set point limiter [X]	
Dynamic Functions	Lead/ Lag, Dead time, Timer, Feed Forward, Velocity limit, Totalise [X]	
PID Functions	PID basic controller, PID cascade, PID bias, PID differential gap, PID non –liner, PID self tuning, External output, racking, Reset limiting [X]	
Linearisation	Square root Extraction, Flow Computation (Pr. & Temp compensation), Thermocouple, Linearisation & cold junction compensation, RTD linearisation, Polynomial [X]	
Sequence Functions	Set block On/Off- Auto manual, Set alarm limit, Set points, Set ramp rates-ramp On/Off, Get/Set block parameter, Active/Abort sequences, Open/Close valves, Start/Stop pumps/motors [X]	
Miscellaneous Functions	Bump less transfer between all control modes, ramp to set point, ramp to output, Ramp to calculated value, Direct or Reverse output [X]	
AI Function	Logic function	[X]

ALL ALGORITHMS SHALL BE AVAILABLE AS STANDARD FIRM WARE BLOCK IN THE OFFERED PROCESSOR.

5.#		**Input/ Output System**			
5.1.#	Type	Discrete	[X]	Other_____	
		Analog	[X]		
		(I/O module shall be with self- diagnostic functionality).			
5.2.#	Mounting	19" Rack	[X]	Other DIN Rail Mounting	
5.3	Single I/O Configuration				
5.3.1.#	Online replacement of I/O modules	Required	[X]		
5.3.2.#	I/O status Indication	Required	[X]	Local level	[X]
		PLC Console	[X]		
5.3.3.#	Input Isolation	Required	[X]	Optical	[X]
				Other	Relay
	Output Isolation	Required	[X]	Optical	[X]
				Other	Relay

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5.3.4.* a) I/O Requirement :

Inputs : _*_____ No.

Outputs : _*_____ No.

I/O Capability: :_*_____

Type of Module	Model No	Analog		Digital	
Input	As Per Requirement	Capacity	I/O Used	Capacity	I/O used
		*	*	*	*
Output	As Per Requirement	*	*	*	*

5.3.5 .# Input Type Intrinsic safe [ ] Non-Intrinsic Safe [X]

Intrinsic safe with external barriers [X]

Weather proof [X]

5.3.6.* Maximum distance between I/O rack & processor As per control room layout [X]

Allowable_____m

5.3.7.# Single I/O Required [X] Not required [ ]

Auto-testing of I/O's Required [ ] Not required [X]

5.3.8.* Power Supply/ I/O rack Individual [ ] Dual Redundant [X]

5.3.9.* I/O Rack to processor link Individual [ ] Dual Redundant [X]

5.3.10 Input Module

a)# Input Type

i. Potential free contact with interposing relay rated for 24V DC, 2A [X]

MCC Input [X]

ii. 4-20 mA Intrinsically safe (two wire) and

Analog 4-20 mA with HART protocol intrinsically safe (Two wire) [X]

iii. Other As required

b)# Maximum number of Inputs per module (digital)

- Single I/O Eight [ ] Sixteen [X] Offered____

- Dual I/O Sixteen [ ] Thirty Two [ ] Offered____

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c)# Input Interrogation voltage 110 V DC [ ]

24 V DC [X]

Other_____

d)# Maximum number of inputs per module (Analog):

- Single I/O Four [ ] Eight [X] Offered____
- Dual I/O Eight [ ] Sixteen [ ] Offered____

e) # Number of input points

- Digital By GTC vendor as per Package requirement
- Analog By GTC vendor as per Package requirement

f)*

Type of Module	Model No	Input/ Module	Input Impedance (Ω)	Inrush current (A)
Analog	*	*	*	*
Digital (contacts)	*	*	*	*

(I/O module shall be smart type with self-diagnostic features.)

5.3.11 Output module

a)# Output Type

i. Potential free contact with interposing relay contact rating 24 V DC 2.0 A [X]

Potential free contact for PLC fault [X]

Potential free contact for bypass PLC [X]

ii. 4-20 mA Isolated (Two wire) [X]

iii. Non polarized [ ]

iv. Other _____ As required

b)# Maximum number of Outputs per module (Digital):

- Single I/O Eight [ ] Sixteen [X] Offered____
- Dual I/O Sixteen [ ] Offered____

Other _____

c)# Maximum number of Outputs per module (Analog):

- Single I/O Four [ ] Eight [X] Offered____
- Dual I/O Eight [ ] Offered____

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d)*	Output Contact Rating	24 V DC, 2A		[X]
		230 V AC, 5A		[X]
		Other_____		

Note: Interposing Relays are required for all output contacts.

e)* Number of Output points :

- Digital By GTC vendor as per Package requirement
- Analog By GTC vendor as per Package requirement

f)*

Output Contact Rating	Model No	Number of Outputs/Modules

Note1: Interposing relays (with 24 V DC, 2.0 A rating) are required for all the outputs. Rating for the contact to the MCC shall be 230 V AC, 5A as per std. Spec for PLC (6-52-40)

6. PLC Console (PROGRAMMING TERMINAL AS WELL AS FOR UNIT OPERATION / DIAGNOSTICS)

(PLC console along with its printer shall be located at control room)
(PLC console computer shall be supplied from Original Equipment suppliers OEM)

*Model i7 OR LATEST VERSION PROCESSOR

6.1.#	Number of TFTs - LCD		One	[X]	Two	[ ]
	Type		Colour	[X]	Monochromatic	[ ]
	Size	Min 21" Diagonal	[X]			
Other						
	*Character Size	_____				
	*Screen Capacity	_____				
6.2.#	Dual Redundant Link between processor system & PLC console through redundant local area network		Required			[X]
6.3*	Number of Keyboards		One per TFT/LCD			[X]
	Type		Membrane			[ ]
			QWERTY			[X]
6.4**	Printer	Required	[X]	Model		
	**Paper width	Approx. 381 mm	[X]	Offered		
	*Printing speed	300 cps or better	[X]	Offered		
	**Number of copies	Three	[X]	Offered		

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Note: Printer shall print alarm & shutdown report.

6.5.**	Programme storage	Required	[X]	On CD	[X]
		Hard Disk	[X]		
		Capacity_____ MB		Access time_____ ms	
		Other_____			
6.6.#	System Boot-up on power-on	Auto	[X]		

7.0# Interface with Station PLC/RTU (SCADA), Anti-Surge/Performance/master Controllers, Vibration &Temperature Monitoring racks:
(Refer attached system configuration diagram)

a) Interface Required for:

Anti-Surge/Performance/ master Controllers,
Vibration &Temperature Monitoring racks [X]

Dual serial link to Station PLC /RTU (SCADA) . [X]

b) Type of Interface:-

Model No. : __*____

Serial : [X]

RS 485: [X] For Station PLC/ SCADA (RTU) with necessary converter

RS 232 / 485: [X] For Other Systems (as per distance required)

Any Other

c) Protocol Type: -

MODBUS ASCII or RTU (Shall be user selectable) [X] For Station PLC/SCADA (RTU)

MODBUS [X] For others

d) Module Details

Configuration	Interface Module Model No.	Number of Modules	Number of Adapter per module
Dual processor configuration			

e) Total time taken to display alarm generated by PLC on common facility operator console
__*___

8.0.# Software features:

a)	Online Programming	Required	[X]
b)	Online Programme modification	Required	[X]
c)	Disable/Force facility	Required	[X]
d)	Power flow on Ladder/ logic	Required	[X]
e)	First out alarm Capability	Required	[X]

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f)	Self diagnostics	Required	[X]	
g)	I/O mapping	Required	[X]	
h)	Plant operation	Required	[X]	
i)	Alarm Printing	Required	[X]	
j)	Documentation	Required	[X]	
k)	Ladder Logic Monitoring	Required	[X]	
l)	Process display and Overview	Required	[X]	
m)	Shutdown report	Required	[X]	
n)	Alarm summary	Required	[X]	
o)	Alarm History	Required	[X]	
p)	History and Real Time trend	Required	[X]	
q)	Real Time graphic trend for all Analog signals		Required	[X]
r)	Graphic capability (Dynamic)	Required	[X]	
s)	Log Reports	Required	[X]	
t)	First out sequence	Required	[X]	
u)	Multiple watch dog timers	Required	[X]	

v)* Additional special software offered :

i _____

ii _____

iii _____

9.0.# Power Supply

a)	System	110 V AC, 50 Hz UPS	[X]
b)	Input interrogation voltage for Fields switch	24 V DC,	[X]
c)	Output contact rating for contact to MCC	230 V AC,5A	[X]
d)	AC Voltage Distribution	Vendor's Scope	[X]
e)	24 V DC Voltage distribution	Vendor's Scope	[X]
f)	Power supply for SOV's	24V DC	[X]

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VENDOR LIST FOR INSTRUMENTATION ITEMS

PROJECT : CONSTRUCTION OF TRUCK LOADING FACILITIES

CLIENT : M/s KLPL DABHOL

CONSULTANT : ENGINEERS INDIA LIMITED

JOB NO. : B182

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	18.04.2019	Issued with MR	SK	SR	PKS

VENDOR LIST FOR INSTRUMENTATION ITEMS

Sl No.	APPROVED VENDORS NAME
Item: Tube Fittings	
1.	Arya Crafts & Engineering Pvt Ltd
2.	Astec Valves & Fittings Pvt. Ltd
3.	Autoclave Enginers Fluid Components
4.	Circor Instr. Technologies Inc-Form.H608
5.	Comfit & Valves Pvt. Ltd
6.	Excel Hydro Pneumatics Pvt Ltd
7.	Excelsior Engg. Works
8.	Fittok Incorporated
9.	Fluid Controls Pvt Ltd
10.	Ham-Let
11.	Met-Lok Valves and Fittings
12.	Multimetal Industries
13.	Panam Engineers
14.	Precision Engineering Industries
15.	Prime Engineers
16.	Parker Hannifin Corporation
17.	Reliance Engineering & Electricals Corpn
18.	Sealexcel (India) Pvt. Ltd
19.	Swastik Engineering Works
20.	Swagelok Co
21.	SSP Fittings Corporation
22.	TK Fujikin Corporation
23.	Wesmec Engineering Private Limited
24.	Vipal Enterprises Pvt Ltd
Item: Tubing	
1	HEAVY METALS & TUBES LTD. (MEHSANA)
2	JINDAL SAW LTD. (NASHIK WORKS)
3	RATNAMANI METALS AND TUBES LTD.
4	REMI EDELSTAHL TUBULARS LTD
5	SHUBHLAXMI METALS AND TUBES PVT. LTD
6	TK FUJIKIN CORPORATION
Item: Signal Cables	
1.	Associated Cables Pvt Ltd
2.	Associated Flexibles & Wires [P] Ltd
3.	CMI Limited
4.	Cords Cable Industries Ltd

5.	Delton Cables Limited
6.	Elkay Telelinks Ltd
7.	Havells India Ltd.
8.	KEC International - Mysore
9.	KEI Industries Limited
10.	Lapp India Pvt. Ltd
11.	LEONI CABLE SOLUTIONS (INDIA) PVT PTD.
12.	LEONI KERPEN GMBH
13.	Polycab India Ltd
14.	Suyog Electricals Ltd
15.	Thermo Cables Ltd (
16.	T C Communication Pvt. Ltd
17.	Udey Pyrocables Pvt. Ltd
Item: Control Valve	
1.	ARCA REGLER GMBH
2.	AST APPARECCHI DI SICUREZZA E TENUTA SPA
3.	BELLINO SRL
4.	CCI VALVE TECHNOLOGY GMBH
5.	DRESSER PRODUITS INDUSTRIELS
6.	EMERSON PROCESS MANGMNT CHENNAI PVT. LTD
7.	FLOWSERVE INDIA CONTROL PVT LTD-BANGALOR
8.	FLOWSERVE PTE LTD
9.	FORBES MARSHALL ARCA P LTD.(FORMRLY A214
10.	GE Oil & Gas India Pvt. Ltd.
11.	INSTRUMENTATION LTD. (PALGHAT)
12.	ITALVALV S.N.C
13.	KENT INTROL UK LTD (FORM. A-718)
14.	KOSO INDIA PVT LTD (FORM.K176)
15.	KSB MIL CONTROLS LIMITED
16.	METSO FLOW CONTROL OY
17.	MOTOYAMA ENGG WORKS LTD
18.	SAMSON CONTROLS PVT LTD
19.	SAMSON AG MESS-UND REGELTECHNIK
20.	SEVERN GLOCON INDIA PVT LTD
21.	SEVERN GLOCON LTD
22.	SPX VALVES & CONTROLS (FORMERLY DEZURIK)
23.	WEIR VALVES & CONTROLS UK LTD
Item: On-off Valve	
1.	ADVANCE VALVES PVT LTD.
2.	BRAY CONTROLS INDIA PVT LTD
3.	CAMERON ITALY SRL
4.	EL-O-MATIC INDIA (PVT) LTD.

5.	EMERSON PROCESS MANAGEMENT (INDIA) PRIVATE LIMITED
6.	FLOWSERVE INDIA CONTROL PVT LTD-BANGALOR
7.	FLOWSERVE PTE LTD
8.	ITALVALV S.N.C
9.	KITAMURA VALVE MANUFACTURING CO LTD
10.	KITZ CORPORATION OF EUROPE S.A.
11.	KOSO INDIA PVT. LIMITED
12.	L & T VALVES LIMITED
13.	METSO INDIA PRIVATE LIMITED
14.	MICROFINISH VALVES PVT LIMITED
15.	MOTOYAMA ENGG WORKS LTD
16.	PENTAIR VALVES & CONTROLS INDIA PVT LTD
17.	PIBIVIESSE S. R. L.
18.	PERRIN GMBH
19.	ROTEX MANUFACTURERS & ENGINEERS P LTD.
20.	SAMSON AG MESS-UND REGELTECHNIK
21.	SPX VALVES & CONTROLS (FORMERLY DEZURIK
22.	TYCO VALVES & CONTROLS
23.	VALVTECHNOLOGIES INC.
24.	VELAN INC
25.	WEIR VALVES & CONTROLS UK LTD
Item: Self Actuated Pr. Control Valves	
1.	DRESSER PRODUITS INDUSTRIELS
2.	EMERSONPROCESSMANAGEMENT CHENNAI PVT LTD
3.	EMERSON PROCES MGMT ASIA PACIFIC PTE LTD
4.	ELSTER-INSTROMET NV
5.	ESME VALVES LTD.
6.	GE Oil & Gas India Pvt. Ltd.
7.	GORTER CONTROLS B.V.
8.	KSB MIL CONTROLS LIMITED
9.	NIRMAL INDUSTRIAL CONTROL PVT. LTD.
10.	PIETRO FIORENTINI SPA
11.	RICHARDS INDUSTRIES (FORMERLY TRELOAR)
12.	RMG REGEL+MESSTECHNIK GMBH
13.	SAMSON AG MESS-UND REGELTECHNIK
14.	SAMSON CONTROLS PVT LTD
15.	
Item : Instrument Valves& Manifolds	
1.	Anderson Greenwood Crosby
2.	Arya Crafts & Engineering Pvt Ltd
3.	Astec Valves & Fittings Pvt. Ltd

4.	Autoclave Engineers Fluid Components
5.	Baumer Technologies India Pvt. Ltd
6.	Chemtrols Industries Ltd
7.	Comfit & Valves Pvt. Ltd.
8.	Circor Instrumentation Technologies Inc
9.	Excelsior Engineering Works
10.	Excel Hydro Pneumatics Pvt Ltd
11.	Fluid Controls Pvt Ltd
12.	Ham-Let (Israel-Canada) Ltd.
13.	Met-Lok Valves And Fittings
14.	Micro Precision Products Pvt Ltd
15.	Panam Engineers
16.	Parker Hannifin Corporation
17.	Precision Engineering Industries
18.	Prime Engineers
19.	Swastik Engineering Works
20.	Swagelok Company
21.	Swagelok Limited
22.	TK Fujikin Corporation
23.	Wesmec Engineering Private Limited
Item : Control panel & accessories	
1.	Accuosonic Control Pvt Ltd
2.	Control Systems Engineers
3.	Electronic Corporation of India Ltd
4.	Electronic Instrumentation & control P Ltd
5.	Industrial Controls & Appliances Pvt Ltd
6.	Iris Automation Pvt Ltd
7.	Positronics Pvt Ltd
8.	Prima Automation India Pvt Ltd
9.	Pyrotech Electronics Pvt Ltd
10.	Radha Krishna Controls
Item: CABLE GLANDS (HAZARDOUS AREA)	
1.	CMP PRODUCTS LTD
2.	COMET BRASS PRODUCTS
3.	COMET INDUSTRIES
4.	FLEXPRO ELECTRICALS PVT LTD
5.	FLAMEPROOF EQUIPMENTS PVT.LTD
6.	FCG POWER INDUSTRIES PVT LTD
7.	FCG FLAMPROOF CONTROL GEARS P. LTD
8.	KAYSONS TECHNO EQUIPMENT P LTD.
9.	METAL CRAFT INDUSTRIES
10.	SUDHIR SWITCHGEARS PVT LTD

11.	STANDARD METAL INDUSTRIES
Item: JUNCTION BOX (FLAMEPROOF)	
1.	BALIGA LIGHTING EQUIPMENTS (P) LIMITED
2.	FCG FLAMPROOF CONTROL GEARS P. LTD
3.	FCG POWER INDUSTRIES PVT LTD
4.	FLAMEPROOF EQUIPMENTS PVT. LTD
5.	FLEXPRO ELECTRICALS PVT LTD
6.	SUDHIR SWITCHGEARS PVT LTD
7.	KAYSONS TECHNO EQUIPMENT P LTD.
8.	PEPPERL & FUCHS MANUFACTURING INDIA
9.	PHOENIX MECANO INDIA PVT LTD
10.	R STAHL PVT LTD
Item: Field Instruments (P,DP,F,L,T,TD.)	
1.	ABB India Ltd (Bangalore)
2.	ABB Automation Products Gmbh
3.	Emerson Process Management India Pvt Ltd
4.	Emerson Process Mgmt Asia Pacific Pte Ltd
5.	Endress+Hauser Wetzer India Pvt Ltd
	Endress+Hauser (I) Auto Instr. Pvt Ltd
6.	Endress+Hauser Wetzer Gmbh+Co. Kg
7.	Endress+Hauser Gmbh+Co. Kg
8.	Fuji Electric Systems Co. Ltd
9.	Honeywell Automation India Ltd
10.	Honeywell Inc.
11.	Schneider Electric Systems Pvt Ltd
12.	Yokogawa India Limited
13.	Yokogawa Electric Corporation
Item: Pressure Gauges	
1.	AN Instruments Pvt Ltd
2.	Badotherm Process Instruments B.V
3.	Baumer Technologies India Pvt. Ltd
4.	Budenberg Gauge Co. Ltd
5.	Forbes Marshall (Hyd). Pvt. Ltd.
6.	Gauges Bourdon (I) Pvt. Ltd
7.	Goa Instruments Industries Pvt. Ltd.
8.	H Guru Instruments(South India) Pvt. Ltd
9.	H.Guru Industries
10.	Manometer (India) Pvt. Ltd
11.	Precision Mass Products Pvt. Ltd.
12.	Wika Instruments India Pvt Ltd

13.	Walchandnagar Industries Ltd (Tiwac Divn)
14.	Wika Alexander Wiegand & Co Gmbh
Item: Temperature Elements and Thermowells	
1.	ABB Automation Ltd
2.	Altop Industries Ltd
3.	Daily Thermetrics Corporation
4.	Detriv Instrumentation & Electronics Ltd
5.	GAUGES BOURDON (I) PVT LTD (GEN. INST)
6.	Gayesco WIKA USA
7.	Goa Instruments Industries Pvt Ltd
8.	Pyro-Electric Instruments Goa Pvt Ltd
9.	Temp-Tech
10.	Tempsens Instruments India Pvt Ltd
11.	Techno Instruments
12.	Thermal Instrument (I) P Ltd (Gen.Inst)
13.	Thermo Electric CO. INC
14.	TM Tecnomatic SPA
15.	Thermo-Couple Products CO
16.	Thermo-Electra B.V
17.	TOSHNIWAL INDUSTRIES PVT LTD
18.	Wika Alexander Wiegand & Co Gmbh
19.	WIKA INSTRUMENTS INDIA PVT LTD
Item: PROGRAMMABLE LOGIC CONTROLLERS	
1.	ABB INDIA LTD (BANGALORE)
2.	ASEA BROWN BOVERY LTD (ABB LTD)
3.	EMERSON PROCESS MANAGEMENT INDIA PVT LTD
4.	GE INTELLIGENT PLATFORMS PVT LTD
5.	HIMA PAUL HILDEBRANDT GMBH + CO KG
6.	HONEYWELL INC.
7.	HONEYWELL AUTOMATION INDIA LTD.
8.	ICS TRIPLEX (EMEA) PLC [ESSEX]
9.	INVENSYS SOFTWARE SYSTEMS (S) PTE LTD
10.	LARSEN & TOUBRO LTD-MAHAPE
11.	ROCKWELL AUTOMATION INDIA PVT LTD
12.	ROCKWELL AUTOMATION INC.
13.	SIEMENS AG
14.	SIEMENS LTD - NASHIK
15.	YOKOGAWA INDIA LIMITED
Item: TERMINAL AUTOMATION SYSTEM	
1.	ABB AUTOMATION LTD
2.	ADVANCED SYSTEK PVT LTD.

3.	CHEMTROLS INDUSTRIES PVT. LTD.
4.	EMERSON PROCESS MANAGEMENT INDIA PVT LTD.
5.	HONEYWELL AUTOMATION INDIA LTD.
6.	LARSEN & TOUBRO LTD-MAHAPE
Item : GAS DETECTION SYSTEM	
1.	CHEMTROLS INDUSTRIES LTD
2.	CROWCON DETECTION INSTRUMENTS LTD
3.	DETECTOR ELECTRONICS CORP
4.	DRAGER SAFETY AG & CO KGAA
5.	EMERSON PROCESS MANAGEMENT INDIA PVT LTD
6.	HONEYWELL ANALYTICS
7.	INDUSTRIAL SCIENTIFIC CORPORATION
8.	JSC ELECTRONSTANDART-PRIBOR(ESP CO)
9.	MINE SAFETY APPLIANCES COMPANY
10.	NET SAFETY MONITORING
11.	RIKEN KEIKI CO LTD
12.	RESPO PRODUCTS
Item: PRESSURE RELIEF VALVE	
1.	ANDERSON GREENWOOD CROSBY
2.	ANDERSON GREENWOOD CROSBY SANMAR LTD.
3.	AST APPARECCHI DI SICUREZZA E TENUTA SPA
4.	BHEL (TRICHY)
5.	BLISS ANAND PVT LTD
6.	CURTISS WRIGHT FLOW CONTROL CORPORATION
7.	DRESSER INC.
8.	FAINGER LESER VALVES (P) LTD.
9.	INSTRUMENTATION LTD. (PALGHAT)
10.	LESER GMBH & CO. KG
11.	NAKAKITA SEISAKUSHO CO LTD
12.	WEIR BDK VALVES-A UNIT OF WEIR INDIA PVT
Item: TEMP.GAUGES(BI METALLIC,FILLED SYSTEM)	
1.	AN INSTRUMENTS PVT LTD
2.	BAUMER TECHNOLOGIES INDIA PVT.LTD
3.	BADOTHERM PROCESS INSTRUMENTS B.V.
4.	Forbes Marshall (Hyd) Pvt. Ltd.
5.	GAUGES BOURDON (I) PVT. LTD. (GEN.INST)
6.	GOA INSTRUMENTS INDUSTRIES PVT. LTD.
7.	H GURU INSTRUMENTS (SOUTH INDIA) PVT. LTD
8.	H.GURU INDUSTRIES
9.	PRECISION MASS PRODUCTS PVT. LTD.
10.	WIKA INSTRUMENTS INDIA PVT LTD

11.	WALCHANDNAGAR INDUSTRIES LTD(TIWAC DIVN)
12.	WIKA ALEXANDER WIEGAND & CO GMBH
Item: Orifice Plates & Flanges	
1.	Baliga Lighting Equipments (P) Limited
2.	Cameron Ltd.
3.	Chemtrols Samil (India) Pvt. Ltd.
4.	Comfit & Valves Pvt. Ltd
5.	Daniel Measurement & Control Asia Pacific
6.	Eureka Industrial Equipments (P) Ltd
7.	EMERSON PROCESS MANAGEMENT ASIA PACIFIC PTE LTD.
8.	Guru Nanak Engg Works
9.	HYDROPNEUMATICS PVT. LTD
10.	Instrumentation Ltd. (Palghat)
11.	Micro Precision Products Pvt Ltd
12.	Minco (India) Pvt Ltd (Gen. Inst.)
13.	Petrol Valves SRL
14.	Pietro Fiorentini SPA
15.	Star-Mech Controls (India) Pvt Ltd
16.	TM Tecnomatic SPA
Item : Gauge Glasses & Cocks	
1.	BLISS ANAND PVT LTD
2.	CESARE BONNETTI S.P.A.
3.	CHEMTROLS SAMIL (INDIA) PVT LTD
4.	GAUGES BOURDON (I) PVT LTD (GEN. INST)
5.	JERGUSON GAUGE & VALVE
6.	KLINGER SPA
7.	NIHON KLINGAGE CO LTD
8.	NISAN SCIENTIFIC PROCESS EQUIP. P LTD
9.	PRATOLINA INSTRUMENTS PVT LTD
10.	PUNE TECHTROL PVT LTD
11.	SIGMA INSTRUMENTS CO
Item : Tank Level Instrument (Radar, Ultrasonic)	
1.	AMETEK DREXELBROOK
2.	EMERSON PROCESS MANAGEMENT INDIA PVT LTD
3.	ENDRESS+HAUSER (I) AUTO. INSTR. PVT. LTD
4.	ENDRESS+HAUSER GMBH +CO.KG
5.	ENRAF B.V. (GR. COMPANY OF HONEYWELL)
6.	HAWK MEASUREMENT SYSTEM PTY LTD
7.	KROHNE S.A.S. [CEDEX]
8.	L & J TECHNOLOGIES
9.	MAGNETROL INTERNATIONAL N.V

10.	MOBREY LTD
11.	ROSEMOUNT TANK RADAR AB
12.	SIEMENS AG
13.	VEGA GRIESHABER KG
Item : Loop Powered Indicators	
1.	BEKA ASSOCIATES LTD
2.	EMERSON PROCESS MANAGEMENT INDIA PVT LTD
3.	ENDRESS + HAUSER WETZER INDIA PVT LTD
4.	ENDRESS+HAUSER WETZER GMBH+ CO.KG
5.	HONEYWELL AUTOMATION INDIA LTD.
6.	MTL INSTRUMENTS PVT LTD
7.	YOKOGAWA INDIA LIMITED
Item : Mass flowmeters	
1.	ABB AUTOMATION PRODUCTS GMBH
2.	BRONKHORST HIGH TECH BV
3.	BROOKS INSTRUMENT
4.	EMERSON PROCESS MANAGEMENT INDIA PVT LTD
5.	EMERSON PROCES MGMT ASIA PACIFIC PTE LTD
6.	ENDRESS + HAUSER FLOWTEC AG
7.	ENDRESS+HAUSER (I) PVT. LTD.
8.	ENDRESS+HAUSER FLOWTEC (INDIA) PVT LTD
9.	FLUID COMPONENTS INTERNATIONAL LLC
10.	FOX THERMAL INSTRUMENT INC.
11.	HEINRICHS MESSTECHNIK GMBH
12.	KROHNE LIMITED
13.	KURZ INSTRUMENTS INC
14.	MAGNETROL INTERNATIONAL N.V
15.	RHEONIK MESSGERATE GMBH
16.	ROTA YOKOGAWA GMBH & CO. KG
17.	YOKOGAWA INDIA LIMITED

NOTES:

1. Vendor may procure material from any of approved vendors listed above. However current validity and range of approval as per enlistment letter, workload, stability and solvency need to be verified by the Vendor before placement of order.

2. For equipments/components other than the above, vendor shall submit past track record for the proposed sub-vendors and obtain written approval from Owner / EIL before placing order.

3. The sub-vendors list shall be approved by owner/EIL prior to placement of order by vendor. Vendor shall list down the proposed suppliers/vendors for such items and submit the same for owner review/approval along with necessary documents/PTR. Non-acceptance of a particular

proposed vendor due to any reasons whatsoever shall not be a cause of schedule and cost implication. If equipments are sourced from outside India, vendor shall obtain prior approval for make of equipments before placement of order.

INSTRUMENTATION INPUT

LIST OF ATTACHMENT

GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE
(MR No:B240-910-KA-MR-5010)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
A	18.04.2019	Issued with MR	PS	SR	PKS

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S. No.	Description	Document No.	No. of sheets
1	Instrumentation Scope of Work	B240-910-16-51-SOW-5010	9
2	Instrumentation Job Specifications	B240-910-16-51-SP-5010	22
3	Vendor Data requirement	B240-910-16-51-VDR-5010	6
4	Technical Compliance	B240-910-16-51-CF-5010	2
5	Logistic Support format	B240-910-00-LSF-5010	1
6	Overall System configuration & interface schematic for Gas Turbine driven Compressor package.	B240-910-16-51-SK-0001	1
8	Capacity Control System Configuration for Gas Turbine driven Compressor package.	B240-910-16-51-SK-0002	1
9	Data Sheet for PLC	B240-910-YE-DS-5010	10
10	Mandatory spares list	B240-910-16-51-SL-5010	4
11	Vendor List-Instrumentation	B240-910-16-51-MD-5010	11
12	Standard Specification for Package Units	6-52-0052	76
13	Standard Specification for Programmable Logic controllers	6-52-0040	20
14	Inst. Connection on vessels, standpipes and tanks	7-52-0001	1
15	Inst. Connection on piping	7-52-0002	1
16	Pressure gauge liquid / gas service.	7-52-0432	1
17	Pressure instrument gas service meter above.	7-52-0441	1
18	Diff. press. instrument DP-type on vessel meter above	7-52-0472	1
19	Level instrument guided wave radar on vessel / standpipe	7-52-0475	1
20	Flow instrument DP type gas service meter above.	7-52-0405	1

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VENDOR DATA REQUIREMENTS
FOR
GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
A	18-APR-2019	Issued with MR	PS	SR	PKS

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VENDOR DATA REQUIREMENTS

The following drawings/documents marked "✔" shall be furnished by the bidder.

S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Drawing and Document Schedule		✔		✔	
2.	Piping and Instrument Diagram		✔		✔	
3.	Instrument Index			✔	✔	
4.	Sub-Vendor List for Instruments and accessories		✔		✔	
5.	Utility requirements	✔		✔		
6.	Level Sketches / Nozzle Elevations for level Instrument			✔		
7.	Purchase Requisition (Note 2)		✔		✔	*1. For Record Also.* *2. Review Only for Critical items like PLC, Anti-surge controller, Machine Monitoring System, Control valve, On-off valves, Pressure Safety Valve, self actuated control valves. Others are for Records only.* *3. Documents other than those identified for review by Client/ EIL shall be submitted for record.*
8.	Functional schematic			✔	✔	
9.	UCP PLC Logic in I.S.A format along with description of all interlocks and sequence of operation		✔		✔	
10.	Instrument I/O list from Interconnecting I/Os between UCP & Station common facilities PLC.			✔	✔	
11.	GA & wiring drawing of Unit control Panel.			✔	✔	
12.	Graphic display drawings			✔	✔	
13.	Instrument loop drawings		✔		✔	
14.	Serial mapping list with tag number wise MODBUS address for UCP PLC.			✔	✔	
15.	System configuration diagram/Topology diagram of complete Integrated Gas turbine compressor control system including Anti surge controllers & performance /Master controller, Load sharing controller if applicable), Vibration, displacement & temperature monitoring display units etc		✔		✔	
16.	Power Supply Distribution			✔	✔	
17.	Instrument Cable Schedule			✔	✔	

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S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
18.	Air supply distribution drawing from instrument air header to instruments.			✔	✔	
19.	Bill of material			✔	✔	
20.	Instrument Installation drawing which shall indicate the requirement of various installation materials required for installation of each instrument.			✔	✔	
21.	Instrumentaiton/ Electrical interface details			✔		
22.	Grounding details for Instrument / Cabinet			✔	✔	
23.	Special test equipment/ tool requirement for maintenance			✔	✔	
24.	Spare part list for 2 years operation	✔		✔	✔	
25.	Spare part list for Start up, Commissioning & Consumables			✔	✔	
26.	Spare part list for Mandatory Spares		✔		✔	
27.	Inspection and test procedure		✔		✔	
28.	Complete catalogues with part list for all vendor supplied instruments, control, etc.				✔	
29.	Installation, operation, Programming and maintenance manuals				✔	
30.	Loop checking / calibration report				✔	
31.	Certificates (Statutory/ Inspection/ Calibration test)			✔	✔	

S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Factory testing and acceptance procedure for system oriented items		✔		✔	
2.	Point data base for UCP PLC			✔	✔	
3.	SAT Procedure		✔		✔	

Notes :

1. "TICK" denotes applicability.
2. Post order, drawing / document review shall commence only after approval of Document Control Index (DCI).
3. All post order documents shall be submitted / approved through EIL eDMS portal.
4. Final documentation shall be submitted in hard copy (Six prints) and soft (two CDs/DVDs) in addition to submission through EIL eDMS.

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5. Refer - 6-78-0001: Specification for quality management system from Bidders.
6. Refer - 6-78-0002: Specification for documentation requirements from Contractors.
7. Refer - 6-78-0003: Specification for documentation requirement from Suppliers.
8. All drawings & documents shall be submitted in A4 or A3 paper sizes. Documents in higher paper size shall be submitted in exceptional circumstances or as indicated in the MR/Tender.
9. Post order- The schedule of drawing / data submission shall be mutually agreed between EIL & the bidder / contractor / supplier during finalization of Document Control Index (DCI).
10. "@" indicates submission of documents to Inspection Agency.
11. Bill of Material shall form part of the respective drawing.
12. Documents to be prepared and provided in SPI (Smart Plant Instrumentation 2009 Service Pack 4 Version: 09.00.01.0117).
13. Soft copies of all the documents in Autocad /MS Word/MS Excel format shall be provided for loading in ownerâs documentation system.
14. Bidder to note that the system engineering documents are required for further engineering and site work. These documents shall be, positively, provided as per mutually agreed schedule after order.
15. Any other document/drawing not listed above but required to carryout the engineering and for integration of other equipment packages sub-ordered by contractor shall also be prepared and furnished to Client / EIL.
16. All instrument document/drawing shall be submitted after issue of P&IDs. The submission of document / drawing is sequenced in such a way that submitted document /drawing is neither dependent nor changed due to drawing / document yet to be submitted. Document/ drawing submission schedule shall be made accordingly.
17. Bidder shall prepare & submit the as built drawings / documents after commissioning. All the drawings/documents listed shall be converted into âAs Builtâ after commissioning of Project. âAs Builtâ shall include documents generated by Contractor & documents generated/ submitted by various Sub-vendors.
18. a) Review Only for Critical items like Analyser, Control valve On-off valves, Pressure Safety Valve, self actuated control valves. Others are for Records only.
b) Documents other than those identified for review by Client/ EIL shall be submitted for record.

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ANNEXURE -1(B240-910-00-LSF-5010)

CERTIFICATE FOR LOGISTICS SUPPORT

(To be signed by Manufacturer's corporate level signatory on company's letterhead)

I, on behalf of M/s_____ confirm that the (Name of the control system such as PLC, Anti-Surge control system, Performance controlller, Vibration and Temperature monitoring system etc) Model No._____ for _____ measurement and control quoted by M/s_____ for M/s GAIL, against Material Requisition no. B240-910-KA-MR-5010 shall continue to be supported by us for a period of minimum 10 years. The quoted system shall not be withdrawn from Indian market as a matter of our corporate policy.

I further confirm that in case of placement of order by GAIL on us, we shall continue to support GAIL in providing back-up engineering, maintenance support and spare part support for a period of 10 years from the date of placement of order.

SIGNATURE WITH SEAL
AUTHOURIZED, SENIOR
MANAGEMENT LEVEL SIGNATORY

DATA REQUIREMENT FROM VENDOR (CIVIL-STRUCTURAL) FOR COMPRESSOR

PROJECT : **Installation of New GTC Compressor at Gandhar, Gujarat,**

OWNER : **Gas Authority of India Limited**

PMC : **Engineers India Limited**

JOB NO. : **B240**

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
A	27.03.19	ISSUED FOR MR	LP	CK	VG

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The minimum data required from vendor for Civil structural design of Compressor foundation (by others) for Revival of Ramagundam Fertilizer Complex project shall be following:

1. LAYOUT

i. The sizes of different parts of concrete foundation with proper plan dimensions and elevations.

ii. The pocket sizes in plan, their depths and locations. The distance between edge of pocket and outside edge of concrete shall be kept as minimum100mm.

iii. The locations and sizes of bolts in case they are to be placed in position at the time of concreting. The distance between of bolt and outside edge of concrete shall be kept as 125mm (minimum).

iv. The thickness and type of non-shrink/epoxy grout.

v. The location of machine reference axis in X,Y direction in plan and Z in Elevation.

vi. Layout and details of all auxiliary equipments, operating/maintenance platforms, along with the machine.

vii. Location and size of openings if any, on foundation/platform.

viii. Detail of all embedded parts like insert/ G.I. sleeve etc.

2. LOADING

i. The static loads from different components of the machine and locations of the line of action of all these loads defined in all three axes.

ii. The static weights of the rotating parts of the machine.

iii. Dynamic loading/equivalent static design of the foundation.

iv. Static loading of Auxiliary equipments/maintenance platforms, and loads on inserts, as applicable.

3. AMPLITUDES AND FREQUENCIES

The magnitude of permissible amplitudes of vibration shall be supplied at the bottom of base frame/top of concrete foundation.

Vendor shall note that:

i. If the magnitude of permissible amplitude of vibration at the bottom of base frame/top of foundation is not specified, the same shall be assumed to be 200 microns one way (i.e. 400 microns peak to peak) as per IS:2974, part I.

ii. The natural frequencies of vibration of the machine foundation system shall be kept +20% away from the operating frequency of the machine.

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4. UNBALANCED FORCES

The magnitudes and direction of all unbalanced forces caused due to out of balance of the rotating parts at the bottom of base plat/top of foundation at any one particular instant of time. (Different set of unbalanced forces at another instant of time, if any, shall be furnished as a separate set; unbalanced forces at different instants of time shall not be clubbed together).

5. OPERATING FREQUENCY/CRITICAL SPEED

i. The operating frequencies of the machine and the drive.

ii. The critical speed of the machine, as applicable.

6. MISCELLANEOUS

i. Distance of main shaft of machine from top of machine foundation and Mass Moment of Inertia.

ii. Type and position of anti-vibration mountings, if recommended, including their static and dynamic properties.

iii. GD2 value of each item resolved to motor speed.

iv. Any other information necessary for comprehensive design of the foundation system, requiring special consideration during engineering.

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गेल (इंडिया) लिमिटेड

GAIL (INDIA) LIMITED

गांधार कम्प्रैसर परियोजना

GANDHAR COMPRESSOR PROJECT

PIPING JOB SPECIFICATION FOR COMPRESSOR STATION

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
D	18.09.2019	REVISED & REISSUED FOR BIDS	SS/TLP	RSB	MSG
C	11.09.2019	REVISED & REISSUED FOR BIDS	SS/TLP	RSB	MSG
B	06.09.2019	REVISED & REISSUED FOR BIDS	TLP	RSB	MSG
A	24.06.2019	ISSUED FOR BIDS	TLP	RSB	MSG

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1.0 GENERAL

2.0 SCOPE OF WORK FOR PIPING

3.0 SCOPE OF SUPPLY

4.0 OTHER TECHNICAL REQUIREMENTS

5.0 VENDOR DOCUMENT REQUIREMENT SCHEDULE

6.0 ATTACHMENTS

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1.0 GENERAL

This document describes the minimum requirements for Piping Works associated with proposed Gas Turbine Compressor system (MR No. B240-910-KA-MR-5010) at GPU Gandhar of M/s GAIL.

2.0 SCOPE OF WORK FOR PIPING

The detailed scope of piping work pertaining to compressor station inside the battery limit as shown in the Typical Equipment Layout No. B240-910-83-41-11901 shall be in general but not limited to the following:-

2.1 Engineering for all the auxiliary facilities including following

1. Fuel Gas Conditioning Skid piping; and complete piping from Skid to Gas Turbine Compressor (GTC)
2. Compressor Oil reservoir Piping; and piping from Reservoir to GTC
3. Seal Gas Skid piping; and piping from Skid to GTC
4. Gas Turbine Oil reservoir Piping; and piping from Reservoir to GTC
5. Utility piping from Battery limit to GTC
6. Drain & Vent piping from all Skids to battery limit

2.2 Preparation of Piping General Arrangement Drawings (GAD), Layouts, Isometrics etc.

2.3 Procurement & Supply of all materials as per scope of supply clause no.3.0

2.4 Construction Supervision of Compressor, Skids and all Piping in Bidder's Scope, including installation of Pipe Supports.

2.5 All such works that are not indicated above but are otherwise required to complete the work in all respects shall form part of BIDDER's Scope of Work.

Engineering and supply of all process piping shall be by COMPANY and complete erection of the equipment and piping shall be by third party.

3.0 SCOPE OF SUPPLY

BIDDER shall supply all Materials as per scope of work. The procurement and supply of all materials required shall be strictly in accordance with the requirements of P&ID's and PMS (B240-000-83-41-SP-0001) enclosed with the MR document. As a minimum, the following materials shall be supplied by BIDDER:-

1. All Piping materials (Pipes, fittings, flanges, valves, nuts, bolts, gaskets) for all systems mentioned in clause 2.1 & P & IDs.

2. All Valves as indicated in P&IDs, including Direct Gas Actuated Ball Valves with Tag Nos. 910-AV-1107, 910-AV-1108, 910-AV-1109, 910-AV-1110, 910-AV-1111, 910-AV-1112, 910-AV-1113, 910-AV-1202, 910-AV-1301.

3. Apart from the Valves included in (1) & (2) above, manually operated Full Bore Ball Valves to the Upstream & Downstream of PSVs with Tag Nos. 910-PSV-1401A & 910-PSV-1401B.

4. All companion flanges (including bolts, nuts, gaskets & adequate no. of Spare gaskets) at Battery Limits for process piping at all inlet/outlet connections of

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GTC, Fuel Gas Booster/ Conditioning Skid and Seal Gas Skid. Companion Flanges of all Valves in Bidder's scope of supply.

5. Strainers for Compressor & Fuel Gas Skid; including mating Flanges (with Nuts, Bolts, Gaskets & adequate no. of Spare gaskets).

6. All Carbon Steel Ball valves (size 2" & above) shall be supplied as per Standard Specification for Pipeline Ball Valves (6-71-0014) and data sheets. All other valves shall be supplied as per Technical Notes for Valves (6-44-0052).

7. All supporting material for all Piping (including vents) in Bidder's scope of supply.

4.0 OTHER TECHNICAL REQUIREMENTS

4.1 All piping systems shall be designed and engineered in accordance with the provisions of the latest edition of code ASME B31.8 (Gas Transmission and Distribution Piping Systems). In addition, code ASME B31.3 (Process Piping) shall be applicable for Utility Piping.

4.2 All piping shall be designed as per

- Piping & Instrument Diagram
- Equipment Layout
- Piping Material Specification

4.3 The following requirements shall be met.

a) Minimum level of bottom of piping shall be 500 mm.

b) Minimum level of overhead piping shall be such that a clear 2.2 m headroom is available below pipe.

c) All Vent lines originating from skids/ piping inside Compressor house shall be connected to flare line above, upto Battery Limits. All supporting structure for these vent lines shall be provided by Bidder.

d) Drain shall be piped to nearest open or closed sewer system.

e) Proper access to all operating points including valves and instruments shall be provided.

f) Piping flexibility shall be ensured and support locations and types shall be indicated in the GAD. Span between pipe supports shall not exceed the basic span indicated in the table enclosed. Support Standards attached with this document are for reference purpose only.

g) Allowable loads on inlet/ outlet connections of various equipments shall be provided to COMPANY.

h) All piping routing under Bidder's scope of work shall be reviewed by COMPANY for interference with process piping and same shall be modified, if required, by BIDDER.

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4.4 BIDDER shall submit all drawings for COMPANY's review and approval. Modification if any as per COMPANY's comments shall be incorporated in final drawings.

5.0 VENDOR DOCUMENT REQUIREMENT SCHEDULE

After placement of order, the vendor shall submit various documents/ drawings as per Vendor Document Requirement Schedule No. B240-910-83-41-VDR-5010 enclosed with bid document.

6.0 ATTACHMENTS

Sl. No	Title	Document No.	Rev.
1.	Piping Material Specification (with Annexures & Attachments)	B240-000-83-41-SP-0001	1
2.	DataSheet for Ball Valve	B240-000-83-41-DS-0011	A
3.	DataSheet for Ball Valve	B240-000-83-41-DS-0014	A
4.	DataSheet for Ball Valve	B240-000-83-41-DS-0015	B
5.	DataSheet for Ball Valve	B240-000-83-41-DS-0016	A
6.	DataSheet for Ball Valve	B240-000-83-41-DS-0017	A
7.	DataSheet for Ball Valve	B240-000-83-41-DS-0018	B
8.	Datasheet for Direct Gas Actuator	B240-000-83-41-DS-0019	C
9.	DataSheet for Ball Valve	B240-000-83-41-DS-0081	A
10.	DataSheet for Strainer	B240-000-83-41-DS-0071	B
11.	DataSheet for Strainer	B240-000-83-41-DS-0072	B
12.	Datasheet for Globe Valves	Tag No. 52045 of 6-44-0006	7
13.	Datasheet for Torque Values	Form-T	-
14.	Typical Equipment Layout for Gandhar Compressor Station	B240-910-83-41-11901	A
15.	Vendor Document Requirement Schedule (Piping)	B240-910-83-41-VDR-5010	A
16.	Specification for Strainers	B240-000-83-41-SP-0003	0
17.	Job Specification for Direct Gas Actuators	B240-000-83-41-SP-0004	1
18.	Welding specification for Piping Classes	B240-000-02-42-WSP-0001	0
19.	Welding Specification Charts for Piping Classes	B240-000-02-42-WSC-0001	0
20.	Specification for Surface Preparation and Protective Coating System – New Construction	B240-000-02-42-PCS-0001	0
21.	Technical notes for Pipes	6-44-0051	6
22.	Technical notes for Valves	6-44-0052	7
23.	Technical notes for Gaskets	6-44-0056	5
24.	Technical notes for Bolts and Nuts	6-44-0057	5
25.	Standard specification for Pipeline Ball Valves	6-71-0014	5
26.	Standard specification for flanges and welded fittings (size DN 450 mm (18") & above)	6-71-0023	5
27.	Standard specification for seamless fittings and flanges [Size upto DN 400 mm (16")]	6-71-0024	5

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28.	T-strainer Type-1; 2" - 4" (150CL RF, 300 CL RF and RTJ, 600 CL RF and RTJ)	7-44-0303	6
29.	T Strainer Type-1; 6"-24" (150# RF, 300# RF and RTJ, 600# RF and RTJ)	7-44-0304	6
30.	Tolerances for fabrication	7-44-0486	5
31.	Clearances	7-44-0501	3
32.	Accessibility for valves and instruments	7-44-0502	3
33.	Valve accessibility and clearances	7-44-0503	3
34.	Table of basic span	7-44-0506	3
35.	Maximum spacing of guides for vertical and horizontal pipes	7-44-0507	3
36.	Pipe saddle for bare pipe size 2" thru 48"; Type-S6A (for temp. Upto 343°C)	7-44-0606	5
37.	Pipe shoe for slope line pipe size 2" thru 8" type S9	7-44-0609	5
38.	Low support sliding for bare & insulated pipe size 2" thru 36" type L1 & L1A	7-44-0621	5
39.	Low support fixed for bare and insulated pipe size 2" thru. 36" type – L3 and L3A	7-44-0623	5
40.	Low support sliding for bare pipe size 3/4" thru. 36" type - L5 and L5A	7-44-0625	5
41.	Low support sliding for bare and insulated pipe size 2" thru. 36" type – L6	7-44-0626	5
42.	Low support fixed/restrained for bare and insulated pipe size 2" thru. 36" type – L7 and L7A	7-44-0627	5
43.	Restrained low support for bare & insulated pipe size 2" thru 36" type L8 & l8A	7-44-0628	5
44.	Adjustable low support with 4 bolts for pipe size 8" thru.24" type-L17 & 17A	7-44-0637	5
45.	Pipe clamp for bare pipe size 1/2" thru. 24" type C-1	7-44-0641	4
46.	U-bolt for bare pipe size 1/2" thru. 24" type C-4	7-44-0644	4
47.	Pipe hold down clamp for bare pulsating pipe size 1" thru.24" type C-11	7-44-0651	4
48.	Pipe u-clamp for bare pipe size 1/2" thru. 24" type C-15	7-44-0655	4
49.	Pipe clamp for bare pipe size 1/2" thru. 24" type C-16	7-44-0656	4
50.	Guide support for bare pipe size 1/2" thru 24", Type - G2 and G2A (For temp. upto 343 deg. C)	7-44-0752	5
51.	Supporting arrangement for angle & relief valves type SP2	7-44-0792	4
52.	List of Approved Vendors (Pipeline Engineering Dept.)	B240-000-83-41-LL-0001	1

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PIPING MATERIAL SPECIFICATION

Spec Name : B240-000-83-41-SP-0001-1

Spec Desc. : Piping Material Specifications

Client : GAIL (INDIA) LIMITED

Project : GANDHAR COMPRESSOR PROJECT

Location : GUJARAT

Job No. : B240

Dept/Sec. : 83-41

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
1	06/09/2019	REVISED & REISSUED FOR ENGINEERING	TLP	RSB	MSG
0	21/06/2019	ISSUED FOR ENGINEERING	TLP	RSB	MSG

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Abbreviations:

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CONTENTS

Sl. No.	Description	Pages
1	Piping Material Specifications (B240-000-83-41-SP-0001) Rev. 1	70
2	Annexure-I, Piping Material Specification General Notes (B240-000-83-41-SP-0001-A1) Rev. 1	12
3	Annexure -II, List of Specifications & Datsheets (B240-000-83-41-SP-0001-A2) Rev. 1	4

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	

PIPING MATERIAL SPECIFICATION INDEX

Sl. No	Piping Class	Rating	C.A	Spl. Reqt.	Basic Material	Service	Remarks
1	AA1A	150	1.5		CARBON STEEL	NATURAL GAS	
2	AA1K	150	0		SS 304	NATURAL GAS; UTILITIES (INST. AIR)	
3	AA3A	150	1.5		CARBON STEEL	UTILITIES:- INST. AIR, PLANT AIR, NITROGEN, SERVICE WATER	
4	AA4A	150	1.5	LOW TEMPERATURE SERVICE	CARBON STEEL	NATURAL GAS, LOW TEMPERATURE SERVICE	
5	BA1A	300	1.5		CARBON STEEL	NATURAL GAS	
6	BA1K	300	0		SS 304	NATURAL GAS	
7	BA3A	300	1.5		CARBON STEEL	UTILITIES:- INST. AIR, PLANT AIR, NITROGEN, SERVICE WATER	
8	BA4A	300	1.5	LOW TEMPERATURE SERVICE	CARBON STEEL	NATURAL GAS, LOW TEMPERATURE SERVICE	
9	DA1A	600	1.5		CARBON STEEL	NATURAL GAS	
10	DA1K	600	0		SS 304	NATURAL GAS	
11	DA4A	600	1.5	LOW TEMPERATURE SERVICE	CARBON STEEL	NATURAL GAS, LOW TEMPERATURE SERVICE	
12	EA1A	900	1.5		CARBON STEEL	NATURAL GAS	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	

PIPING MATERIAL SPECIFICATION INDEX

Sl. No	Piping Class	Rating	C.A	Spl. Reqt.	Basic Material	Service	Remarks
13	EA4A	900	1.5	LOW TEMPERATURE SERVICE	CARBON STEEL	NATURAL GAS, LOW TEMPERATURE SERVICE	

Notes : 1. For PMS General notes, refer Annexure-I of this document.

2. For List of Specifications & Datasheets, refer Annexure - II of this document.

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA1A** Sheet 1 of 5

PIPE CLASS : **AA1A**
RATING : 150
BASE MATERIAL : CARBON STEEL
CORROSION ALLOWANCE : 1.5 MM
SPECIAL REQUIREMENT :

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-29	38	50	65	100	150
PRESS	19.98	19.98	19.57	19.11	18.04	16.11

SERVICE

NATURAL GAS

NOTES

101 PIPING DESIGN SHALL BE AS PER PNGRB REGULATIONS, OISD-226 AND ASME B31.8.

102 ALL VENTS AND DRAINS SHALL BE PROVIDED WITH BALL VALVE (WITH PUP-PIECE) WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

103 ALL ABOVE GROUND PIPING BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON THE NEXT PAGE. IN BURIED PIPING O'LETS SHALL NOT BE USED AND BRANCH CONNECTION SHALL BE DONE BY USING 'TEES' & REDUCERS AS REQUIRED. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARDS SHALL BE IGNORED.

108 CHARPY V NOTCH TEST AND HARDNESS TEST SHALL BE CONDUCTED FOR SIZE 2 INCH AND ABOVE PIPES, FITTINGS, O'LETS AND FLANGES. THE AVERAGE ABSORBED ENERGY OF THREE FULL SIZED SPECIMENS SHALL BE 27J. THE MINIMUM IMPACT ENERGY VALUE OF ANY ONE OF THE THREE SPECIMENS ANALYZED ABOVE SHALL NOT BE LESS THAN 22J.

110 NDT OF WELDS SHALL BE AS FOLLOWS:-
RADIOGRAPHY: ALL BUTT WELDS 100%
MPI: SOCKET WELDS 100%
ALL OTHER REQUIREMENTS SHALL BE AS PER NDT SPECIFICATION.

111 FOR MATERIAL DESCRIPTION OF VALVES APPLICABLE DATA SHEETS SHALL BE REFERRED.

113 FOR DIMENSIONS OF HANDLE PROJECTION FOR SPACER & BLIND, REFER EIL STD. NO. 7-44-0166.

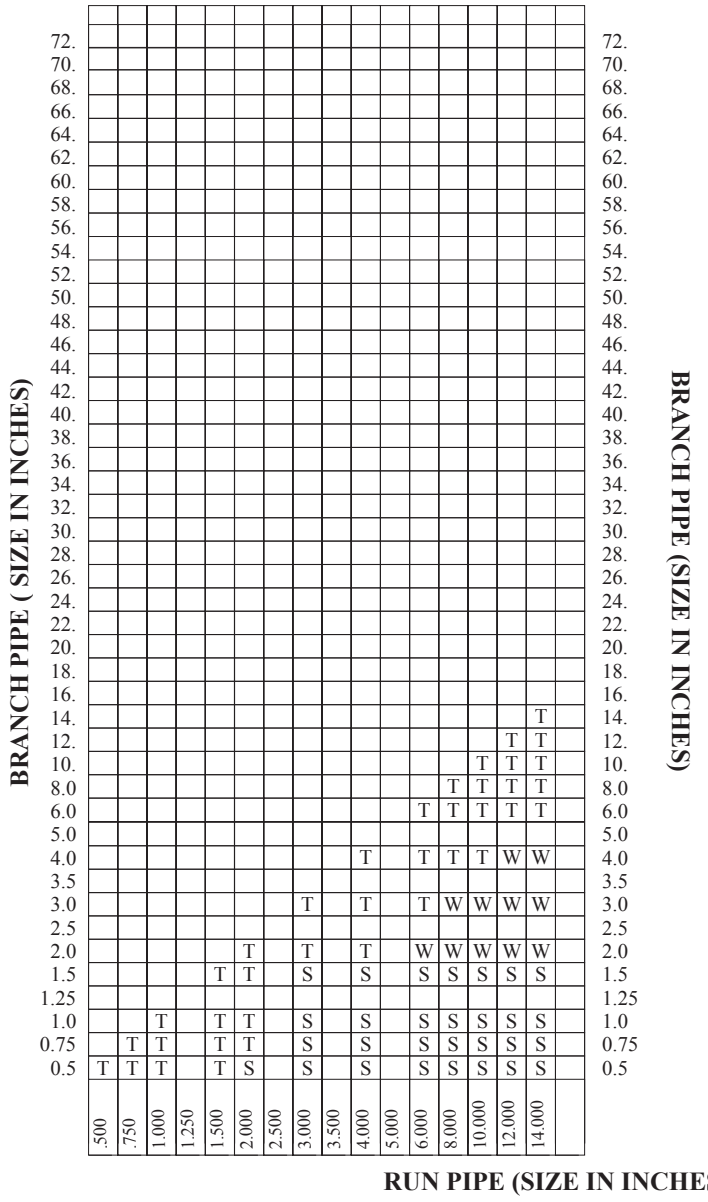
124 ALL NUTS & BOLTS SHALL BE HOT DIP GALVANIZED AS PER ASTM A153

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION	A.CODE
MAINTAINENCE JOINTS	ALL	FLANGED (TO BE KEPT MINIMUM)	
PIPE JOINTS	1.5" & BELOW	SW COUPLING	
PIPE JOINTS	2.0" & ABOVE	BUTTWELDED	
DRAINS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
VENTS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
TEMPERATURE CONN.	1.5"	"FLANGED TYPE" AS PER EIL STD 7-44-0353. "WELDED TYPE"& "SKIN TYPE"AS PER INSTRUMENTATION STANDARD	
PRESSURE CONNECTION	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA1A** Sheet 2 of 5



RUN PIPE (SIZE IN INCHES)

CODE	DESCRIPTION				
F	SADDLE FUSED JT	**T**	TEES	**J**	THREADOLET
H	H. COUPLING	**W**	WELDOLETS		
P	PIPE TO PIPE	**I**	INSTRUMENT TEE		
R	REINFORCED	**X**	Refer Notes		
S	SOCKOLETS	**L**	SWEEPOLET		

Package : **IPMCS**
Report No. : **50**

AA1A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA1A** Sheet 3 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Pipe Group									
PIP	PIPE	.5	.75	S160	B-36.10	ASTM A 106 GR.B	PE, SEAMLESS	PI21977Z0	
PIP	PIPE	1	1.5	XS	B-36.10	ASTM A 106 GR.B	PE, SEAMLESS	PI21977Z0	
PIP	PIPE	2	2	XS	B-36.10	ASTM A 106 GR.B (CHARPY)	BE, SEAMLESS	PI2H717Z0	
PIP	PIPE	3	3	STD	B-36.10	ASTM A 106 GR.B (CHARPY)	BE, SEAMLESS	PI2H717Z0	
PIP	PIPE	4	4	STD	B-36.10	ASTM A 106 GR.B (CHARPY)	BE, SEAMLESS	PI2H717Z0	
PIP	PIPE	6	6	STD	B-36.10	ASTM A 106 GR.B (CHARPY)	BE, SEAMLESS	PI2H717Z0	
PIP	PIPE	8	8	7.9	API 5L	API 5L GR.B PSL2	BE, SEAMLESS	PIAF817Z0	
PIP	PIPE	10	10	9.3	API 5L	API 5L GR.B PSL2	BE, SEAMLESS	PIAF817Z0	
PIP	PIPE	12	12	10.3	API 5L	API 5L GR.B PSL2	BE, SEAMLESS	PIAF817Z0	
PIP	PIPE	14	14	11.1	API 5L	API 5L GR.B PSL2	BE, SAW	PIAF816Z0	
NIP	NIPPLE	.5	.75	M	B-36.10	ASTM A 106 GR.B	PBE, SEAMLESS	PN21967Z0	
NIP	NIPPLE	1	1.5	M	B-36.10	ASTM A 106 GR.B	PBE, SEAMLESS	PN21967Z0	
Flange Group									
FLG	FLNG.WN	.5	1.5	M	B-16.5	ASTM A 105	150, RF/125AARH	FWC0127Z0	
FLG	FLNG.WN	2	14	M	B-16.5	ASTM A 105 (CHARPY)	150, RF/125AARH	FWC9827Z0	
FLB	FLNG.BLIND	.5	1.5		B-16.5	ASTM A 105	150, RF/125AARH	FBC0127Z0	
FLB	FLNG.BLIND	2	14		B-16.5	ASTM A 105 (CHARPY)	150, RF/125AARH	FBC9827Z0	
FEF	FLNG.FIG.8	.5	1.5		ASME-B16.48	ASTM A 105	150, FF/125AARH	FGK0121Z0	
FEF	FLNG.FIG.8	2	8		ASME-B16.48	ASTM A 105 (CHARPY)	150, FF/125AARH	FGK9821Z0	
FEF	SPCR&BLND	10	14		ASME-B16.48	ASTM A 105 (CHARPY)	150, FF/125AARH	FCK9821Z0	
Fitting Group									
ELB90	ELBOW.90	.5	.75		B-16.11	ASTM A 105	SW, 6000	WA602D3Z0	
ELB90	ELBOW.90	1	1.5		B-16.11	ASTM A 105	SW, 3000	WA602D2Z0	
ELB90	ELBOW.90	2	14	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW, 1.5D	WAGM84Z10	

Package : IPMCS
Report No. : 50

AA1A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA1A** Sheet 4 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
ELB45	ELBOW.45	.5	.75		B-16.11	ASTM A 105	SW, 6000	WB602D3Z0	
ELB45	ELBOW.45	1	1.5		B-16.11	ASTM A 105	SW, 3000	WB602D2Z0	
ELB45	ELBOW.45	2	14	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW, 1.5D	WBGM84Z10	
TEQ	T.EQUAL	.5	.75		B-16.11	ASTM A 105	SW, 6000	WE602D3Z0	
TEQ	T.EQUAL	1	1.5		B-16.11	ASTM A 105	SW, 3000	WE602D2Z0	
TEQ	T.EQUAL	2	14	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WEGM84ZZ0	
TRED	T.RED	.5	.75		B-16.11	ASTM A 105	SW, 6000	WR602D3Z0	
TRED	T.RED	1	1.5		B-16.11	ASTM A 105	SW, 3000	WR602D2Z0	
TRED	T.RED	2	14	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WRGM84ZZ0	
REDC	REDUC.CONC	2	14	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WUGM84ZZ0	
REDE	REDUC.ECC	2	14	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WVGM84ZZ0	
SWGC	SWAGE.CONC	.5	3	M, M	BS-3799	ASTM A 105 (CHARPY)	PBE	WNHM76ZZ0	
SWGE	SWAGE.ECC	.5	3	M, M	BS-3799	ASTM A 105 (CHARPY)	PBE	WPHM76ZZ0	
CAP	CAP	.5	.75		B-16.11	ASTM A 105	SCRF, 6000	WF60283Z0	
CAP	CAP	1	1.5		B-16.11	ASTM A 105	SCRF, 3000	WF60282Z0	
CAP	CAP	2	14	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WFGM84ZZ0	
CPLF	CPLNG.FULL	.5	.75		B-16.11	ASTM A 105	SW, 6000	WJ602D3Z0	
CPLF	CPLNG.FULL	1	1.5		B-16.11	ASTM A 105	SW, 3000	WJ602D2Z0	
CPLH	CPLNG.HALF	.5	.75		B-16.11	ASTM A 105	SW, 6000	WK602D3Z0	
CPLH	CPLNG.HALF	1	1.5		B-16.11	ASTM A 105	SW, 3000	WK602D2Z0	
CPLL	CPLNG.LH	.5	.75		B-16.11	ASTM A 105	SW, 6000	WL602D3Z0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA1A** Sheet 5 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
CPLL	CPLNG.LH	1	1.5		B-16.11	ASTM A 105	SW, 3000	WL602D2Z0	
CPLR	CPLNG.RED	.5	.75		B-16.11	ASTM A 105	SW, 6000	WM602D3Z0	
CPLR	CPLNG.RED	1	1.5		B-16.11	ASTM A 105	SW, 3000	WM602D2Z0	
O'let Group									
SLT	SOCKOLET	.5	.75		MSS-SP97	ASTM A 105	SW, 6000	YSS02D3Z0	
SLT	SOCKOLET	1	1.5		MSS-SP97	ASTM A 105	SW, 3000	YSS02D2Z0	
WLT	WELDOLET	2	4	M, XXS	MSS-SP97	ASTM A 105 (CHARPY)	BW	YWSM74ZZ0	
Bolt Group									
BOS	BOLT.STUD	.5	14		B-18.2	BOLT:A193 GR.B7, NUT:A194 GR.2H		BS40404Z0	124
Gasket Group									
GAS	GASKET	.5	14		B-16.20-ANSI B16.5	SP.WND SS316+GRAFIL	SPIRAL, 150	GK65072Z0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA1K** Sheet 1 of 4

PIPE CLASS : **AA1K**
RATING : 150
BASE MATERIAL : SS 304
CORROSION ALLOWANCE : 0 MM
SPECIAL REQUIREMENT :

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-29	38	50	100	150
PRESS	19.37	19.37	18.66	16	14.48

SERVICE

NATURAL GAS; UTILITIES (INST. AIR)

NOTES

101 PIPING DESIGN SHALL BE AS PER PNGRB REGULATIONS, OISD-226 AND ASME B31.8.

102 ALL VENTS AND DRAINS SHALL BE PROVIDED WITH BALL VALVE (WITH PUP-PIECE) WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

103 ALL ABOVE GROUND PIPING BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON THE NEXT PAGE. IN BURIED PIPING O'LETS SHALL NOT BE USED AND BRANCH CONNECTION SHALL BE DONE BY USING 'TEES' & REDUCERS AS REQUIRED. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARDS SHALL BE IGNORED.

110 NDT OF WELDS SHALL BE AS FOLLOWS:-
RADIOGRAPHY: ALL BUTT WELDS 100%
MPI: SOCKET WELDS 100%
ALL OTHER REQUIREMENTS SHALL BE AS PER NDT SPECIFICATION.

111 FOR MATERIAL DESCRIPTION OF VALVES APPLICABLE DATA SHEETS SHALL BE REFERRED.

124 ALL NUTS & BOLTS SHALL BE HOT DIP GALVANIZED AS PER ASTM A153

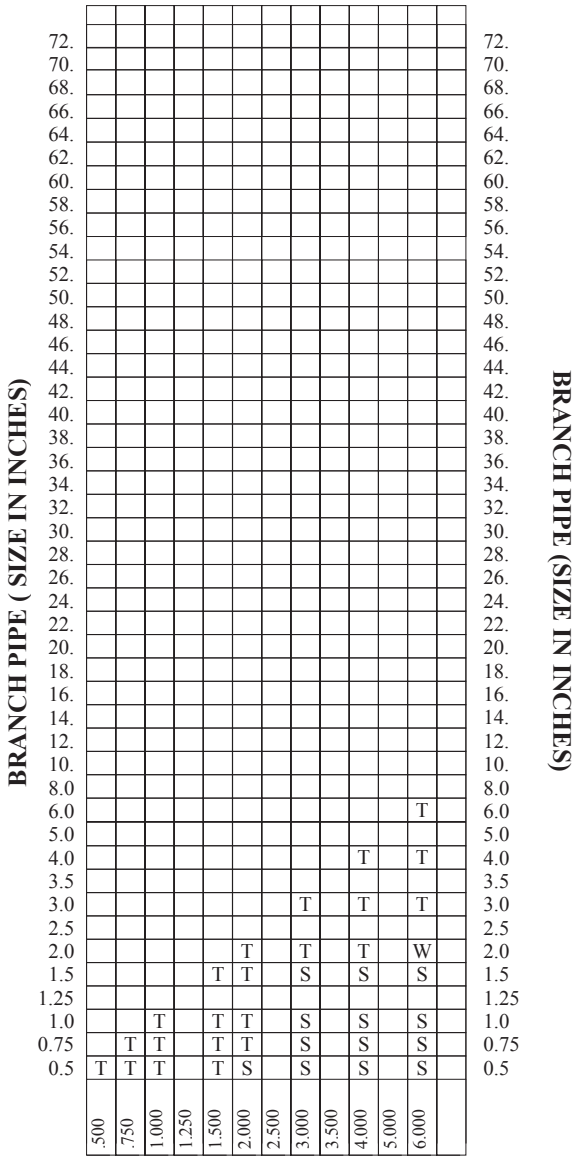
125 DETAILS OF STRAINER INDICATED HERE SHALL BE APPLICABLE ONLY FOR THOSE SIZES FOR WHICH SEPARATE DATASHEETS ARE NOT ATTACHED. FOR SIZES FOR WHICH SEPARATE DATASHEETS HAVE BEEN ATTACHED, DETAILS INDICATED HERE SHALL BE IGNORED.

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION	A.CODE
MAINTAINENCE JOINTS	ALL	FLANGED, TO BE KEPT MINIMUM	
PIPE JOINTS	1.5" & BELOW	SW COUPLING	
PIPE JOINTS	2" & ABOVE	BUTT WELDED	
DRAINS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
VENTS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
TEMPERATURE CONN.	1.5"	"FLANGED TYPE" AS PER EIL STD 7-44-0353. "WELDED TYPE" & "SKIN TYPE" AS PER INSTRUMENTATION STANDARD	
PRESSURE CONNECTION	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA1K** Sheet 2 of 4



CODE	DESCRIPTION				
F	SADDLE FUSED JT	**T**	TEES	**J**	THREADOLET
H	H. COUPLING	**W**	WELDOLETS		
P	PIPE TO PIPE	**I**	INSTRUMENT TEE		
R	REINFORCED	**X**	Refer Notes		
S	SOCKOLETS	**L**	SWEEPOLET		

Package : IPMCS
Report No. : 50

AA1K

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA1K** Sheet 3 of 4

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Pipe Group									
PIP	PIPE	.5	.75	80S	B-36.19	ASTM A 312 TP304	PE, SEAMLESS	PI33577Z0	
PIP	PIPE	1	1.5	40S	B-36.19	ASTM A 312 TP304	PE, SEAMLESS	PI33577Z0	
PIP	PIPE	2	6	40S	B-36.19	ASTM A 312 TP304	BE, SEAMLESS	PI33517Z0	
NIP	NIPPLE	.5	.75	M	B-36.19	ASTM A 312 TP304	PBE, SEAMLESS	PN33567Z0	
NIP	NIPPLE	1	1.5	M	B-36.19	ASTM A 312 TP304	PBE, SEAMLESS	PN33567Z0	
Flange Group									
FLG	FLNG.WN	.5	1.5	M	B-16.5	ASTM A 182 GR.F304	150, RF/125AARH	FWC4127Z0	
FLG	FLNG.WN	2	6	M	B-16.5	ASTM A 182 GR.F304	150, RF/125AARH	FWC4127Z0	
FLB	FLNG.BLIND	.5	6		B-16.5	ASTM A 182 GR.F304	150, RF/125AARH	FBC4127Z0	
FEF	FLNG.FIG.8	.5	6		ASME-B16.48	ASTM A 182 GR.F304	150, FF/125AARH	FGK4121Z0	
Fitting Group									
ELB90	ELBOW.90	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WA642D2Z0	
ELB90	ELBOW.90	2	6	M	B-16.9	ASTM A 403 GR.WP304-S	BW, 1.5D	WAG874Z10	
ELB45	ELBOW.45	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WB642D2Z0	
ELB45	ELBOW.45	2	6	M	B-16.9	ASTM A 403 GR.WP304-S	BW, 1.5D	WBG874Z10	
TEQ	T.EQUAL	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WE642D2Z0	
TEQ	T.EQUAL	2	6	M	B-16.9	ASTM A 403 GR.WP304-S	BW	WEG874ZZ0	
TRED	T.RED	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WR642D2Z0	
TRED	T.RED	2	6	M, M	B-16.9	ASTM A 403 GR.WP304-S	BW	WRG874ZZ0	
REDC	REDUC.CONC	2	6	M, M	B-16.9	ASTM A 403 GR.WP304-S	BW	WUG874ZZ0	
REDE	REDUC.ECC	2	6	M, M	B-16.9	ASTM A 403 GR.WP304-S	BW	WVG874ZZ0	
SWGC	SWAGE.CONC	.5	3	M, M	BS-3799	ASTM A 182 GR.F304	PBE	WNH426ZZ0	
SWGE	SWAGE.ECC	.5	3	M, M	BS-3799	ASTM A 182 GR.F304	PBE	WPH426ZZ0	
CAP	CAP	.5	1.5		B-16.11	ASTM A 182 GR.F304	SCRF, 3000	WF64282Z0	

Package : **IPMCS**
Report No. : **50**

AA1K

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA1K** Sheet 4 of 4

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
CAP	CAP	2	6	M	B-16.11	ASTM A 403 GR.WP304-S	BW	WF6874ZZ0	
CPLF	CPLNG.FULL	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WJ642D2Z0	
CPLH	CPLNG.HALF	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WK642D2Z0	
CPLL	CPLNG.LH	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WL642D2Z0	
CPLR	CPLNG.RED	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WM642D2Z0	
O'let Group									
SLT	SOCKOLET	.5	1.5		MSS-SP97	ASTM A 182 GR.F304	SW, 3000	YSS42D2Z0	
WLT	WELDOLET	2	2	M, M	MSS-SP97	ASTM A 182 GR.F304	BW	YWS424ZZ0	
Bolt Group									
BOS	BOLT.STUD	.5	6		B-18.2	BOLT:A193 GR.B7, NUT:A194 GR.2H		BS40404Z0	124
Gasket Group									
GAS	GASKET	.5	6		B-16.20-ANSI B16.5	SP.WND SS316+GRAFIL+ I RING	SPIRAL, 150	GK66272Z0	
Trap/Strainer Group									
TSR	STRNR.TEMP	1.5	6		EIL'STD	B:A240TP304;INT:SS304	CONETYPE, 150,FF/125AARH	ST14131Z0	125
PSR	STRNR.PERM	.5	1.5		MNF'STD	B:A182GR.F304;INT:SS304	SW, Y-TYPE, 800	SP307D510	125
PSR	STRNR.PERM	2	6	M	EIL'STD	B:A403GR.WP304-S;INT:SS304	BW, T-TYPE	SP15344Z0	125

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA3A** Sheet 1 of 5

PIPE CLASS : **AA3A**
RATING : 150
BASE MATERIAL : CARBON STEEL
CORROSION ALLOWANCE : 1.5 MM
SPECIAL REQUIREMENT :

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-29	38	50	65	100	150
PRESS	19.98	19.98	19.57	19.11	18.04	16.11

SERVICE

UTILITIES:- INST. AIR, PLANT AIR, NITROGEN, SERVICE WATER

NOTES

102 ALL VENTS AND DRAINS SHALL BE PROVIDED WITH BALL VALVE (WITH PUP-PIECE) WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

103 ALL ABOVE GROUND PIPING BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON THE NEXT PAGE. IN BURIED PIPING O'LETS SHALL NOT BE USED AND BRANCH CONNECTION SHALL BE DONE BY USING 'TEES' & REDUCERS AS REQUIRED. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARDS SHALL BE IGNORED.

123 NDT REQUIREMENTS SHALL BE AS PER NDT SPECIFICATION.

124 ALL NUTS & BOLTS SHALL BE HOT DIP GALVANIZED AS PER ASTM A153

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION	A.CODE
MAINTAINENCE JOINTS	ALL	FLANGED (TO BE KEPT MINIMUM)	
PIPE JOINTS	1.5" & BELOW	SW COUPLING	
PIPE JOINTS	2.0" & ABOVE	BUTTWELDED	
DRAINS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
VENTS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
TEMPERATURE CONN.	1.5"	"FLANGED TYPE" AS PER EIL STD 7-44-0353. "WELDED TYPE"& "SKIN TYPE"AS PER INSTRUMENTATION STANDARD	
PRESSURE CONNECTION	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA3A** Sheet 2 of 5

BRANCH PIPE (SIZE IN INCHES)

	.500	.750	1.000	1.250	1.500	2.000	2.500	3.000	3.500	4.000	5.000	6.000
72.												
70.												
68.												
66.												
64.												
62.												
60.												
58.												
56.												
54.												
52.												
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44.												
42.												
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30.												
28.												
26.												
24.												
22.												
20.												
18.												
16.												
14.												
12.												
10.												
8.0												
6.0												T
5.0												
4.0										T		T
3.5												
3.0								T		T		T
2.5												
2.0						T		T		T		T
1.5					T	T		S		S		S
1.25												
1.0			T		T	T		S		S		S
0.75		T	T		T	T		S		S		S
0.5	T	T	T		T	S		S		S		S

BRANCH PIPE (SIZE IN INCHES)

RUN PIPE (SIZE IN INCHES)

CODE	DESCRIPTION				
F	SADDLE FUSED JT	**T**	TEES	**J**	THREADOLET
H	H. COUPLING	**W**	WELDOLETS		
P	PIPE TO PIPE	**I**	INSTRUMENT TEE		
R	REINFORCED	**X**	Refer Notes		
S	SOCKOLETS	**L**	SWEEPOLET		

Package : **IPMCS**
Report No. : **50**

AA3A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA3A** Sheet 3 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Pipe Group									
PIP	PIPE	.5	.75	S160	B-36.10	ASTM A 106 GR.B	PE, SEAMLESS	PI21977Z0	
PIP	PIPE	1	1.5	XS	B-36.10	ASTM A 106 GR.B	PE, SEAMLESS	PI21977Z0	
PIP	PIPE	2	2	XS	B-36.10	ASTM A 106 GR.B (CHARPY)	BE, SEAMLESS	PI2H717Z0	
PIP	PIPE	3	6	STD	B-36.10	ASTM A 106 GR.B (CHARPY)	BE, SEAMLESS	PI2H717Z0	
NIP	NIPPLE	.5	1.5	M	B-36.10	ASTM A 106 GR.B	PBE, SEAMLESS	PN21967Z0	
Flange Group									
FLG	FLNG.WN	.5	1.5	M	B-16.5	ASTM A 105	150, RF/125AARH	FWC0127Z0	
FLG	FLNG.WN	2	6	M	B-16.5	ASTM A 105 (CHARPY)	150, RF/125AARH	FWC9827Z0	
FLB	FLNG.BLIND	.5	1.5		B-16.5	ASTM A 105	150, RF/125AARH	FBC0127Z0	
FLB	FLNG.BLIND	2	6		B-16.5	ASTM A 105 (CHARPY)	150, RF/125AARH	FBC9827Z0	
FEF	FLNG.FIG.8	.5	1.5		ASME-B16.48	ASTM A 105	150, FF/125AARH	FGK0121Z0	
FEF	FLNG.FIG.8	2	6		ASME-B16.48	ASTM A 105 (CHARPY)	150, FF/125AARH	FGK9821Z0	
Fitting Group									
ELB90	ELBOW.90	.5	.75		B-16.11	ASTM A 105	SW, 6000	WA602D3Z0	
ELB90	ELBOW.90	1	1.5		B-16.11	ASTM A 105	SW, 3000	WA602D2Z0	
ELB90	ELBOW.90	2	6	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW, 1.5D	WAGM84Z10	
ELB45	ELBOW.45	.5	.75		B-16.11	ASTM A 105	SW, 6000	WB602D3Z0	
ELB45	ELBOW.45	2	6	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW, 1.5D	WBGM84Z10	
TEQ	T.EQUAL	.5	.75		B-16.11	ASTM A 105	SW, 6000	WE602D2Z0	
TEQ	T.EQUAL	1	1.5		B-16.11	ASTM A 105	SW, 3000	WE602D2Z0	
TEQ	T.EQUAL	2	6	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WEGM84ZZ0	
TRED	T.RED	.5	1.5		B-16.11	ASTM A 105	SW, 3000	WR602D2Z0	
TRED	T.RED	1	1.5		B-16.11	ASTM A 105	SW, 3000	WR602D2Z0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA3A** Sheet 4 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
TRED	T.RED	2	6	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WRGM84ZZ0	
REDC	REDUC.CONC	2	6	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WUGM84ZZ0	
REDE	REDUC.ECC	2	6	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WVGM84ZZ0	
SWGC	SWAGE.CONC	.5	3	M, M	BS-3799	ASTM A 105	PBE	WNH026ZZ0	
SWGE	SWAGE.ECC	.5	3	M, M	BS-3799	ASTM A 105	PBE	WPH026ZZ0	
CAP	CAP	.5	.75		B-16.11	ASTM A 105	SCRF, 6000	WF60283Z0	
CAP	CAP	1	1.5		B-16.11	ASTM A 105	SCRF, 3000	WF60282Z0	
CAP	CAP	2	6	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WFGM84ZZ0	
CPLF	CPLNG.FULL	.5	.75		B-16.11	ASTM A 105	SW, 6000	WJ602D3Z0	
CPLF	CPLNG.FULL	1	1.5		B-16.11	ASTM A 105	SW, 3000	WJ602D2Z0	
CPLH	CPLNG.HALF	.5	.75		B-16.11	ASTM A 105	SW, 6000	WK602D3Z0	
CPLH	CPLNG.HALF	1	1.5		B-16.11	ASTM A 105	SW, 3000	WK602D2Z0	
CPLL	CPLNG.LH	.5	.75		B-16.11	ASTM A 105	SW, 6000	WL602D3Z0	
CPLL	CPLNG.LH	1	1.5		B-16.11	ASTM A 105	SW, 3000	WL602D2Z0	
CPLR	CPLNG.RED	.5	.75		B-16.11	ASTM A 105	SW, 6000	WM602D3Z0	
CPLR	CPLNG.RED	1	1.5		B-16.11	ASTM A 105	SW, 3000	WM602D2Z0	
UNN	UNION	.5	.75		BS-3799	ASTM A 105	SW, 6000	WQH02D3Z0	
UNN	UNION	1	1.5		BS-3799	ASTM A 105	SW, 3000	WQH02D2Z0	
O'let Group									
SLT	SOCKOLET	.5	.75		MSS-SP97	ASTM A 105	SW, 6000	YSS02D3Z0	
SLT	SOCKOLET	1	1.5		MSS-SP97	ASTM A 105	SW, 3000	YSS02D2Z0	
Bolt Group									

Package : **IPMCS**
Report No. : **50**

AA3A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA3A** Sheet 5 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Bolt Group									
BOM	BOLT.M/C	.5	6		B-18.2	BOLT:A193 GR.B7, NUT:A194 GR.2H		BM40404Z0	124
Gasket Group									
GAS	GASKET	.5	6		B-16.21-ANSI B16.5	SP.WND SS316+GRAFIL	SPIRAL, 150	GKB5072Z0	
Trap/Strainer Group									
TRP	TRAP.STEAM	.5	1.5		MNF'STD	B:A105;T:13%CR;S:SS304	FLGD, THRMDNMC, 150,RF/125AARH	TR3065530	
TSR	STRNR.TEMP	1.5	6		EIL'STD	B:A285GR.C;INT:SS304	CONETYPE, 150,FF/125AARH	ST14431Z0	
PSR	STRNR.PERM	.5	1.5		MNF'STD	B:A105;INT:SS304	SW, Y-TYPE, 800	SP303D510	
PSR	STRNR.PERM	2	6	M	EIL'STD	B:A234GR.WPB;INT:SS304	BW, T-TYPE	SP13344Z0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA4A** Sheet 1 of 5

PIPE CLASS : **AA4A**
RATING : 150
BASE MATERIAL : CARBON STEEL
CORROSION ALLOWANCE : 1.5 MM
SPECIAL REQUIREMENT : LOW TEMPERATURE SERVICE

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-45	38	50	65	100	150
PRESS	19.98	19.98	19.57	19.11	18.04	16.11

SERVICE

NATURAL GAS, LOW TEMPERATURE SERVICE

NOTES

101 PIPING DESIGN SHALL BE AS PER PNGRB REGULATIONS, OISD-226 AND ASME B31.8.

102 ALL VENTS AND DRAINS SHALL BE PROVIDED WITH BALL VALVE (WITH PUP-PIECE) WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

103 ALL ABOVE GROUND PIPING BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON THE NEXT PAGE. IN BURIED PIPING O'LETS SHALL NOT BE USED AND BRANCH CONNECTION SHALL BE DONE BY USING 'TEES' & REDUCERS AS REQUIRED. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARDS SHALL BE IGNORED.

110 NDT OF WELDS SHALL BE AS FOLLOWS:-
RADIOGRAPHY: ALL BUTT WELDS 100%
MPI: SOCKET WELDS 100%
ALL OTHER REQUIREMENTS SHALL BE AS PER NDT SPECIFICATION.

111 FOR MATERIAL DESCRIPTION OF VALVES APPLICABLE DATA SHEETS SHALL BE REFERRED.

112 IMPACT TESTING IS REQUIRED AS PER APPLICABLE STANDARD.

113 FOR DIMENSIONS OF HANDLE PROJECTION FOR SPACER & BLIND, REFER EIL STD. NO. 7-44-0166.

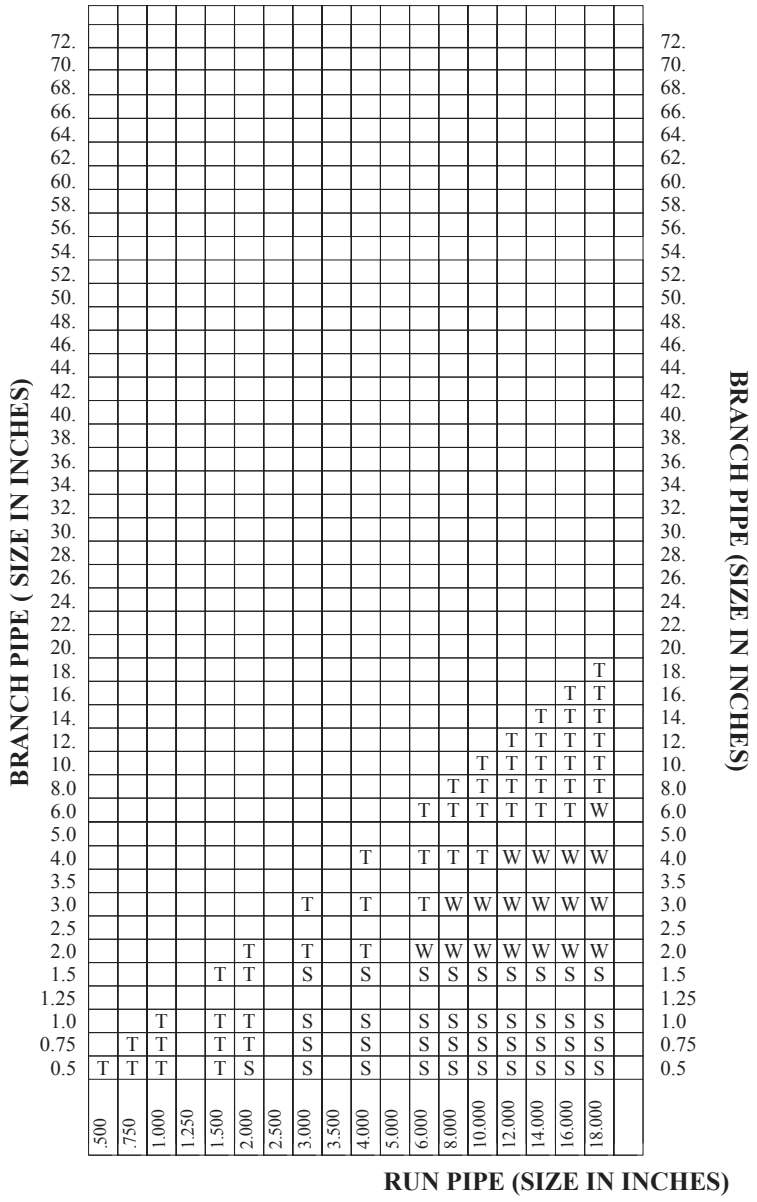
124 ALL NUTS & BOLTS SHALL BE HOT DIP GALVANIZED AS PER ASTM A153

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION	A.CODE
MAINTAINENCE JOINTS	ALL	FLANGED, TO BE KEPT MINIMUM	
PIPE JOINTS	1.5" & BELOW	SW COUPLING	
PIPE JOINTS	2.0" & ABOVE	BUTTWELDED	
DRAINS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
VENTS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
TEMPERATURE CONN.	1.5"	"FLANGED TYPE" AS PER EIL STD 7-44-0353. "WELDED TYPE" &"SKIN TYPE"AS PER INSTRUMENTATION STANDARD	
PRESSURE CONNECTION	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA4A** Sheet 2 of 5



CODE	DESCRIPTION				
F	SADDLE FUSED JT	**T**	TEES	**J**	THREADOLET
H	H. COUPLING	**W**	WELDOLETS		
P	PIPE TO PIPE	**I**	INSTRUMENT TEE		
R	REINFORCED	**X**	Refer Notes		
S	SOCKOLETS	**L**	SWEEPOLET		

Package : **IPMCS**
Report No. : **50**

AA4A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA4A** Sheet 3 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Pipe Group									
PIP	PIPE	.5	.75	S160	B-36.10	ASTM A 333 GR.6	PE, SEAMLESS	PI24677Z5	
PIP	PIPE	1	1.5	XS	B-36.10	ASTM A 333 GR.6	PE, SEAMLESS	PI24677Z5	
PIP	PIPE	2	2	XS	B-36.10	ASTM A 333 GR.6	BE, SEAMLESS	PI24617Z5	
PIP	PIPE	3	18	STD	B-36.10	ASTM A 333 GR.6	BE, SEAMLESS	PI24617Z5	
NIP	NIPPLE	.5	.75	M	B-36.10	ASTM A 333 GR.6	PBE, SEAMLESS	PN24667Z5	
NIP	NIPPLE	1	1.5	M	B-36.10	ASTM A 333 GR.6	PBE, SEAMLESS	PN24667Z5	
Flange Group									
FLG	FLNG.WN	.5	18	M	B-16.5	ASTM A 350 GR.LF2 CL.1	150, RF/125AARH	FWCD727Z5	
FLB	FLNG.BLIND	.5	18		B-16.5	ASTM A 350 GR.LF2 CL.1	150, RF/125AARH	FBCD727Z5	
FEF	FLNG.FIG.8	.5	8		ASME-B16.48	ASTM A 350 GR.LF2 CL.1	150, FF/125AARH	FGKD721Z5	
FEF	SPCR&BLND	10	18		ASME-B16.48	ASTM A 350 GR.LF2 CL.1	150, FF/125AARH	FCKD721Z5	
Fitting Group									
ELB90	ELBOW.90	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WA6T7D3Z5	
ELB90	ELBOW.90	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WA6T7D2Z5	
ELB90	ELBOW.90	2	16	M	B-16.9	ASTM A 420 GR.WPL6	BW, 1.5D	WAGB44Z15	
ELB90	ELBOW.90	18	18	M	B-16.9	ASTM A 420 GR.WPL6-W	BW, 1.5D	WAGB54Z15	
ELB45	ELBOW.45	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WB6T7D3Z5	
ELB45	ELBOW.45	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WB6T7D2Z5	
ELB45	ELBOW.45	2	16	M	B-16.9	ASTM A 420 GR.WPL6	BW, 1.5D	WBGB44Z15	
ELB45	ELBOW.45	18	18	M	B-16.9	ASTM A 420 GR.WPL6-W	BW, 1.5D	WBGB54Z15	
TEQ	T.EQUAL	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WE6T7D3Z5	
TEQ	T.EQUAL	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WE6T7D2Z5	
TEQ	T.EQUAL	2	16	M	B-16.9	ASTM A 420 GR.WPL6	BW	WEGB44ZZ5	
TEQ	T.EQUAL	18	18	M	B-16.9	ASTM A 420 GR.WPL6-W	BW	WEGB54ZZ5	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA4A** Sheet 4 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
TRED	T.RED	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WR6T7D3Z5	
TRED	T.RED	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WR6T7D2Z5	
TRED	T.RED	2	16	M, M	B-16.9	ASTM A 420 GR.WPL6	BW	WRGB44ZZ5	
TRED	T.RED	18	18	M, M	B-16.9	ASTM A 420 GR.WPL6-W	BW	WRGB54ZZ5	
REDC	REDUC.CONC	2	16	M, M	B-16.9	ASTM A 420 GR.WPL6	BW	WUGB44ZZ5	
REDC	REDUC.CONC	18	18	M, M	B-16.9	ASTM A 420 GR.WPL6-W	BW	WUGB54ZZ5	
REDE	REDUC.ECC	2	16	M, M	B-16.9	ASTM A 420 GR.WPL6	BW	WVGB44ZZ5	
REDE	REDUC.ECC	18	18	M, M	B-16.9	ASTM A 420 GR.WPL6-W	BW	WVGB54ZZ5	
SWGC	SWAGE.CONC	.5	3	M, M	BS-3799	ASTM A 350 GR.LF2 CL.1	PBE	WNHT76ZZ5	
SWGE	SWAGE.ECC	.5	3	M, M	BS-3799	ASTM A 350 GR.LF2 CL.1	PBE	WPHT76ZZ5	
CAP	CAP	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SCRF, 6000	WF6T783Z5	
CAP	CAP	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SCRF, 3000	WF6T782Z5	
CAP	CAP	2	16	M	B-16.9	ASTM A 420 GR.WPL6	BW	WFGB44ZZ5	
CAP	CAP	18	18	M	B-16.9	ASTM A 420 GR.WPL6-W	BW	WFGB54ZZ5	
CPLF	CPLNG.FULL	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WJ6T7D3Z5	
CPLF	CPLNG.FULL	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WJ6T7D2Z5	
CPLH	CPLNG.HALF	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WK6T7D3Z5	
CPLH	CPLNG.HALF	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WK6T7D2Z5	
CPLL	CPLNG.LH	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WL6T7D3Z5	
CPLL	CPLNG.LH	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WL6T7D2Z5	
CPLR	CPLNG.RED	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WM6T7D3Z5	
CPLR	CPLNG.RED	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WM6T7D2Z5	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : AA4A** Sheet 5 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
O'let Group									
SLT	SOCKOLET	.5	.75		MSS-SP97	ASTM A 350 GR.LF2 CL.1	SW, 6000	YSST7D3Z5	
SLT	SOCKOLET	1	1.5		MSS-SP97	ASTM A 350 GR.LF2 CL.1	SW, 3000	YSST7D2Z5	
WLT	WELDOLET	2	6	M, XXS	MSS-SP97	ASTM A 350 GR.LF2 CL.1	BW	YWST74ZZ5	
Bolt Group									
BOS	BOLT.STUD	.5	16		B-18.2	BOLT:A320 GR.L7, NUT:A194 GR.4		BS42007Z5	124
Gasket Group									
GAS	GASKET	.5	16		B-16.20-ANSI B16.5	SP.WND SS316+GRAFIL	SPIRAL, 150	GK65072Z5	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA1A** Sheet 1 of 7

PIPE CLASS : **BA1A**
RATING : 300
BASE MATERIAL : CARBON STEEL
CORROSION ALLOWANCE : 1.5 MM
SPECIAL REQUIREMENT :

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-29	38	50	65	100	150
PRESS	52.1	52.1	51.08	50.01	47.51	45.98

SERVICE

NATURAL GAS

NOTES

101 PIPING DESIGN SHALL BE AS PER PNGRB REGULATIONS, OISD-226 AND ASME B31.8.

102 ALL VENTS AND DRAINS SHALL BE PROVIDED WITH BALL VALVE (WITH PUP-PIECE) WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

103 ALL ABOVE GROUND PIPING BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON THE NEXT PAGE. IN BURIED PIPING O'LETS SHALL NOT BE USED AND BRANCH CONNECTION SHALL BE DONE BY USING 'TEES' & REDUCERS AS REQUIRED. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARDS SHALL BE IGNORED.

108 CHARPY V NOTCH TEST AND HARDNESS TEST SHALL BE CONDUCTED FOR SIZE 2 INCH AND ABOVE PIPES, FITTINGS, O'LETS AND FLANGES. THE AVERAGE ABSORBED ENERGY OF THREE FULL SIZED SPECIMENS SHALL BE 27J. THE MINIMUM IMPACT ENERGY VALUE OF ANY ONE OF THE THREE SPECIMENS ANALYZED ABOVE SHALL NOT BE LESS THAN 22J.

110 NDT OF WELDS SHALL BE AS FOLLOWS:-
RADIOGRAPHY: ALL BUTT WELDS 100%
MPI: SOCKET WELDS 100%
ALL OTHER REQUIREMENTS SHALL BE AS PER NDT SPECIFICATION.

111 FOR MATERIAL DESCRIPTION OF VALVES APPLICABLE DATA SHEETS SHALL BE REFERRED.

113 FOR DIMENSIONS OF HANDLE PROJECTION FOR SPACER & BLIND, REFER EIL STD. NO. 7-44-0166.

114 THESE WELDOLETS SHALL BE USED WHEN WELDOLET IS DIRECTLY WELDED TO MAIN PIPELINE IN ABOVEGROUND SECTION

115 THESE FLANGES SHALL BE USED FOR WELDING WITH MAIN PIPELINE IN ABOVEGROUND SECTION, NEAR SCRAPER TRAPS

118 THIS ITEM REFERS TO MAIN 18" PIPELINE FROM GPU-GANDHAR TO NTPC-JHANORE

124 ALL NUTS & BOLTS SHALL BE HOT DIP GALVANIZED AS PER ASTM A153

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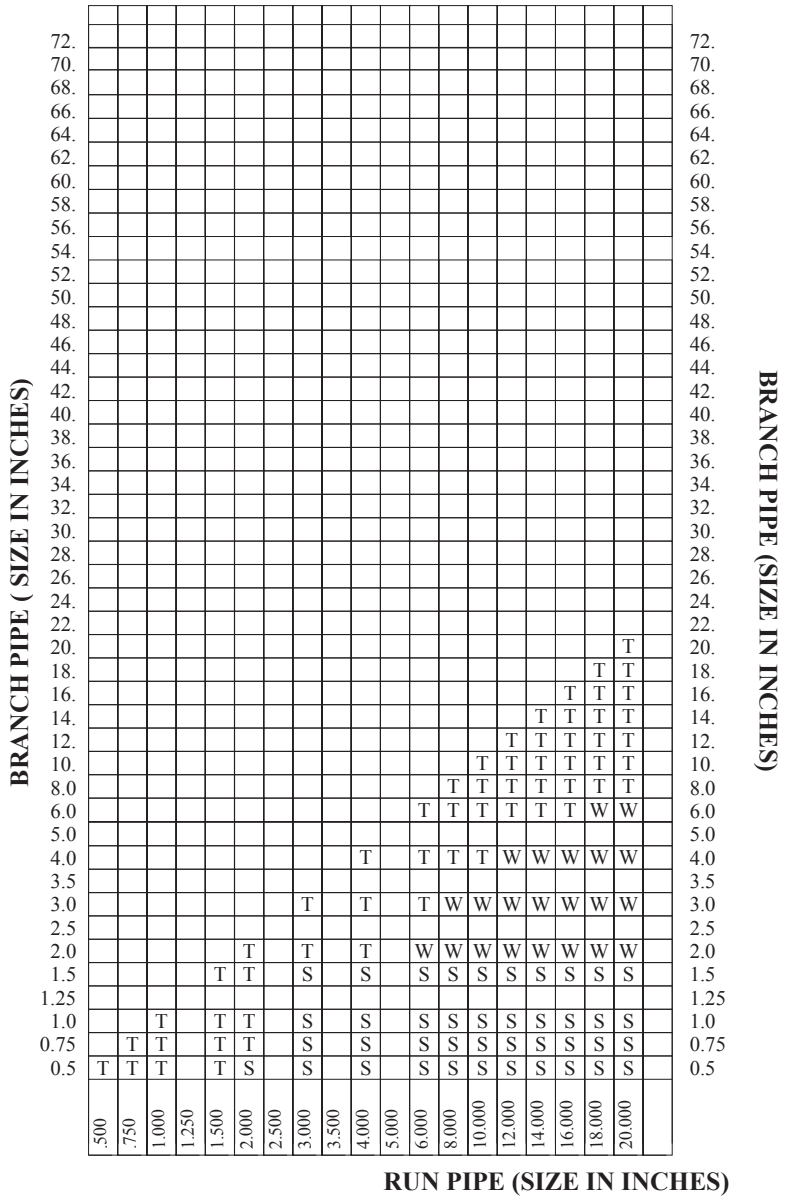
Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA1A** Sheet 2 of 7

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION	A.CODE
MAINTAINENCE JOINTS	ALL	FLANGED (TO BE KEPT MINIMUM)	
PIPE JOINTS	1.5" & BELOW	SW COUPLING	
PIPE JOINTS	2.0" & ABOVE	BUTTWELDED	
DRAINS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
VENTS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
TEMPERATURE CONN.	1.5"	"FLANGED TYPE" AS PER EIL STD 7-44-0353. "WELDED TYPE"& "SKIN TYPE"AS PER INSTRUMENTATION STANDARD	
PRESSURE CONNECTION	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA1A** Sheet 3 of 7



RUN PIPE (SIZE IN INCHES)

CODE	DESCRIPTION				
F	SADDLE FUSED JT	**T**	TEES	**J**	THREADOLET
H	H. COUPLING	**W**	WELDOLETS		
P	PIPE TO PIPE	**I**	INSTRUMENT TEE		
R	REINFORCED	**X**	Refer Notes		
S	SOCKOLETS	**L**	SWEEPOLET		

Package : **IPMCS**
Report No. : **50**

BA1A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA1A** Sheet 4 of 7

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Pipe Group									
PIP	PIPE	.5	.75	S160	B-36.10	ASTM A 106 GR.B	PE, SEAMLESS	PI21977Z0	
PIP	PIPE	1	1.5	XS	B-36.10	ASTM A 106 GR.B	PE, SEAMLESS	PI21977Z0	
PIP	PIPE	2	2	XS	B-36.10	ASTM A 106 GR.B (CHARPY)	BE, SEAMLESS	PI2H717Z0	
PIP	PIPE	3	6	STD	B-36.10	ASTM A 106 GR.B (CHARPY)	BE, SEAMLESS	PI2H717Z0	
PIP	PIPE	8	8	7.9	API 5L	API 5L GR.B PSL2	BE, SEAMLESS	PIAF817Z0	
PIP	PIPE	10	10	9.3	API 5L	API 5L GR.B PSL2	BE, SEAMLESS	PIAF817Z0	
PIP	PIPE	12	12	10.3	API 5L	API 5L GR.B PSL2	BE, SEAMLESS	PIAF817Z0	
PIP	PIPE	14	14	11.1	API 5L	API 5L GR.B PSL2	BE, SEAMLESS	PIAF817Z0	
PIP	PIPE	16	16	12.7	API 5L	API 5L GR.B PSL2	BE, SAW	PIAF816Z0	
PIP	PIPE	18	18	14.3	API 5L	API 5L GR.B PSL2	BE, SAW	PIAF816Z0	
PIP	PIPE	20	20	15.9	API 5L	API 5L GR.B PSL2	BE, SAW	PIAF816Z0	
PIP/3	PIPE	18	18	9.5	API 5L	API 5L GR.X-70 PSL2	BE, SAW	PIAH416Z0	118
NIP	NIPPLE	.5	.75	M	B-36.10	ASTM A 106 GR.B	PBE, SEAMLESS	PN21967Z0	
NIP	NIPPLE	1	1.5	M	B-36.10	ASTM A 106 GR.B	PBE, SEAMLESS	PN21967Z0	
Flange Group									
FLG	FLNG.SW	.5	1.5	M	B-16.5	ASTM A 105	300, RF/125AARH	FSC0147Z0	
FLG	FLNG.WN	2	20	M	B-16.5	ASTM A 105 (CHARPY)	300, RF/125AARH	FWC9847Z0	
FLG/300	FLNG.WN	18	18	M	B-16.5	ASTM A 694 GR.F-70 (CHARPY)	300, RF/125AARH	FWCA647Z0	115
FLB	FLNG.BLIND	.5	1.5		B-16.5	ASTM A 105	300, RF/125AARH	FBC0147Z0	
FLB	FLNG.BLIND	2	20		B-16.5	ASTM A 105 (CHARPY)	300, RF/125AARH	FBC9847Z0	
FEF	FLNG.FIG.8	.5	1.5		ASME-B16.48	ASTM A 105	300, FF/125AARH	FGK0141Z0	
FEF	FLNG.FIG.8	2	8		ASME-B16.48	ASTM A 105 (CHARPY)	300, FF/125AARH	FGK9841Z0	
FEF	SPCR&BLND	10	20		ASME-B16.48	ASTM A 105 (CHARPY)	300, FF/125AARH	FCK9841Z0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA1A** Sheet 5 of 7

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
ELB90	ELBOW.90	.5	.75		B-16.11	ASTM A 105	SW, 6000	WA602D3Z0	
ELB90	ELBOW.90	1	1.5		B-16.11	ASTM A 105	SW, 3000	WA602D2Z0	
ELB90	ELBOW.90	2	16	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW, 1.5D	WAGM84Z10	
ELB90	ELBOW.90	18	20	M	B-16.9	ASTM A 234 GR.WPB-W (CHARPY)	BW, 1.5D	WAGM94Z10	
ELB45	ELBOW.45	.5	.75		B-16.11	ASTM A 105	SW, 6000	WB602D3Z0	
ELB45	ELBOW.45	1	1.5		B-16.11	ASTM A 105	SW, 3000	WB602D2Z0	
ELB45	ELBOW.45	2	16	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW, 1.5D	WBGM84Z10	
ELB45	ELBOW.45	18	20	M	B-16.9	ASTM A 234 GR.WPB-W (CHARPY)	BW, 1.5D	WBGM94Z10	
TEQ	T.EQUAL	.5	.75		B-16.11	ASTM A 105	SW, 6000	WE602D3Z0	
TEQ	T.EQUAL	1	1.5		B-16.11	ASTM A 105	SW, 3000	WE602D2Z0	
TEQ	T.EQUAL	2	16	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WEGM84ZZ0	
TEQ	T.EQUAL	18	20	M	B-16.9	ASTM A 234 GR.WPB-W (CHARPY)	BW	WEGM94ZZ0	
TRED	T.RED	.5	.75		B-16.11	ASTM A 105	SW, 6000	WR602D3Z0	
TRED	T.RED	1	1.5		B-16.11	ASTM A 105	SW, 3000	WR602D2Z0	
TRED	T.RED	2	16	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WRGM84ZZ0	
TRED	T.RED	18	20	M, M	B-16.9	ASTM A 234 GR.WPB-W (CHARPY)	BW	WRGM94ZZ0	
REDC	REDUC.CONC	2	16	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WUGM84ZZ0	
REDC	REDUC.CONC	18	20	M, M	B-16.9	ASTM A 234 GR.WPB-W (CHARPY)	BW	WUGM94ZZ0	
REDE	REDUC.ECC	2	16	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WVGM84ZZ0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA1A** Sheet 6 of 7

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
REDE	REDUC.ECC	18	20	M, M	B-16.9	ASTM A 234 GR.WPB-W (CHARPY)	BW	WVGM94ZZ0	
SWGC	SWAGE.CONC	.5	3	M, M	BS-3799	ASTM A 105 (CHARPY)	PBE	WNHM76ZZ0	
SWGE	SWAGE.ECC	.5	3	M, M	BS-3799	ASTM A 105 (CHARPY)	PBE	WPHM76ZZ0	
CAP	CAP	.5	.75		B-16.11	ASTM A 105	SCRF, 6000	WF60283Z0	
CAP	CAP	1	1.5		B-16.11	ASTM A 105	SCRF, 3000	WF60282Z0	
CAP	CAP	2	16	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WFGM84ZZ0	
CAP	CAP	18	20	M	B-16.9	ASTM A 234 GR.WPB-W (CHARPY)	BW	WFGM94ZZ0	
PLG	PLUG	.5	.75		B-16.11	ASTM A 105	SCRM, 6000	WH60293Z0	
PLG	PLUG	1	1.5		B-16.11	ASTM A 105	SCRM, 3000	WH60292Z0	
CPLF	CPLNG.FULL	.5	.75		B-16.11	ASTM A 105	SW, 6000	WJ602D3Z0	
CPLF	CPLNG.FULL	1	1.5		B-16.11	ASTM A 105	SW, 3000	WJ602D2Z0	
CPLH	CPLNG.HALF	.5	.75		B-16.11	ASTM A 105	SW, 6000	WK602D3Z0	
CPLH	CPLNG.HALF	1	1.5		B-16.11	ASTM A 105	SW, 3000	WK602D2Z0	
CPLL	CPLNG.LH	.5	.75		B-16.11	ASTM A 105	SW, 6000	WL602D3Z0	
CPLL	CPLNG.LH	1	1.5		B-16.11	ASTM A 105	SW, 3000	WL602D2Z0	
CPLR	CPLNG.RED	.5	.75		B-16.11	ASTM A 105	SW, 6000	WM602D3Z0	
CPLR	CPLNG.RED	1	1.5		B-16.11	ASTM A 105	SW, 3000	WM602D2Z0	
O'let Group									
SLT	SOCKOLET	.5	.75		MSS-SP97	ASTM A 105	SW, 6000	YSS02D3Z0	
SLT	SOCKOLET	1	1.5		MSS-SP97	ASTM A 105	SW, 3000	YSS02D2Z0	
WLT	WELDOLET	2	6	M, XXS	MSS-SP97	ASTM A 105 (CHARPY)	BW	YWSM74ZZ0	
WLT/2	WELDOLET	2	6	M, XXS	MSS-SP97	ASTM A 694 GR.F-70 (CHARPY)	BW	YWSN74ZZ0	114

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA1A** Sheet 7 of 7

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Bolt Group									
BOS	BOLT.STUD	.5	20		B-18.2	BOLT:A193 GR.B7, NUT:A194 GR.2H		BS40404Z0	124
Gasket Group									
GAS	GASKET	.5	20		B-16.20-ANSI B16.5	SP.WND SS316+GRAFIL	SPIRAL, 300	GK65074Z0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA1K** Sheet 1 of 4

PIPE CLASS : **BA1K**
RATING : 300
BASE MATERIAL : SS 304
CORROSION ALLOWANCE : 0 MM
SPECIAL REQUIREMENT :

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-29	38	50	100	150
PRESS	50.58	50.58	48.74	41.71	37.73

SERVICE

NATURAL GAS

NOTES

101 PIPING DESIGN SHALL BE AS PER PNGRB REGULATIONS, OISD-226 AND ASME B31.8.

102 ALL VENTS AND DRAINS SHALL BE PROVIDED WITH BALL VALVE (WITH PUP-PIECE) WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

103 ALL ABOVE GROUND PIPING BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON THE NEXT PAGE. IN BURIED PIPING O'LETS SHALL NOT BE USED AND BRANCH CONNECTION SHALL BE DONE BY USING 'TEES' & REDUCERS AS REQUIRED. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARDS SHALL BE IGNORED.

110 NDT OF WELDS SHALL BE AS FOLLOWS:-
RADIOGRAPHY: ALL BUTT WELDS 100%
MPI: SOCKET WELDS 100%
ALL OTHER REQUIREMENTS SHALL BE AS PER NDT SPECIFICATION.

111 FOR MATERIAL DESCRIPTION OF VALVES APPLICABLE DATA SHEETS SHALL BE REFERRED.

124 ALL NUTS & BOLTS SHALL BE HOT DIP GALVANIZED AS PER ASTM A153

125 DETAILS OF STRAINER INDICATED HERE SHALL BE APPLICABLE ONLY FOR THOSE SIZES FOR WHICH SEPARATE DATASHEETS ARE NOT ATTACHED. FOR SIZES FOR WHICH SEPARATE DATASHEETS HAVE BEEN ATTACHED, DETAILS INDICATED HERE SHALL BE IGNORED.

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION	A.CODE
MAINTENANCE JOINTS	ALL	FLANGED, TO BE KEPT MINIMUM	
PIPE JOINTS	1.5" & BELOW	SW COUPLING	
PIPE JOINTS	2" & ABOVE	BUTT WELDED	
DRAINS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
VENTS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
TEMPERATURE CONN.	1.5"	"FLANGED TYPE" AS PER EIL STD 7-44-0353 "WELDED TYPE" & "SKIN TYPE" AS PER INSTRUMENTATION STANDARD	
PRESSURE CONNECTION	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA1K** Sheet 2 of 4

BRANCH PIPE (SIZE IN INCHES)

	.500	.750	1.000	1.250	1.500	2.000	2.500	3.000	3.500	4.000	5.000	6.000
72.												
70.												
68.												
66.												
64.												
62.												
60.												
58.												
56.												
54.												
52.												
50.												
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5.0												
4.0										T		T
3.5												
3.0								T		T		T
2.5												
2.0						T		T		T		W
1.5					T	T		S		S		S
1.25												
1.0			T		T	T		S		S		S
0.75		T	T		T	T		S		S		S
0.5	T	T	T		T	S		S		S		S

BRANCH PIPE (SIZE IN INCHES)

RUN PIPE (SIZE IN INCHES)

CODE	DESCRIPTION				
F	SADDLE FUSED JT	**T**	TEES	**J**	THREADOLET
H	H. COUPLING	**W**	WELDOLETS		
P	PIPE TO PIPE	**I**	INSTRUMENT TEE		
R	REINFORCED	**X**	Refer Notes		
S	SOCKOLETS	**L**	SWEEPOLET		

Package : **IPMCS**
Report No. : **50**

BA1K

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA1K** Sheet 3 of 4

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Pipe Group									
PIP	PIPE	.5	.75	80S	B-36.19	ASTM A 312 TP304	PE, SEAMLESS	PI33577Z0	
PIP	PIPE	1	1.5	40S	B-36.19	ASTM A 312 TP304	PE, SEAMLESS	PI33577Z0	
PIP	PIPE	2	6	40S	B-36.19	ASTM A 312 TP304	BE, SEAMLESS	PI33517Z0	
NIP	NIPPLE	.5	.75	M	B-36.19	ASTM A 312 TP304	PBE, SEAMLESS	PN33567Z0	
NIP	NIPPLE	1	1.5	M	B-36.19	ASTM A 312 TP304	PBE, SEAMLESS	PN33567Z0	
Flange Group									
FLG	FLNG.SW	.5	1.5	M	B-16.5	ASTM A 182 GR.F304	300, RF/125AARH	FSC4147Z0	
FLG	FLNG.WN	2	6	M	B-16.5	ASTM A 182 GR.F304	300, RF/125AARH	FWC4147Z0	
FLB	FLNG.BLIND	.5	6		B-16.5	ASTM A 182 GR.F304	300, RF/125AARH	FBC4147Z0	
FEF	FLNG.FIG.8	.5	6		ASME-B16.48	ASTM A 182 GR.F304	300, FF/125AARH	FGK4141Z0	
Fitting Group									
ELB90	ELBOW.90	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WA642D2Z0	
ELB90	ELBOW.90	2	6	M	B-16.9	ASTM A 403 GR.WP304-S	BW, 1.5D	WAG874Z10	
ELB45	ELBOW.45	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WB642D2Z0	
ELB45	ELBOW.45	2	6	M	B-16.9	ASTM A 403 GR.WP304-S	BW, 1.5D	WBG874Z10	
TEQ	T.EQUAL	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WE642D2Z0	
TEQ	T.EQUAL	2	6	M	B-16.9	ASTM A 403 GR.WP304-S	BW	WEG874ZZ0	
TRED	T.RED	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WR642D2Z0	
TRED	T.RED	2	6	M, M	B-16.9	ASTM A 403 GR.WP304-S	BW	WRG874ZZ0	
REDC	REDUC.CONC	2	6	M, M	B-16.9	ASTM A 403 GR.WP304-S	BW	WUG874ZZ0	
REDE	REDUC.ECC	2	6	M, M	B-16.9	ASTM A 403 GR.WP304-S	BW	WVG874ZZ0	
SWGC	SWAGE.CONC	.5	3	M, M	BS-3799	ASTM A 182 GR.F304	PBE	WNH426ZZ0	
SWGE	SWAGE.ECC	.5	3	M, M	BS-3799	ASTM A 182 GR.F304	PBE	WPH426ZZ0	
CAP	CAP	.5	1.5		B-16.11	ASTM A 182 GR.F304	SCRF, 3000	WF64282Z0	

Package : **IPMCS**
Report No. : **50**

BA1K

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA1K** Sheet 4 of 4

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
CAP	CAP	2	6	M	B-16.11	ASTM A 403 GR.WP304-S	BW	WF6874ZZ0	
CPLF	CPLNG.FULL	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WJ642D2Z0	
CPLH	CPLNG.HALF	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WK642D2Z0	
CPLL	CPLNG.LH	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WL642D2Z0	
CPLR	CPLNG.RED	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WM642D2Z0	
O'let Group									
SLT	SOCKOLET	.5	1.5		MSS-SP97	ASTM A 182 GR.F304	SW, 3000	YSS42D2Z0	
WLT	WELDOLET	2	2	M, M	MSS-SP97	ASTM A 182 GR.F304	BW	YWS424ZZ0	
Bolt Group									
BOS	BOLT.STUD	.5	6		B-18.2	BOLT:A193 GR.B7, NUT:A194 GR.2H		BS40404Z0	124
Gasket Group									
GAS	GASKET	.5	6		B-16.20-ANSI B16.5	SP.WND SS316+GRAFIL+ I RING	SPIRAL, 300	GK66274Z0	
Trap/Strainer Group									
TSR	STRNR.TEMP	1.5	6		EIL'STD	B:A240TP304;INT:SS304	CONETYPE, 300,FF/125AARH	ST14139Z0	125
PSR	STRNR.PERM	.5	1.5		MNF'STD	B:A182GR.F304;INT:SS304	SW, Y-TYPE, 800	SP307D510	125
PSR	STRNR.PERM	2	6	M	EIL'STD	B:A403GR.WP304-S;INT:SS304	BW, T-TYPE	SP15344Z0	125

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA3A** Sheet 1 of 5

PIPE CLASS : **BA3A**
RATING : 300
BASE MATERIAL : CARBON STEEL
CORROSION ALLOWANCE : 1.5 MM
SPECIAL REQUIREMENT :

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-29	38	50	65	100	150
PRESS	52.1	52.1	51.08	50.01	47.51	45.98

SERVICE

UTILITIES:- INST. AIR, PLANT AIR, NITROGEN, SERVICE WATER

NOTES

102 ALL VENTS AND DRAINS SHALL BE PROVIDED WITH BALL VALVE (WITH PUP-PIECE) WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

103 ALL ABOVE GROUND PIPING BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON THE NEXT PAGE. IN BURIED PIPING O'LETS SHALL NOT BE USED AND BRANCH CONNECTION SHALL BE DONE BY USING 'TEES' & REDUCERS AS REQUIRED. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARDS SHALL BE IGNORED.

123 NDT REQUIREMENTS SHALL BE AS PER NDT SPECIFICATION.

124 ALL NUTS & BOLTS SHALL BE HOT DIP GALVANIZED AS PER ASTM A153

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION	A.CODE
MAINTAINENCE JOINTS	ALL	FLANGED (TO BE KEPT MINIMUM)	
PIPE JOINTS	1.5" & BELOW	SW COUPLING	
PIPE JOINTS	2.0" & ABOVE	BUTTWELDED	
DRAINS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
VENTS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
TEMPERATURE CONN.	1.5"	"FLANGED TYPE" AS PER EIL STD 7-44-0353. "WELDED TYPE"& "SKIN TYPE"AS PER INSTRUMENTATION STANDARD	
PRESSURE CONNECTION	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA3A** Sheet 2 of 5

BRANCH PIPE (SIZE IN INCHES)

	.500	.750	1.000	1.250	1.500	2.000	2.500	3.000	3.500	4.000	5.000	6.000
72.												
70.												
68.												
66.												
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2.0						T		T		T		T
1.5					T	T		S		S		S
1.25												
1.0			T		T	T		S		S		S
0.75		T	T		T	T		S		S		S
0.5	T	T	T		T	S		S		S		S

BRANCH PIPE (SIZE IN INCHES)

RUN PIPE (SIZE IN INCHES)

CODE	DESCRIPTION				
F	SADDLE FUSED JT	**T**	TEES	**J**	THREADOLET
H	H. COUPLING	**W**	WELDOLETS		
P	PIPE TO PIPE	**I**	INSTRUMENT TEE		
R	REINFORCED	**X**	Refer Notes		
S	SOCKOLETS	**L**	SWEEPOLET		

Package : **IPMCS**
Report No. : **50**

BA3A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA3A** Sheet 3 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Pipe Group									
PIP	PIPE	.5	.75	S160	B-36.10	ASTM A 106 GR.B	PE, SEAMLESS	PI21977Z0	
PIP	PIPE	1	1.5	XS	B-36.10	ASTM A 106 GR.B	PE, SEAMLESS	PI21977Z0	
PIP	PIPE	2	2	XS	B-36.10	ASTM A 106 GR.B (CHARPY)	BE, SEAMLESS	PI2H717Z0	
PIP	PIPE	3	6	STD	B-36.10	ASTM A 106 GR.B (CHARPY)	BE, SEAMLESS	PI2H717Z0	
NIP	NIPPLE	.5	1.5	M	B-36.10	ASTM A 106 GR.B	PBE, SEAMLESS	PN21967Z0	
Flange Group									
FLG	FLNG.SW	.5	1.5	M	B-16.5	ASTM A 105	300, RF/125AARH	FSC0147Z0	
FLG	FLNG.WN	2	6	M	B-16.5	ASTM A 105 (CHARPY)	300, RF/125AARH	FWC9847Z0	
FLB	FLNG.BLIND	.5	1.5		B-16.5	ASTM A 105	300, RF/125AARH	FBC0147Z0	
FLB	FLNG.BLIND	2	6		B-16.5	ASTM A 105 (CHARPY)	300, RF/125AARH	FBC9847Z0	
FEF	FLNG.FIG.8	.5	1.5		ASME-B16.48	ASTM A 105	300, FF/125AARH	FGK0141Z0	
FEF	FLNG.FIG.8	2	6		ASME-B16.48	ASTM A 105 (CHARPY)	300, FF/125AARH	FGK9841Z0	
Fitting Group									
ELB90	ELBOW.90	.5	.75		B-16.11	ASTM A 105	SW, 6000	WA602D3Z0	
ELB90	ELBOW.90	1	1.5		B-16.11	ASTM A 105	SW, 3000	WA602D2Z0	
ELB90	ELBOW.90	2	6	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW, 1.5D	WAGM84Z10	
ELB45	ELBOW.45	.5	.75		B-16.11	ASTM A 105	SW, 6000	WB602D3Z0	
ELB45	ELBOW.45	2	6	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW, 1.5D	WBGM84Z10	
TEQ	T.EQUAL	.5	.75		B-16.11	ASTM A 105	SW, 6000	WE602D2Z0	
TEQ	T.EQUAL	1	1.5		B-16.11	ASTM A 105	SW, 3000	WE602D2Z0	
TEQ	T.EQUAL	2	6	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WEGM84ZZ0	
TRED	T.RED	.5	1.5		B-16.11	ASTM A 105	SW, 3000	WR602D2Z0	
TRED	T.RED	1	1.5		B-16.11	ASTM A 105	SW, 3000	WR602D2Z0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA3A** Sheet 4 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
TRED	T.RED	2	6	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WRGM84ZZ0	
REDC	REDUC.CONC	2	6	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WUGM84ZZ0	
REDE	REDUC.ECC	2	6	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WVGM84ZZ0	
SWGC	SWAGE.CONC	.5	3	M, M	BS-3799	ASTM A 105	PBE	WNH026ZZ0	
SWGE	SWAGE.ECC	.5	3	M, M	BS-3799	ASTM A 105	PBE	WPH026ZZ0	
CAP	CAP	.5	.75		B-16.11	ASTM A 105	SCRF, 6000	WF60283Z0	
CAP	CAP	1	1.5		B-16.11	ASTM A 105	SCRF, 3000	WF60282Z0	
CAP	CAP	2	6	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WFGM84ZZ0	
CPLF	CPLNG.FULL	.5	.75		B-16.11	ASTM A 105	SW, 6000	WJ602D3Z0	
CPLF	CPLNG.FULL	1	1.5		B-16.11	ASTM A 105	SW, 3000	WJ602D2Z0	
CPLH	CPLNG.HALF	.5	.75		B-16.11	ASTM A 105	SW, 6000	WK602D3Z0	
CPLH	CPLNG.HALF	1	1.5		B-16.11	ASTM A 105	SW, 3000	WK602D2Z0	
CPLL	CPLNG.LH	.5	.75		B-16.11	ASTM A 105	SW, 6000	WL602D3Z0	
CPLL	CPLNG.LH	1	1.5		B-16.11	ASTM A 105	SW, 3000	WL602D2Z0	
CPLR	CPLNG.RED	.5	.75		B-16.11	ASTM A 105	SW, 6000	WM602D3Z0	
CPLR	CPLNG.RED	1	1.5		B-16.11	ASTM A 105	SW, 3000	WM602D2Z0	
UNN	UNION	.5	.75		BS-3799	ASTM A 105	SW, 6000	WQH02D3Z0	
UNN	UNION	1	1.5		BS-3799	ASTM A 105	SW, 3000	WQH02D2Z0	
O'let Group									
SLT	SOCKOLET	.5	.75		MSS-SP97	ASTM A 105	SW, 6000	YSS02D3Z0	
SLT	SOCKOLET	1	1.5		MSS-SP97	ASTM A 105	SW, 3000	YSS02D2Z0	
Bolt Group									

Package : IPMCS
Report No. : 50

BA3A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA3A** Sheet 5 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Bolt Group									
BOM	BOLT.M/C	.5	6		B-18.2	BOLT:A193 GR.B7, NUT:A194 GR.2H		BM40404Z0	124
Gasket Group									
GAS	GASKET	.5	6		B-16.21-ANSI B16.5	SP.WND SS316+GRAFIL	SPIRAL, 150	GKB5072Z0	
Trap/Strainer Group									
TRP	TRAP.STEAM	.5	1.5		MNF'STD	B:A105;T:13%CR;S:SS304	FLGD, THRMDNMC, 300,RF/125AARH	TR30655B0	
TSR	STRNR.TEMP	1.5	6		EIL'STD	B:A285GR.C;INT:SS304	CONETYPE, 300,RF/125AARH	ST1443BZ0	
PSR	STRNR.PERM	.5	1.5		MNF'STD	B:A105;INT:SS304	SW, Y-TYPE, 800	SP303D510	
PSR	STRNR.PERM	2	6	M	EIL'STD	B:A234GR.WPB;INT:SS304	BW, T-TYPE	SP13344Z0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA4A** Sheet 1 of 4

PIPE CLASS : **BA4A**
RATING : 300
BASE MATERIAL : CARBON STEEL
CORROSION ALLOWANCE : 1.5 MM
SPECIAL REQUIREMENT : LOW TEMPERATURE SERVICE

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-45	38	50	65	100	150
PRESS	52.1	52.1	51.08	50.01	47.51	45.98

SERVICE

NATURAL GAS, LOW TEMPERATURE SERVICE

NOTES

101 PIPING DESIGN SHALL BE AS PER PNGRB REGULATIONS, OISD-226 AND ASME B31.8.

102 ALL VENTS AND DRAINS SHALL BE PROVIDED WITH BALL VALVE (WITH PUP-PIECE) WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

103 ALL ABOVE GROUND PIPING BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON THE NEXT PAGE. IN BURIED PIPING O'LETS SHALL NOT BE USED AND BRANCH CONNECTION SHALL BE DONE BY USING 'TEES' & REDUCERS AS REQUIRED. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARDS SHALL BE IGNORED.

110 NDT OF WELDS SHALL BE AS FOLLOWS:-
RADIOGRAPHY: ALL BUTT WELDS 100%
MPI: SOCKET WELDS 100%
ALL OTHER REQUIREMENTS SHALL BE AS PER NDT SPECIFICATION.

111 FOR MATERIAL DESCRIPTION OF VALVES APPLICABLE DATA SHEETS SHALL BE REFERRED.

112 IMPACT TESTING IS REQUIRED AS PER APPLICABLE STANDARD.

113 FOR DIMENSIONS OF HANDLE PROJECTION FOR SPACER & BLIND, REFER EIL STD. NO. 7-44-0166.

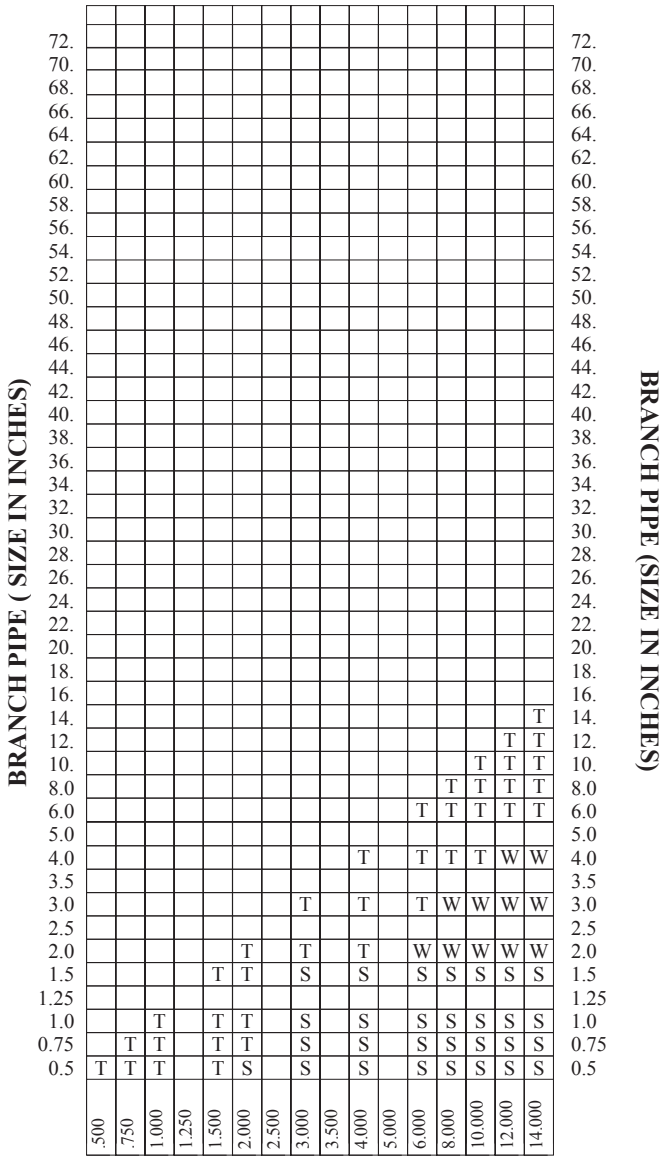
124 ALL NUTS & BOLTS SHALL BE HOT DIP GALVANIZED AS PER ASTM A153

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION	A.CODE
MAINTAINENCE JOINTS	ALL	FLANGED, TO BE KEPT MINIMUM	
PIPE JOINTS	1.5" & BELOW	SW COUPLING	
PIPE JOINTS	2.0" & ABOVE	BUTTWELDED	
DRAINS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
VENTS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
TEMPERATURE CONN.	1.5"	"FLANGED TYPE" AS PER EIL STD 7-44-0353. "WELDED TYPE" &"SKIN TYPE"AS PER INSTRUMENTATION STANDARD	
PRESSURE CONNECTION	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA4A** Sheet 2 of 4



CODE	DESCRIPTION				
F	SADDLE FUSED JT	**T**	TEES	**J**	THREADOLET
H	H. COUPLING	**W**	WELDOLETS		
P	PIPE TO PIPE	**I**	INSTRUMENT TEE		
R	REINFORCED	**X**	Refer Notes		
S	SOCKOLETS	**L**	SWEEPOLET		

Package : **IPMCS**
Report No. : **50**

BA4A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA4A** Sheet 3 of 4

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Pipe Group									
PIP	PIPE	.5	.75	S160	B-36.10	ASTM A 333 GR.6	PE, SEAMLESS	PI24677Z5	
PIP	PIPE	1	1.5	XS	B-36.10	ASTM A 333 GR.6	PE, SEAMLESS	PI24677Z5	
PIP	PIPE	2	2	XS	B-36.10	ASTM A 333 GR.6	BE, SEAMLESS	PI24617Z5	
PIP	PIPE	3	14	STD	B-36.10	ASTM A 333 GR.6	BE, SEAMLESS	PI24617Z5	
NIP	NIPPLE	.5	.75	M	B-36.10	ASTM A 333 GR.6	PBE, SEAMLESS	PN24667Z5	
NIP	NIPPLE	1	1.5	M	B-36.10	ASTM A 333 GR.6	PBE, SEAMLESS	PN24667Z5	
Flange Group									
FLG	FLNG.SW	.5	1.5	M	B-16.5	ASTM A 350 GR.LF2 CL.1	300, RF/125AARH	FSCD747Z5	
FLG	FLNG.WN	2	14	M	B-16.5	ASTM A 350 GR.LF2 CL.1	300, RF/125AARH	FWCD747Z5	
FLB	FLNG.BLIND	.5	14		B-16.5	ASTM A 350 GR.LF2 CL.1	300, RF/125AARH	FBCD747Z5	
FEF	FLNG.FIG.8	.5	8		ASME-B16.48	ASTM A 350 GR.LF2 CL.1	300, FF/125AARH	FGKD741Z5	
FEF	SPCR&BLND	10	14		ASME-B16.48	ASTM A 350 GR.LF2 CL.1	300, FF/125AARH	FCKD741Z5	
Fitting Group									
ELB90	ELBOW.90	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WA6T7D3Z5	
ELB90	ELBOW.90	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WA6T7D2Z5	
ELB90	ELBOW.90	2	14	M	B-16.9	ASTM A 420 GR.WPL6	BW, 1.5D	WAGB44Z15	
ELB45	ELBOW.45	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WB6T7D3Z5	
ELB45	ELBOW.45	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WB6T7D2Z5	
ELB45	ELBOW.45	2	14	M	B-16.9	ASTM A 420 GR.WPL6	BW, 1.5D	WBGB44Z15	
TEQ	T.EQUAL	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WE6T7D3Z5	
TEQ	T.EQUAL	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WE6T7D2Z5	
TEQ	T.EQUAL	2	14	M	B-16.9	ASTM A 420 GR.WPL6	BW	WEGB44ZZ5	
TRED	T.RED	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WR6T7D3Z5	
TRED	T.RED	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WR6T7D2Z5	

Package : **IPMCS**
Report No. : **50**

BA4A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : BA4A** Sheet 4 of 4

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
TRED	T.RED	2	14	M, M	B-16.9	ASTM A 420 GR.WPL6	BW	WRGB44ZZ5	
REDC	REDUC.CONC	2	14	M, M	B-16.9	ASTM A 420 GR.WPL6	BW	WUGB44ZZ5	
REDE	REDUC.ECC	2	14	M, M	B-16.9	ASTM A 420 GR.WPL6	BW	WVGB44ZZ5	
SWGC	SWAGE.CONC	.5	3	M, M	BS-3799	ASTM A 350 GR.LF2 CL.1	PBE	WNHT76ZZ5	
SWGE	SWAGE.ECC	.5	3	M, M	BS-3799	ASTM A 350 GR.LF2 CL.1	PBE	WPHT76ZZ5	
CAP	CAP	2	14	M	B-16.9	ASTM A 420 GR.WPL6	BW	WFGB44ZZ5	
CPLF	CPLNG.FULL	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WJ6T7D3Z5	
CPLF	CPLNG.FULL	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WJ6T7D2Z5	
CPLH	CPLNG.HALF	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WK6T7D3Z5	
CPLH	CPLNG.HALF	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WK6T7D2Z5	
CPLL	CPLNG.LH	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WL6T7D3Z5	
CPLL	CPLNG.LH	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WL6T7D2Z5	
CPLR	CPLNG.RED	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WM6T7D3Z5	
CPLR	CPLNG.RED	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WM6T7D2Z5	
O'let Group									
SLT	SOCKOLET	.5	.75		MSS-SP97	ASTM A 350 GR.LF2 CL.1	SW, 6000	YSST7D3Z5	
SLT	SOCKOLET	1	1.5		MSS-SP97	ASTM A 350 GR.LF2 CL.1	SW, 3000	YSST7D2Z5	
WLT	WELDOLET	2	4	M, XXS	MSS-SP97	ASTM A 350 GR.LF2 CL.1	BW	YWST74ZZ5	
Bolt Group									
BOS	BOLT.STUD	.5	14		B-18.2	BOLT:A320 GR.L7, NUT:A194 GR.4		BS42007Z5	124
Gasket Group									
GAS	GASKET	.5	14		B-16.20-ANSI B16.5	SP.WND SS316H+GRAFIL	SPIRAL, 300	GK63574Z5	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA1A** Sheet 1 of 7

PIPE CLASS : **DA1A**
RATING : 600
BASE MATERIAL : CARBON STEEL
CORROSION ALLOWANCE : 1.5 MM
SPECIAL REQUIREMENT :

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-29	38	50	65	100	150
PRESS	104.11	104.11	102.17	100.03	95.03	91.97

SERVICE

NATURAL GAS

NOTES

101 PIPING DESIGN SHALL BE AS PER PNGRB REGULATIONS, OISD-226 AND ASME B31.8.

102 ALL VENTS AND DRAINS SHALL BE PROVIDED WITH BALL VALVE (WITH PUP-PIECE) WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

103 ALL ABOVE GROUND PIPING BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON THE NEXT PAGE. IN BURIED PIPING O'LETS SHALL NOT BE USED AND BRANCH CONNECTION SHALL BE DONE BY USING 'TEES' & REDUCERS AS REQUIRED. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARDS SHALL BE IGNORED.

104 MATERIAL GRADE & WALL THICKNESS FOR MAINLINES SHALL BE AS MENTIONED IN ANNEXURE-I OF THIS SPECIFICATION.

105 IN ORDER TO MINIMISE POTENTIAL LEAK SOURCES, VALVES USED IN OR CONNECTED TO MAINLINE SHALL HAVE BUTT WELDED ENDS.

106 MAINLINE WELDING AND NDT REQUIREMENTS OF WELDS SHALL AS PER WELDING SPECIFICATION.

107 FOR PIPELINE SPECIALITY ITEMS(SCRAPER TRAP, FLOW TEE, IJ, LR BENDS etc) & THEIR MATERIAL DESCRIPTION, REFER ANNEXURE-I OF THIS DOCUMENT.

108 CHARPY V NOTCH TEST AND HARDNESS TEST SHALL BE CONDUCTED FOR SIZE 2 INCH AND ABOVE PIPES, FITTINGS, O'LETS AND FLANGES. THE AVERAGE ABSORBED ENERGY OF THREE FULL SIZED SPECIMENS SHALL BE 27J. THE MINIMUM IMPACT ENERGY VALUE OF ANY ONE OF THE THREE SPECIMENS ANALYZED ABOVE SHALL NOT BE LESS THAN 22J.

109 NDT OF WELDS WITHIN TERMINALS (EXCLUDING MAINLINE) SHALL BE AS FOLLOWS:-
RADIOGRAPHY: ALL BUTT WELDS 100%
MPI: SOCKET WELDS 100%
ALL OTHER REQUIREMENTS SHALL BE AS PER NDT SPECIFICATION.

111 FOR MATERIAL DESCRIPTION OF VALVES APPLICABLE DATA SHEETS SHALL BE REFERRED.

113 FOR DIMENSIONS OF HANDLE PROJECTION FOR SPACER & BLIND, REFER EIL STD. NO. 7-44-0166.

114 THESE WELDOLETS SHALL BE USED WHEN WELDOLET IS DIRECTLY WELDED TO MAIN PIPELINE IN ABOVEGROUND SECTION

115 THESE FLANGES SHALL BE USED FOR WELDING WITH MAIN PIPELINE IN ABOVEGROUND SECTION, NEAR SCRAPER TRAPS

116 THIS ITEM REFERS TO MAIN 12" PIPELINE FROM NTPC-JHANORE TO GPU-GANDHAR

117 THIS ITEM REFERS TO MAIN 14" PIPELINE FROM VEMAR TO NTPC-JHANORE

119 THIS ITEM REFERS TO MAIN 36" HVJ PIPELINE FROM HAZIRA TO VIJAIPUR

120 THIS ITEM REFERS TO MAIN 42" DVPL-1 PIPELINE FROM DAHEJ TO VIJAIPUR

121 THIS ITEM REFERS TO MAIN 48" DVPL-2 PIPELINE FROM DAHEJ TO VIJAIPUR

124 ALL NUTS & BOLTS SHALL BE HOT DIP GALVANIZED AS PER ASTM A153

125 DETAILS OF STRAINER INDICATED HERE SHALL BE APPLICABLE ONLY FOR THOSE SIZES FOR WHICH SEPARATE DATASHEETS ARE NOT ATTACHED. FOR SIZES FOR WHICH SEPARATE DATASHEETS HAVE BEEN ATTACHED, DETAILS INDICATED HERE SHALL BE IGNORED.

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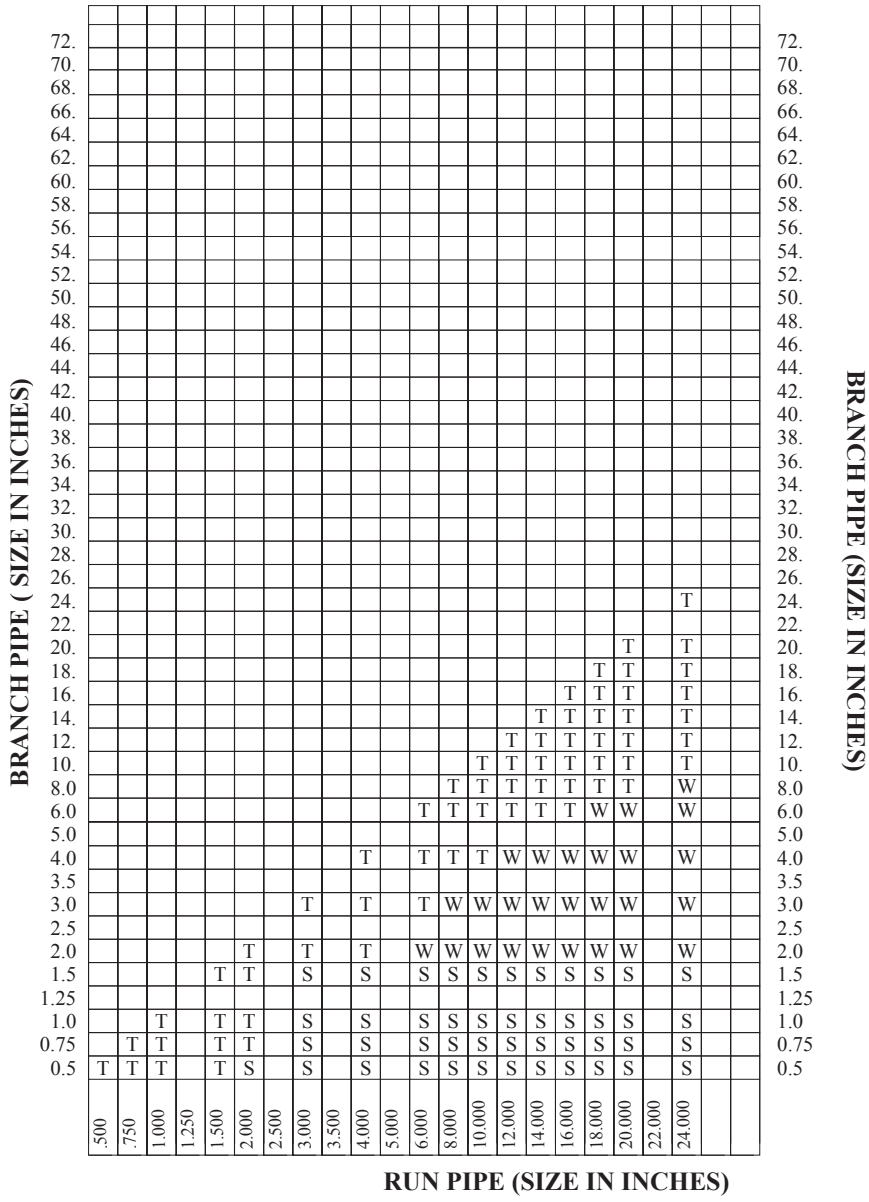
Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA1A** Sheet 2 of 7

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION	A.CODE
MAINTAINENCE JOINTS	ALL	FLANGED (TO BE KEPT MINIMUM)	
PIPE JOINTS	1.5" & BELOW	SW COUPLING	
PIPE JOINTS	2.0" & ABOVE	BUTTWELDED	
DRAINS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
VENTS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
TEMPERATURE CONN.	1.5"	"FLANGED TYPE" AS PER EIL STD 7-44-0353. "WELDED TYPE"& "SKIN TYPE"AS PER INSTRUMENTATION STANDARD	
PRESSURE CONNECTION	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA1A** Sheet 3 of 7



CODE	DESCRIPTION				
F	SADDLE FUSED JT	**T**	TEES	**J**	THREADOLET
H	H. COUPLING	**W**	WELDOLETS		
P	PIPE TO PIPE	**I**	INSTRUMENT TEE		
R	REINFORCED	**X**	Refer Notes		
S	SOCKOLETS	**L**	SWEEPOLET		

Package : **IPMCS**
Report No. : **50**

DA1A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA1A** Sheet 4 of 7

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Pipe Group									
PIP	PIPE	.5	.75	S160	B-36.10	ASTM A 106 GR.B	PE, SEAMLESS	PI21977Z0	
PIP	PIPE	1	1.5	XS	B-36.10	ASTM A 106 GR.B	PE, SEAMLESS	PI21977Z0	
PIP	PIPE	2	6	XS	B-36.10	ASTM A 106 GR.B (CHARPY)	BE, SEAMLESS	PI2H717Z0	
PIP	PIPE	8	8	12.7	API 5L	API 5L GR.B PSL2	BE, SEAMLESS	PIAF817Z0	
PIP	PIPE	10	10	14.3	API 5L	API 5L GR.B PSL2	BE, SEAMLESS	PIAF817Z0	
PIP	PIPE	12	14	14.3	API 5L	API 5L GR.X-52 PSL2	BE, SEAMLESS	PIAG517Z0	
PIP	PIPE	16	16	17.5	API 5L	API 5L GR.X-52 PSL2	BE, SAW	PIAG516Z0	
PIP	PIPE	18	18	19.1	API 5L	API 5L GR.X-52 PSL2	BE, SAW	PIAG516Z0	
PIP	PIPE	20	20	20.6	API 5L	API 5L GR.X-52 PSL2	BE, SAW	PIAG516Z0	
PIP	PIPE	24	24	20.6	API 5L	API 5L GR.X-52 PSL2	BE, SAW	PIAG516Z0	
PIP/6	PIPE	48	48	25.4	API 5L	API 5L GR.X-70 PSL2	BE, SAW	PIAH416Z0	121
PIP/5	PIPE	42	42	23.8	API 5L	API 5L GR.X-70 PSL2	BE, SAW	PIAH416Z0	120
PIP/4	PIPE	36	36	20.6	API 5L	API 5L GR.X-70 PSL2	BE, SAW	PIAH416Z0	119
PIP/2	PIPE	14	14	9.5	API 5L	API 5L GR.X-60 PSL2	BE, E.R.W	PIAG914Z0	117
PIP/1	PIPE	12	12	11.1	API 5L	API 5L GR.X-60 PSL2	BE, E.R.W	PIAG914Z0	116
NIP	NIPPLE	.5	.75	M	B-36.10	ASTM A 333 GR.6	PBE, SEAMLESS	PN24667Z0	
NIP	NIPPLE	1	1.5	M	B-36.10	ASTM A 333 GR.6	PBE, SEAMLESS	PN24667Z0	
Flange Group									
FLG	FLNG.SW	.5	1.5	M	B-16.5	ASTM A 105	600, RF/125AARH	FSC0167Z0	
FLG	FLNG.WN	2	10	M	B-16.5	ASTM A 105 (CHARPY)	600, RF/125AARH	FWC9867Z0	
FLG	FLNG.WN	12	24	M	B-16.5	ASTM A 694 GR.F-52 (CHARPY)	600, RF/125AARH	FWCA267Z0	
FLG/600	FLNG.WN	14	14	9.5	B-16.5	ASTM A 694 GR.F-60 (CHARPY)	600, RF/125AARH	FWCA467Z0	115
FLG/600	FLNG.WN	12	12	11.1	B-16.5	ASTM A 694 GR.F-60 (CHARPY)	600, RF/125AARH	FWCA467Z0	115

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA1A** Sheet 5 of 7

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Flange Group									
FLB	FLNG.BLIND	.5	1.5		B-16.5	ASTM A 105	600, RF/125AARH	FBC0167Z0	
FLB	FLNG.BLIND	2	24		B-16.5	ASTM A 105 (CHARPY)	600, RF/125AARH	FBC9867Z0	
FEF	FLNG.FIG.8	.5	1.5		ASME-B16.48	ASTM A 105	600, FF/125AARH	FGK0161Z0	
FEF	FLNG.FIG.8	2	8		ASME-B16.48	ASTM A 105 (CHARPY)	600, FF/125AARH	FGK9861Z0	
FEF	SPCR&BLND	10	24		ASME-B16.48	ASTM A 105 (CHARPY)	600, FF/125AARH	FCK9861Z0	
Fitting Group									
ELB90	ELBOW.90	.5	.75		B-16.11	ASTM A 105	SW, 6000	WA602D3Z0	
ELB90	ELBOW.90	1	1.5		B-16.11	ASTM A 105	SW, 3000	WA602D2Z0	
ELB90	ELBOW.90	2	10	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW, 1.5D	WAGM84Z10	
ELB90	ELBOW.90	12	14	M	B-16.9	MSS SP-75 GR.WPHY-52	BW, 1.5D	WAGG24Z10	
ELB90	ELBOW.90	16	24	M	MSS-SP75	MSS SP-75 GR.WPHY-52	BW, 1.5D	WAUG24Z10	
ELB45	ELBOW.45	.5	.75		B-16.11	ASTM A 105	SW, 6000	WB602D3Z0	
ELB45	ELBOW.45	1	1.5		B-16.11	ASTM A 105	SW, 3000	WB602D2Z0	
ELB45	ELBOW.45	2	10	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW, 1.5D	WBGM84Z10	
ELB45	ELBOW.45	12	14	M	B-16.9	MSS SP-75 GR.WPHY-52	BW, 1.5D	WBGG24Z10	
ELB45	ELBOW.45	16	24	M	MSS-SP75	MSS SP-75 GR.WPHY-52	BW, 1.5D	WBUG24Z10	
TEQ	T.EQUAL	.5	.75		B-16.11	ASTM A 105	SW, 6000	WE602D3Z0	
TEQ	T.EQUAL	1	1.5		B-16.11	ASTM A 105	SW, 3000	WE602D2Z0	
TEQ	T.EQUAL	2	10	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WEGM84ZZ0	
TEQ	T.EQUAL	12	14	M	B-16.9	MSS SP-75 GR.WPHY-52	BW	WEGG24ZZ0	
TEQ	T.EQUAL	16	24	M	MSS-SP75	MSS SP-75 GR.WPHY-52	BW	WEUG24ZZ0	
TRED	T.RED	.5	.75		B-16.11	ASTM A 105	SW, 6000	WR602D3Z0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA1A** Sheet 6 of 7

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
TRED	T.RED	1	1.5		B-16.11	ASTM A 105	SW, 3000	WR602D2Z0	
TRED	T.RED	2	10	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WRGM84ZZ0	
TRED	T.RED	12	14	M, M	B-16.9	MSS SP-75 GR.WPHY-52	BW	WRGG24ZZ0	
TRED	T.RED	16	24	M, M	MSS-SP75	MSS SP-75 GR.WPHY-52	BW	WRUG24ZZ0	
REDC	REDUC.CONC	2	10	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WUGM84ZZ0	
REDC	REDUC.CONC	12	14	M, M	B-16.9	MSS SP-75 GR.WPHY-52	BW	WUGG24ZZ0	
REDC	REDUC.CONC	16	24	M, M	MSS-SP75	MSS SP-75 GR.WPHY-52	BW	WUUG24ZZ0	
REDE	REDUC.ECC	2	10	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WVGM84ZZ0	
REDE	REDUC.ECC	12	14	M, M	B-16.9	MSS SP-75 GR.WPHY-52	BW	WVGG24ZZ0	
REDE	REDUC.ECC	16	24	M, M	MSS-SP75	MSS SP-75 GR.WPHY-52	BW	WVUG24ZZ0	
SWGC	SWAGE.CONC	.5	3	M, M	BS-3799	ASTM A 105 (CHARPY)	PBE	WNHM76ZZ0	
SWGE	SWAGE.ECC	.5	3	M, M	BS-3799	ASTM A 105 (CHARPY)	PBE	WPHM76ZZ0	
CAP	CAP	.5	.75		B-16.11	ASTM A 105	SCRF, 6000	WF60283Z0	
CAP	CAP	1	1.5		B-16.11	ASTM A 105	SCRF, 3000	WF60282Z0	
CAP	CAP	2	10	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WFGM84ZZ0	
CAP	CAP	12	14	M	B-16.9	MSS SP-75 GR.WPHY-52	BW	WFGG24ZZ0	
CAP	CAP	16	24	M	MSS-SP75	MSS SP-75 GR.WPHY-52	BW	WFUG24ZZ0	
PLG	PLUG	.5	.75		B-16.11	ASTM A 105	SCRM, 6000	WH60293Z0	
PLG	PLUG	1	1.5		B-16.11	ASTM A 105	SCRM, 3000	WH60292Z0	
CPLF	CPLNG.FULL	.5	.75		B-16.11	ASTM A 105	SW, 6000	WJ602D3Z0	
CPLF	CPLNG.FULL	1	1.5		B-16.11	ASTM A 105	SW, 3000	WJ602D2Z0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA1A** Sheet 7 of 7

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
CPLH	CPLNG.HALF	.5	.75		B-16.11	ASTM A 105	SW, 6000	WK602D3Z0	
CPLH	CPLNG.HALF	1	1.5		B-16.11	ASTM A 105	SW, 3000	WK602D2Z0	
CPLL	CPLNG.LH	.5	.75		B-16.11	ASTM A 105	SW, 6000	WL602D3Z0	
CPLL	CPLNG.LH	1	1.5		B-16.11	ASTM A 105	SW, 3000	WL602D2Z0	
CPLR	CPLNG.RED	.5	.75		B-16.11	ASTM A 105	SW, 6000	WM602D3Z0	
CPLR	CPLNG.RED	1	1.5		B-16.11	ASTM A 105	SW, 3000	WM602D2Z0	
O'let Group									
SLT	SOCKOLET	.5	.75		MSS-SP97	ASTM A 105	SW, 6000	YSS02D3Z0	
SLT	SOCKOLET	1	1.5		MSS-SP97	ASTM A 105	SW, 3000	YSS02D2Z0	
WLT	WELDOLET	2	8	M, XXS	MSS-SP97	ASTM A 105 (CHARPY)	BW	YWSM74ZZ0	
WLT/1	WELDOLET	2	6	M, XXS	MSS-SP97	ASTM A 694 GR.F-70 (CHARPY)	BW	YWSN74ZZ0	114
Bolt Group									
BOS	BOLT.STUD	.5	36		B-18.2	BOLT:A193 GR.B7, NUT:A194 GR.2H		BS40404Z0	124
Gasket Group									
GAS	GASKET	.5	24		B-16.20-ANSI B16.5	SP.WND SS316+GRAFIL	SPIRAL, 600	GK65076Z0	
GAS	GASKET	28	36		B-16.20-ANSI B16.47A	SP.WND SS316L+GRAFIL	SPIRAL, 600	GK44976Z0	
Trap/Strainer Group									
TSR	STRNR.TEMP	.5	24		EIL'STD	B:A285GR.C;INT:SS304	CONETYPE, 600,FF/125AARH	ST1443IZ0	125
PSR	STRNR.PERM	.5	1.5		MNF'STD	B:A105;INT:SS304	SW, Y-TYPE, 800	SP303D510	125
PSR	STRNR.PERM	2	24	M	EIL'STD	B:A234GR.WPB;INT:SS304	BW, Y-TYPE	SP13345Z0	125

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA1K** Sheet 1 of 5

PIPE CLASS : **DA1K**
RATING : 600
BASE MATERIAL : SS 304
CORROSION ALLOWANCE : 0 MM
SPECIAL REQUIREMENT :

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-29	38	50	100	150
PRESS	101.25	101.25	97.48	83.31	75.45

SERVICE

NATURAL GAS

NOTES

101 PIPING DESIGN SHALL BE AS PER PNGRB REGULATIONS, OISD-226 AND ASME B31.8.

102 ALL VENTS AND DRAINS SHALL BE PROVIDED WITH BALL VALVE (WITH PUP-PIECE) WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

103 ALL ABOVE GROUND PIPING BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON THE NEXT PAGE. IN BURIED PIPING O'LETS SHALL NOT BE USED AND BRANCH CONNECTION SHALL BE DONE BY USING 'TEES' & REDUCERS AS REQUIRED. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARDS SHALL BE IGNORED.

110 NDT OF WELDS SHALL BE AS FOLLOWS:-
RADIOGRAPHY: ALL BUTT WELDS 100%
MPI: SOCKET WELDS 100%
ALL OTHER REQUIREMENTS SHALL BE AS PER NDT SPECIFICATION.

111 FOR MATERIAL DESCRIPTION OF VALVES APPLICABLE DATA SHEETS SHALL BE REFERRED.

124 ALL NUTS & BOLTS SHALL BE HOT DIP GALVANIZED AS PER ASTM A153

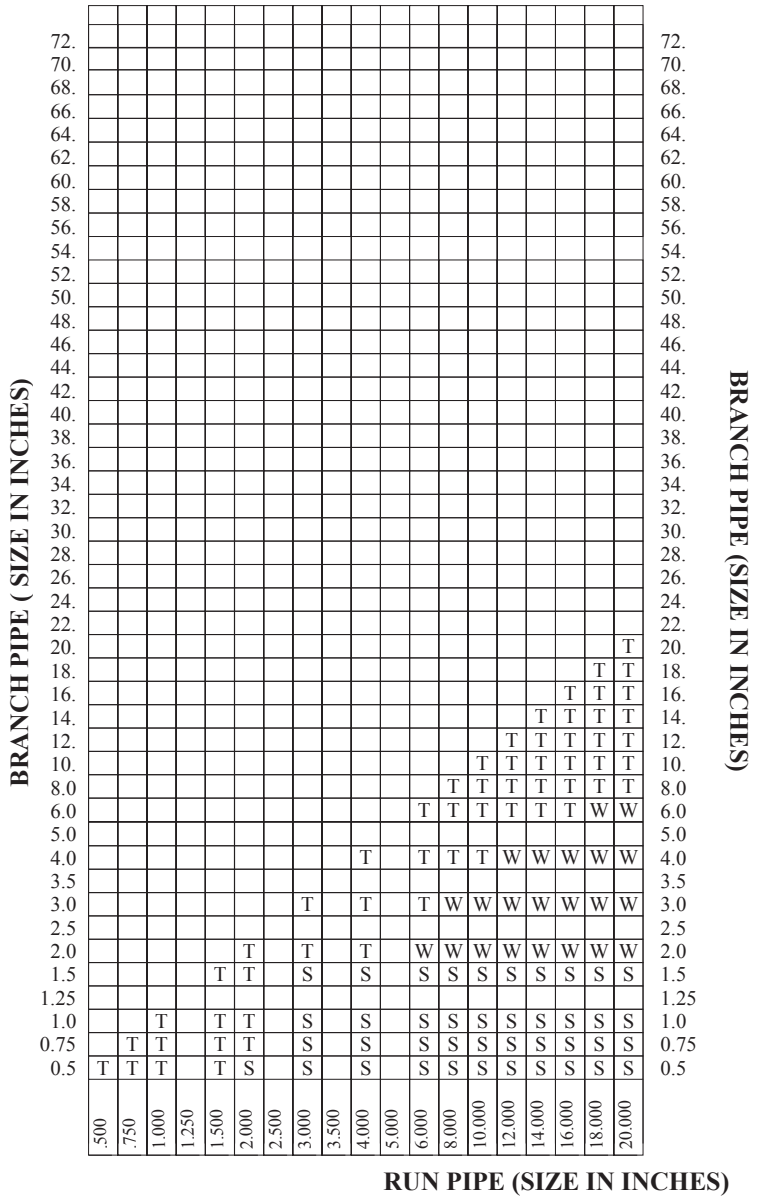
125 DETAILS OF STRAINER INDICATED HERE SHALL BE APPLICABLE ONLY FOR THOSE SIZES FOR WHICH SEPARATE DATASHEETS ARE NOT ATTACHED. FOR SIZES FOR WHICH SEPARATE DATASHEETS HAVE BEEN ATTACHED, DETAILS INDICATED HERE SHALL BE IGNORED.

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION	A.CODE
MAINTENANCE JOINTS	ALL	FLANGED, TO BE KEPT MINIMUM	
PIPE JOINTS	1.5" & BELOW	SW COUPLING	
PIPE JOINTS	2" & ABOVE	BUTT WELDED	
DRAINS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
VENTS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
TEMPERATURE CONN.	1.5"	"FLANGED TYPE" AS PER EIL STD 7-44-0353 "WELDED TYPE" & "SKIN TYPE" AS PER INSTRUMENTATION STANDARD	
PRESSURE CONNECTION	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA1K** Sheet 2 of 5



CODE	DESCRIPTION				
F	SADDLE FUSED JT	**T**	TEES	**J**	THREADOLET
H	H. COUPLING	**W**	WELDOLETS		
P	PIPE TO PIPE	**I**	INSTRUMENT TEE		
R	REINFORCED	**X**	Refer Notes		
S	SOCKOLETS	**L**	SWEEPOLET		

Package : IPMCS
Report No. : 50

DA1K

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA1K** Sheet 3 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Pipe Group									
PIP	PIPE	.5	.75	80S	B-36.19	ASTM A 312 TP304	PE, SEAMLESS	PI33577Z0	
PIP	PIPE	1	1.5	40S	B-36.19	ASTM A 312 TP304	PE, SEAMLESS	PI33577Z0	
PIP	PIPE	2	3	40S	B-36.19	ASTM A 312 TP304	BE, SEAMLESS	PI33517Z0	
PIP	PIPE	4	6	80S	B-36.19	ASTM A 312 TP304	BE, SEAMLESS	PI33517Z0	
PIP	PIPE	8	8	14.3	B-36.10	ASTM A 312 TP304	BE, SEAMLESS	PI23517Z0	
PIP	PIPE	10	10	17.5	B-36.10	ASTM A 358 TP304 CL.1	BE, E.FS.W	PI25513Z0	
PIP	PIPE	12	12	20.6	B-36.10	ASTM A 358 TP304 CL.1	BE, E.FS.W	PI25513Z0	
PIP	PIPE	14	14	22.2	B-36.10	ASTM A 358 TP304 CL.1	BE, E.FS.W	PI25513Z0	
PIP	PIPE	16	16	25.4	B-36.10	ASTM A 358 TP304 CL.1	BE, E.FS.W	PI25513Z0	
PIP	PIPE	18	18	28.6	B-36.10	ASTM A 358 TP304 CL.1	BE, E.FS.W	PI25513Z0	
PIP	PIPE	20	20	31.8	B-36.10	ASTM A 358 TP304 CL.1	BE, E.FS.W	PI25513Z0	
NIP	NIPPLE	.5	.75	M	B-36.19	ASTM A 312 TP304	PBE, SEAMLESS	PN33567Z0	
NIP	NIPPLE	1	1.5	M	B-36.19	ASTM A 312 TP304	PBE, SEAMLESS	PN33567Z0	
Flange Group									
FLG	FLNG.SW	.5	1.5	M	B-16.5	ASTM A 182 GR.F304	600, RF/125AARH	FSC4167Z0	
FLG	FLNG.WN	2	20	M	B-16.5	ASTM A 182 GR.F304	600, RF/125AARH	FWC4167Z0	
FLB	FLNG.BLIND	.5	20		B-16.5	ASTM A 182 GR.F304	600, RF/125AARH	FBC4167Z0	
FEF	FLNG.FIG.8	.5	8		ASME-B16.48	ASTM A 182 GR.F304	300, FF/125AARH	FGK4141Z0	
FEF	SPCR&BLND	10	20		ASME-B16.48	ASTM A 182 GR.F304	600, FF/125AARH	FCK4161Z0	
Fitting Group									
ELB90	ELBOW.90	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WA642D2Z0	
ELB90	ELBOW.90	2	8	M	B-16.9	ASTM A 403 GR.WP304-S	BW, 1.5D	WAG874Z10	
ELB90	ELBOW.90	10	20	M	B-16.9	ASTM A 403 GR.WP304-WX	BW, 1.5D	WAG894Z10	
ELB45	ELBOW.45	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WB642D2Z0	

Package : **IPMCS**
Report No. : **50**

DA1K

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA1K** Sheet 4 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
ELB45	ELBOW.45	2	8	M	B-16.9	ASTM A 403 GR.WP304-S	BW, 1.5D	WBG874Z10	
ELB45	ELBOW.45	10	20	M	B-16.9	ASTM A 403 GR.WP304-WX	BW, 1.5D	WBG894Z10	
TEQ	T.EQUAL	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WE642D2Z0	
TEQ	T.EQUAL	2	8	M	B-16.9	ASTM A 403 GR.WP304-S	BW	WEG874ZZ0	
TEQ	T.EQUAL	10	20	M	B-16.9	ASTM A 403 GR.WP304-WX	BW	WEG894ZZ0	
TRED	T.RED	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WR642D2Z0	
TRED	T.RED	2	8	M, M	B-16.9	ASTM A 403 GR.WP304-S	BW	WRG874ZZ0	
TRED	T.RED	10	20	M, M	B-16.9	ASTM A 403 GR.WP304-WX	BW	WRG894ZZ0	
REDC	REDUC.CONC	2	8	M, M	B-16.9	ASTM A 403 GR.WP304-S	BW	WUG874ZZ0	
REDC	REDUC.CONC	10	20	M, M	B-16.9	ASTM A 403 GR.WP304-WX	BW	WUG894ZZ0	
REDE	REDUC.ECC	2	8	M, M	B-16.9	ASTM A 403 GR.WP304-S	BW	WVG874ZZ0	
REDE	REDUC.ECC	10	20	M, M	B-16.9	ASTM A 403 GR.WP304-WX	BW	WVG894ZZ0	
SWGC	SWAGE.CONC	.5	3	M, M	BS-3799	ASTM A 182 GR.F304	PBE	WNH426ZZ0	
SWGE	SWAGE.ECC	.5	3	M, M	BS-3799	ASTM A 182 GR.F304	PBE	WPH426ZZ0	
CAP	CAP	.5	1.5		B-16.11	ASTM A 182 GR.F304	SCRF, 3000	WF64282Z0	
CAP	CAP	2	20	M	B-16.11	ASTM A 403 GR.WP304-S	BW	WF6874ZZ0	
CPLF	CPLNG.FULL	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WJ642D2Z0	
CPLH	CPLNG.HALF	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WK642D2Z0	
CPLL	CPLNG.LH	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WL642D2Z0	
CPLR	CPLNG.RED	.5	1.5		B-16.11	ASTM A 182 GR.F304	SW, 3000	WM642D2Z0	
O'let Group									
SLT	SOCKOLET	.5	1.5		MSS-SP97	ASTM A 182 GR.F304	SW, 3000	YSS42D2Z0	
WLT	WELDOLET	2	6	M, 80S	MSS-SP97	ASTM A 182 GR.F304	BW	YWS424ZZ0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA1K** Sheet 5 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Bolt Group									
BOS	BOLT.STUD	.5	20		B-18.2	BOLT:A193 GR.B7, NUT:A194 GR.2H		BS40404Z0	124
Gasket Group									
GAS	GASKET	.5	20		B-16.20-ANSI B16.5	SP.WND SS316+GRAFIL+ I RING	SPIRAL, 300	GK66274Z0	
Trap/Strainer Group									
TSR	STRNR.TEMP	1.5	20		EIL'STD	B:A240TP304;INT:SS304	CONETYPE, 300,FF/125AARH	ST14139Z0	125
PSR	STRNR.PERM	.5	1.5		MNF'STD	B:A182GR.F304;INT:SS304	SW, Y-TYPE, 800	SP307D510	125
PSR	STRNR.PERM	2	8	M	EIL'STD	B:A403GR.WP304-S;INT:SS304	BW, T-TYPE	SP15344Z0	125
PSR	STRNR.PERM	10	20	M	EIL'STD	B:A403GR.WP304-WX;INT:SS304	BW, T-TYPE	SP15444Z0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA4A** Sheet 1 of 5

PIPE CLASS : **DA4A**
RATING : 600
BASE MATERIAL : CARBON STEEL
CORROSION ALLOWANCE : 1.5 MM
SPECIAL REQUIREMENT : LOW TEMPERATURE SERVICE

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-45	38	50	65	100	150
PRESS	104.11	104.11	102.17	100.03	95.03	91.97

SERVICE

NATURAL GAS, LOW TEMPERATURE SERVICE

NOTES

101 PIPING DESIGN SHALL BE AS PER PNGRB REGULATIONS, OISD-226 AND ASME B31.8.

102 ALL VENTS AND DRAINS SHALL BE PROVIDED WITH BALL VALVE (WITH PUP-PIECE) WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

103 ALL ABOVE GROUND PIPING BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON THE NEXT PAGE. IN BURIED PIPING O'LETS SHALL NOT BE USED AND BRANCH CONNECTION SHALL BE DONE BY USING 'TEES' & REDUCERS AS REQUIRED. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARDS SHALL BE IGNORED.

110 NDT OF WELDS SHALL BE AS FOLLOWS:-
RADIOGRAPHY: ALL BUTT WELDS 100%
MPI: SOCKET WELDS 100%
ALL OTHER REQUIREMENTS SHALL BE AS PER NDT SPECIFICATION.

111 FOR MATERIAL DESCRIPTION OF VALVES APPLICABLE DATA SHEETS SHALL BE REFERRED.

112 IMPACT TESTING IS REQUIRED AS PER APPLICABLE STANDARD.

113 FOR DIMENSIONS OF HANDLE PROJECTION FOR SPACER & BLIND, REFER EIL STD. NO. 7-44-0166.

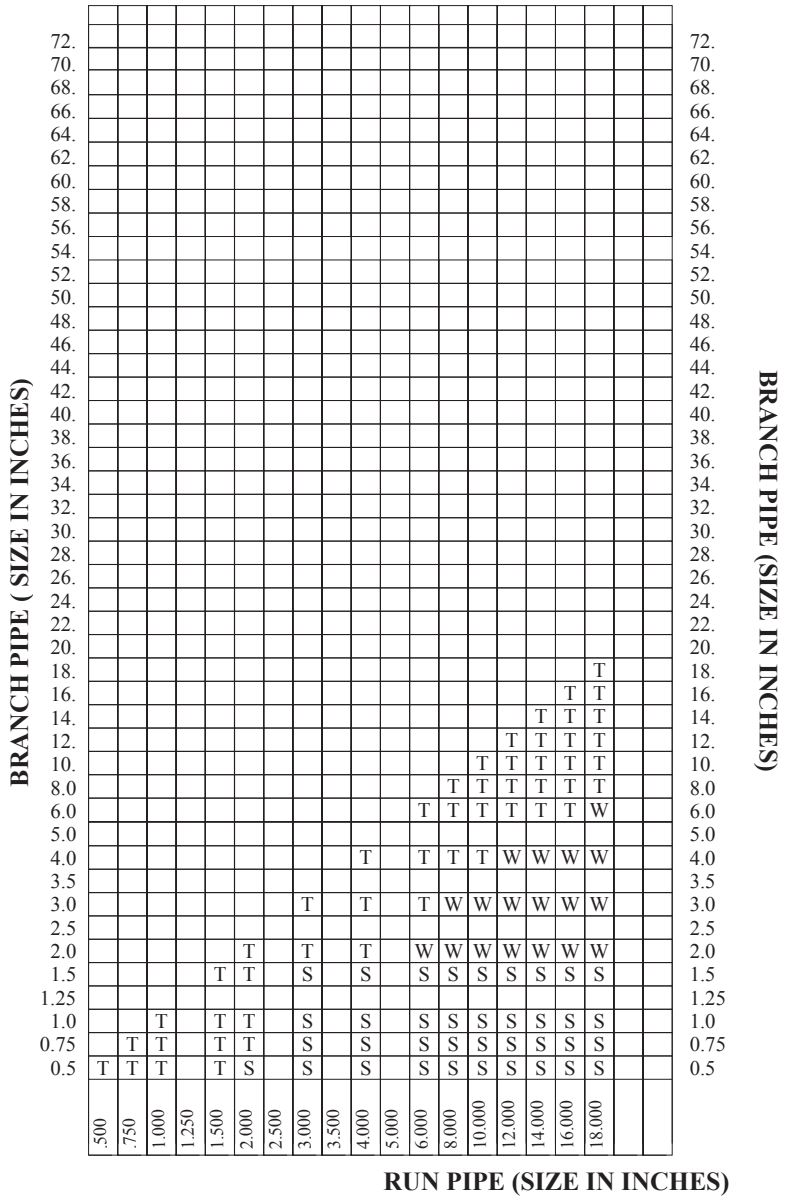
124 ALL NUTS & BOLTS SHALL BE HOT DIP GALVANIZED AS PER ASTM A153

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION	A.CODE
MAINTAINENCE JOINTS	ALL	FLANGED, TO BE KEPT MINIMUM	
PIPE JOINTS	1.5" & BELOW	SW COUPLING	
PIPE JOINTS	2.0" & ABOVE	BUTTWELDED	
DRAINS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
VENTS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
TEMPERATURE CONN.	1.5"	"FLANGED TYPE" AS PER EIL STD 7-44-0353. "WELDED TYPE" &"SKIN TYPE"AS PER INSTRUMENTATION STANDARD	
PRESSURE CONNECTION	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA4A** Sheet 2 of 5



CODE	DESCRIPTION				
F	SADDLE FUSED JT	**T**	TEES	**J**	THREADOLET
H	H. COUPLING	**W**	WELDOLETS		
P	PIPE TO PIPE	**I**	INSTRUMENT TEE		
R	REINFORCED	**X**	Refer Notes		
S	SOCKOLETS	**L**	SWEEPOLET		

Package : **IPMCS**
Report No. : **50**

DA4A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA4A** Sheet 3 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Pipe Group									
PIP	PIPE	.5	.75	S160	B-36.10	ASTM A 333 GR.6	PE, SEAMLESS	PI24677Z5	
PIP	PIPE	1	1.5	XS	B-36.10	ASTM A 333 GR.6	PE, SEAMLESS	PI24677Z5	
PIP	PIPE	2	8	XS	B-36.10	ASTM A 333 GR.6	BE, SEAMLESS	PI24617Z5	
PIP	PIPE	10	14	S80	B-36.10	ASTM A 333 GR.6	BE, SEAMLESS	PI24617Z5	
PIP	PIPE	16	16	22.2	B-36.10	ASTM A 333 GR.6	BE, SAW	PI24616Z5	
PIP	PIPE	18	18	25.4	B-36.10	ASTM A 333 GR.6	BE, SAW	PI24616Z5	
NIP	NIPPLE	.5	.75	M	B-36.10	ASTM A 333 GR.6	PBE, SEAMLESS	PN24667Z5	
NIP	NIPPLE	1	1.5	M	B-36.10	ASTM A 333 GR.6	PBE, SEAMLESS	PN24667Z5	
Flange Group									
FLG	FLNG.SW	.5	1.5	M	B-16.5	ASTM A 350 GR.LF2 CL.1	600, RF/125AARH	FSCD767Z5	
FLG	FLNG.WN	2	18	M	B-16.5	ASTM A 350 GR.LF2 CL.1	600, RF/125AARH	FWCD767Z5	
FLB	FLNG.BLIND	.5	18		B-16.5	ASTM A 350 GR.LF2 CL.1	600, RF/125AARH	FBCD767Z5	
FEF	FLNG.FIG.8	.5	8		ASME-B16.48	ASTM A 350 GR.LF2 CL.1	600, FF/125AARH	FGKD761Z5	
FEF	SPCR&BLND	10	18		ASME-B16.48	ASTM A 350 GR.LF2 CL.1	600, FF/125AARH	FCKD761Z5	
Fitting Group									
ELB90	ELBOW.90	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WA6T7D3Z5	
ELB90	ELBOW.90	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WA6T7D2Z5	
ELB90	ELBOW.90	2	16	M	B-16.9	ASTM A 420 GR.WPL6	BW, 1.5D	WAGB44Z15	
ELB90	ELBOW.90	18	18	M	B-16.9	ASTM A 420 GR.WPL6-W	BW, 1.5D	WAGB54Z15	
ELB45	ELBOW.45	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WB6T7D3Z5	
ELB45	ELBOW.45	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WB6T7D2Z5	
ELB45	ELBOW.45	2	16	M	B-16.9	ASTM A 420 GR.WPL6	BW, 1.5D	WBGB44Z15	
ELB45	ELBOW.45	18	18	M	B-16.9	ASTM A 420 GR.WPL6-W	BW, 1.5D	WBGB54Z15	
TEQ	T.EQUAL	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WE6T7D3Z5	

Package : **IPMCS**
Report No. : **50**

DA4A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA4A** Sheet 4 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
TEQ	T.EQUAL	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WE6T7D2Z5	
TEQ	T.EQUAL	2	16	M	B-16.9	ASTM A 420 GR.WPL6	BW	WEGB44ZZ5	
TEQ	T.EQUAL	18	18	M	B-16.9	ASTM A 420 GR.WPL6-W	BW	WEGB54ZZ5	
TRED	T.RED	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WR6T7D3Z5	
TRED	T.RED	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WR6T7D2Z5	
TRED	T.RED	2	16	M, M	B-16.9	ASTM A 420 GR.WPL6	BW	WRGB44ZZ5	
TRED	T.RED	18	18	M, M	B-16.9	ASTM A 420 GR.WPL6-W	BW	WRGB54ZZ5	
REDC	REDUC.CONC	2	16	M, M	B-16.9	ASTM A 420 GR.WPL6	BW	WUGB44ZZ5	
REDC	REDUC.CONC	18	18	M, M	B-16.9	ASTM A 420 GR.WPL6-W	BW	WUGB54ZZ5	
REDE	REDUC.ECC	2	16	M, M	B-16.9	ASTM A 420 GR.WPL6	BW	WVGB44ZZ5	
REDE	REDUC.ECC	18	18	M, M	B-16.9	ASTM A 420 GR.WPL6-W	BW	WVGB54ZZ5	
SWGC	SWAGE.CONC	.5	3	M, M	BS-3799	ASTM A 350 GR.LF2 CL.1	PBE	WNHT76ZZ5	
SWGE	SWAGE.ECC	.5	3	M, M	BS-3799	ASTM A 350 GR.LF2 CL.1	PBE	WPHT76ZZ5	
CAP	CAP	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SCRF, 6000	WF6T783Z5	
CAP	CAP	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SCRF, 3000	WF6T782Z5	
CAP	CAP	2	16	M	B-16.9	ASTM A 420 GR.WPL6	BW	WFGB44ZZ5	
CAP	CAP	18	18	M	B-16.9	ASTM A 420 GR.WPL6-W	BW	WFGB54ZZ5	
PLG	PLUG	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SCRM, 6000	WH6T793Z5	
PLG	PLUG	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SCRM, 3000	WH6T792Z5	
CPLF	CPLNG.FULL	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WJ6T7D3Z5	
CPLF	CPLNG.FULL	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WJ6T7D2Z5	
CPLH	CPLNG.HALF	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WK6T7D3Z5	
CPLH	CPLNG.HALF	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WK6T7D2Z5	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : DA4A** Sheet 5 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
CPLL	CPLNG.LH	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WL6T7D3Z5	
CPLL	CPLNG.LH	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WL6T7D2Z5	
CPLR	CPLNG.RED	.5	.75		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 6000	WM6T7D3Z5	
CPLR	CPLNG.RED	1	1.5		B-16.11	ASTM A 350 GR.LF2 CL.1	SW, 3000	WM6T7D2Z5	
O'let Group									
SLT	SOCKOLET	.5	.75		MSS-SP97	ASTM A 350 GR.LF2 CL.1	SW, 6000	YSST7D3Z5	
SLT	SOCKOLET	1	1.5		MSS-SP97	ASTM A 350 GR.LF2 CL.1	SW, 3000	YSST7D2Z5	
WLT	WELDOLET	2	6	M, XXS	MSS-SP97	ASTM A 350 GR.LF2 CL.1	BW	YWST74ZZ5	
Bolt Group									
BOS	BOLT.STUD	.5	14		B-18.2	BOLT:A320 GR.L7, NUT:A194 GR.4		BS42007Z5	124
Gasket Group									
GAS	GASKET	.5	14		B-16.20-ANSI B16.5	SP.WND SS316+GRAFIL	SPIRAL, 600	GK65076Z5	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : EA1A** Sheet 1 of 5

PIPE CLASS : **EA1A**
RATING : 900
BASE MATERIAL : CARBON STEEL
CORROSION ALLOWANCE : 1.5 MM
SPECIAL REQUIREMENT :

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-29	38	50	65	100	150
PRESS	156.22	156.22	153.36	150.12	142.55	137.86

SERVICE

NATURAL GAS

NOTES

101 PIPING DESIGN SHALL BE AS PER PNGRB REGULATIONS, OISD-226 AND ASME B31.8.

103 ALL ABOVE GROUND PIPING BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON THE NEXT PAGE. IN BURIED PIPING O'LETS SHALL NOT BE USED AND BRANCH CONNECTION SHALL BE DONE BY USING 'TEES' & REDUCERS AS REQUIRED. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARDS SHALL BE IGNORED.

108 CHARPY V NOTCH TEST AND HARDNESS TEST SHALL BE CONDUCTED FOR SIZE 2 INCH AND ABOVE PIPES, FITTINGS, O'LETS AND FLANGES. THE AVERAGE ABSORBED ENERGY OF THREE FULL SIZED SPECIMENS SHALL BE 27J. THE MINIMUM IMPACT ENERGY VALUE OF ANY ONE OF THE THREE SPECIMENS ANALYZED ABOVE SHALL NOT BE LESS THAN 22J.

110 NDT OF WELDS SHALL BE AS FOLLOWS:-
RADIOGRAPHY: ALL BUTT WELDS 100%
MPI: SOCKET WELDS 100%
ALL OTHER REQUIREMENTS SHALL BE AS PER NDT SPECIFICATION.

111 FOR MATERIAL DESCRIPTION OF VALVES APPLICABLE DATA SHEETS SHALL BE REFERRED.

113 FOR DIMENSIONS OF HANDLE PROJECTION FOR SPACER & BLIND, REFER EIL STD. NO. 7-44-0166.

122 ALL VENTS AND DRAINS SHALL BE PROVIDED WITH 2 NOS. BALL VALVES WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

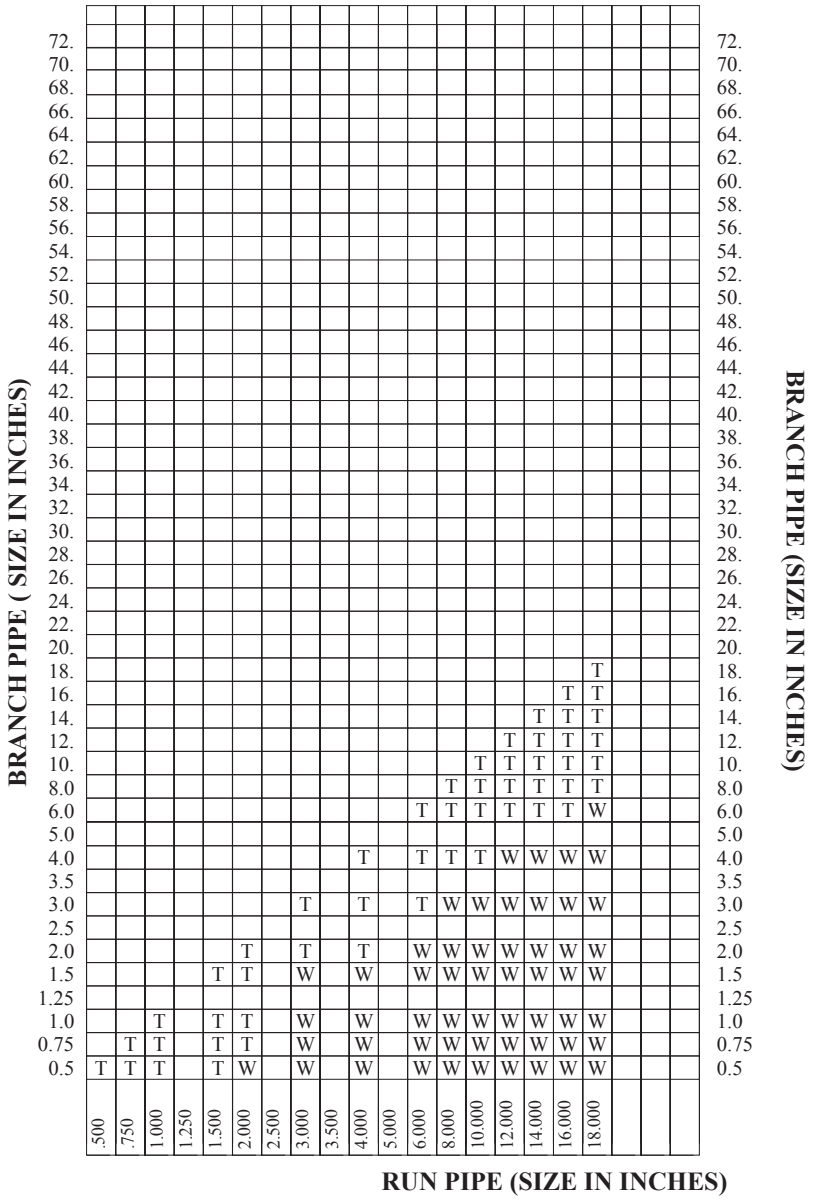
124 ALL NUTS & BOLTS SHALL BE HOT DIP GALVANIZED AS PER ASTM A153

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION	A.CODE
MAINTAINENCE JOINTS	ALL	FLANGED (TO BE KEPT MINIMUM)	
PIPE JOINTS	ALL	BUTTWELDED	
DRAINS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
VENTS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
TEMPERATURE CONN.	1.5"	"FLANGED TYPE" AS PER EIL STD 7-44-0353. "WELDED TYPE"& "SKIN TYPE"AS PER INSTRUMENTATION STANDARD	
PRESSURE CONNECTION	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : EA1A** Sheet 2 of 5



CODE	DESCRIPTION				
F	SADDLE FUSED JT	**T**	TEES	**J**	THREADOLET
H	H. COUPLING	**W**	WELDOLETS		
P	PIPE TO PIPE	**I**	INSTRUMENT TEE		
R	REINFORCED	**X**	Refer Notes		
S	SOCKOLETS	**L**	SWEEPOLET		

Package : **IPMCS**
Report No. : **50**

EA1A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : EA1A** Sheet 3 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Pipe Group									
PIP	PIPE	.5	.75	S160	B-36.10	ASTM A 106 GR.B	BE, SEAMLESS	PI21917Z0	
PIP	PIPE	1	1.5	XS	B-36.10	ASTM A 106 GR.B	BE, SEAMLESS	PI21917Z0	
PIP	PIPE	2	3	XS	B-36.10	ASTM A 106 GR.B (CHARPY)	BE, SEAMLESS	PI2H717Z0	
PIP	PIPE	4	6	S120	B-36.10	ASTM A 106 GR.B (CHARPY)	BE, SEAMLESS	PI2H717Z0	
PIP	PIPE	8	8	15.9	API 5L	API 5L GR.B PSL2	BE, SEAMLESS	PIAF817Z0	
PIP	PIPE	10	10	14.3	API 5L	API 5L GR.X-52 PSL2	BE, SEAMLESS	PIAG517Z0	
PIP	PIPE	12	12	15.9	API 5L	API 5L GR.X-52 PSL2	BE, SEAMLESS	PIAG517Z0	
PIP	PIPE	14	14	17.5	API 5L	API 5L GR.X-52 PSL2	BE, SEAMLESS	PIAG517Z0	
PIP	PIPE	16	16	19.1	API 5L	API 5L GR.X-52 PSL2	BE, SAW	PIAG516Z0	
PIP	PIPE	18	18	22.2	API 5L	API 5L GR.X-52 PSL2	BE, SAW	PIAG516Z0	
NIP	NIPPLE	.5	1.5	M	B-36.10	ASTM A 106 GR.B	PBE, SEAMLESS	PN21967Z0	
Flange Group									
FLG	FLNG.WN	.5	1.5	M	B-16.5	ASTM A 105	1500, RTJ/63AARH	FWC0189Z0	
FLG	FLNG.WN	2	2	M	B-16.5	ASTM A 105 (CHARPY)	1500, RTJ/63AARH	FWC9889Z0	
FLG	FLNG.WN	3	8	M	B-16.5	ASTM A 105 (CHARPY)	900, RTJ/63AARH	FWC9879Z0	
FLG	FLNG.WN	10	18	M	B-16.5	ASTM A 694 GR.F-52 (CHARPY)	900, RTJ/63AARH	FWCA279Z0	
FLB	FLNG.BLIND	.5	1.5		B-16.5	ASTM A 105	1500, RTJ/63AARH	FBC0189Z0	
FLB	FLNG.BLIND	2	2		B-16.5	ASTM A 105 (CHARPY)	1500, RTJ/63AARH	FBC9889Z0	
FLB	FLNG.BLIND	3	18		B-16.5	ASTM A 105 (CHARPY)	900, RTJ/63AARH	FBC9879Z0	
FEF	FLNG.FIG.8	.5	1.5		ASME-B16.48	ASTM A 105	900, RTJ/63AARH	FGK0179Z0	
FEF	FLNG.FIG.8	2	8		ASME-B16.48	ASTM A 105 (CHARPY)	900, RTJ/63AARH	FGK9879Z0	
FEF	SPCR&BLND	10	18		ASME-B16.48	ASTM A 105 (CHARPY)	900, RTJ/63AARH	FCK9879Z0	
Fitting Group									
ELB90	ELBOW.90	.5	1.5	M	B-16.9	ASTM A 234 GR.WPB	BW, 1.5D	WAG684Z10	

Package : **IPMCS**
Report No. : **50**

EA1A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : EA1A** Sheet 4 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
ELB90	ELBOW.90	2	8	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW, 1.5D	WAGM84Z10	
ELB90	ELBOW.90	10	18	M	MSS-SP75	MSS SP-75 GR.WPHY-52	BW, 1.5D	WAUG24Z10	
ELB45	ELBOW.45	.5	1.5	M	B-16.9	ASTM A 234 GR.WPB	BW, 1.5D	WBG684Z10	
ELB45	ELBOW.45	2	8	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW, 1.5D	WBGM84Z10	
ELB45	ELBOW.45	10	18	M	MSS-SP75	MSS SP-75 GR.WPHY-52	BW, 1.5D	WBUG24Z10	
TEQ	T.EQUAL	.5	1.5	M	B-16.9	ASTM A 234 GR.WPB	BW	WEG684ZZ0	
TEQ	T.EQUAL	2	8	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WEGM84ZZ0	
TEQ	T.EQUAL	10	18	M	MSS-SP75	MSS SP-75 GR.WPHY-52	BW	WEUG24ZZ0	
TRED	T.RED	.5	1.5	M, M	B-16.9	ASTM A 234 GR.WPB	BW	WRG684ZZ0	
TRED	T.RED	2	8	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WRGM84ZZ0	
TRED	T.RED	10	18	M, M	MSS-SP75	MSS SP-75 GR.WPHY-52	BW	WRUG24ZZ0	
REDC	REDUC.CONC	.5	1.5	M, M	B-16.9	ASTM A 234 GR.WPB	BW	WUG684ZZ0	
REDC	REDUC.CONC	2	8	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WUGM84ZZ0	
REDC	REDUC.CONC	10	18	M, M	MSS-SP75	MSS SP-75 GR.WPHY-52	BW	WUUG24ZZ0	
REDE	REDUC.ECC	.5	1.5	M, M	B-16.9	ASTM A 234 GR.WPB	BW	WVG684ZZ0	
REDE	REDUC.ECC	2	8	M, M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WVGM84ZZ0	
REDE	REDUC.ECC	10	18	M, M	MSS-SP75	MSS SP-75 GR.WPHY-52	BW	WVUG24ZZ0	
CAP	CAP	.5	1.5	M	B-16.9	ASTM A 234 GR.WPB	BW	WFG684ZZ0	
CAP	CAP	2	8	M	B-16.9	ASTM A 234 GR.WPB (CHARPY)	BW	WFGM84ZZ0	
CAP	CAP	10	18	M	MSS-SP75	MSS SP-75 GR.WPHY-52	BW	WFUG24ZZ0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : EA1A** Sheet 5 of 5

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
O'let Group									
WLT	WELDOLET	.5	6	M, XXS	MSS-SP97	ASTM A 105 (CHARPY)	BW	YWSM74ZZ0	
Bolt Group									
BOS	BOLT.STUD	.5	18		B-18.2	BOLT:A193 GR.B7, NUT:A194 GR.2H		BS40404Z0	124
Gasket Group									
GAS	GASKET	.5	2		B-16.20-ANSI B16.5	SOFT IRON	OCT-RING, 1500	GK67238Z0	
GAS	GASKET	3	18		B-16.20-ANSI B16.5	SOFT IRON	OCT-RING, 900	GK67237Z0	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : EA4A** Sheet 1 of 4

PIPE CLASS : **EA4A**
RATING : 900
BASE MATERIAL : CARBON STEEL
CORROSION ALLOWANCE : 1.5 MM
SPECIAL REQUIREMENT : LOW TEMPERATURE SERVICE

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-45	38	50	65	100	150
PRESS	156.22	156.22	153.36	150.12	142.55	137.86

SERVICE

NATURAL GAS, LOW TEMPERATURE SERVICE

NOTES

101 PIPING DESIGN SHALL BE AS PER PNGRB REGULATIONS, OISD-226 AND ASME B31.8.

103 ALL ABOVE GROUND PIPING BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON THE NEXT PAGE. IN BURIED PIPING O'LETS SHALL NOT BE USED AND BRANCH CONNECTION SHALL BE DONE BY USING 'TEES' & REDUCERS AS REQUIRED. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARDS SHALL BE IGNORED.

110 NDT OF WELDS SHALL BE AS FOLLOWS:-
RADIOGRAPHY: ALL BUTT WELDS 100%
MPI: SOCKET WELDS 100%
ALL OTHER REQUIREMENTS SHALL BE AS PER NDT SPECIFICATION.

111 FOR MATERIAL DESCRIPTION OF VALVES APPLICABLE DATA SHEETS SHALL BE REFERRED.

112 IMPACT TESTING IS REQUIRED AS PER APPLICABLE STANDARD.

113 FOR DIMENSIONS OF HANDLE PROJECTION FOR SPACER & BLIND, REFER EIL STD. NO. 7-44-0166.

122 ALL VENTS AND DRAINS SHALL BE PROVIDED WITH 2 NOS. BALL VALVES WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

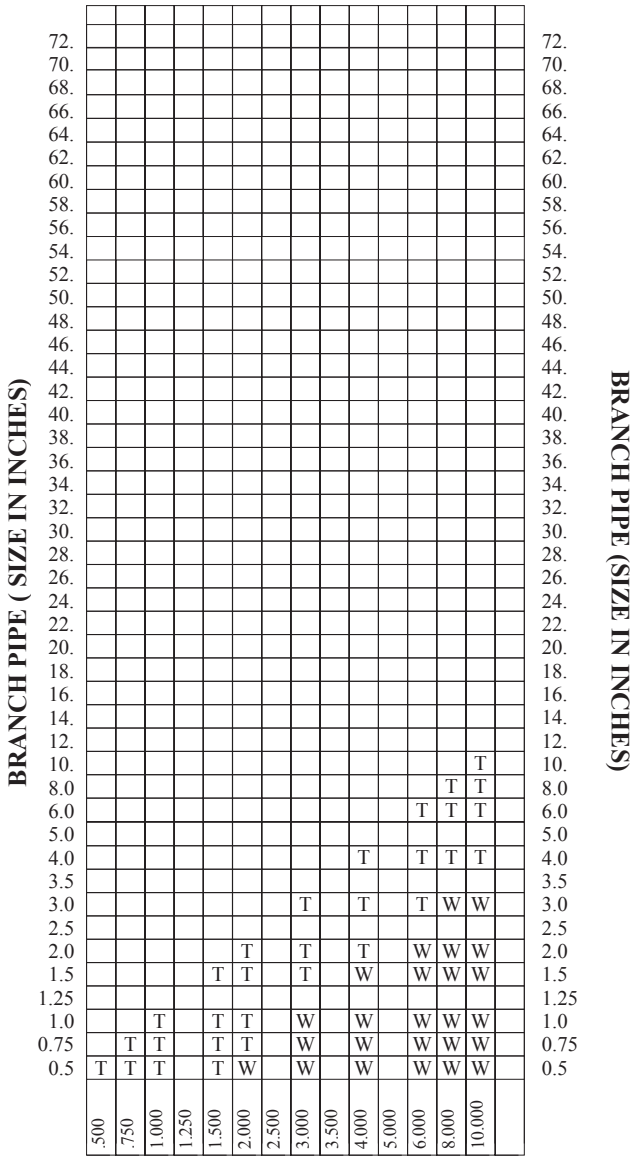
124 ALL NUTS & BOLTS SHALL BE HOT DIP GALVANIZED AS PER ASTM A153

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION	A.CODE
MAINTAINENCE JOINTS	ALL	FLANGED, TO BE KEPT MINIMUM	
PIPE JOINTS	ALL	BUTTWELDED	
DRAINS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
VENTS	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	
TEMPERATURE CONN.	1.5"	"FLANGED TYPE" AS PER EIL STD 7-44-0353. "WELDED TYPE" &"SKIN TYPE"AS PER INSTRUMENTATION STANDARD	
PRESSURE CONNECTION	0.75"	AS PER JOB STANDARD, DOC. NO. B240-910-83-41-45001	

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : EA4A** Sheet 2 of 4



CODE	DESCRIPTION				
F	SADDLE FUSED JT	**T**	TEES	**J**	THREADOLET
H	H. COUPLING	**W**	WELDOLETS		
P	PIPE TO PIPE	**I**	INSTRUMENT TEE		
R	REINFORCED	**X**	Refer Notes		
S	SOCKOLETS	**L**	SWEEPOLET		

Package : **IPMCS**
Report No. : **50**

EA4A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : EA4A** Sheet 3 of 4

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Pipe Group									
PIP	PIPE	.5	.75	S160	B-36.10	ASTM A 333 GR.6	BE, SEAMLESS	PI24617Z5	
PIP	PIPE	1	1.5	XS	B-36.10	ASTM A 333 GR.6	BE, SEAMLESS	PI24617Z5	
PIP	PIPE	2	3	XS	B-36.10	ASTM A 333 GR.6	BE, SEAMLESS	PI24617Z5	
PIP	PIPE	4	6	S120	B-36.10	ASTM A 333 GR.6	BE, SEAMLESS	PI24617Z5	
PIP	PIPE	8	8	15.9	B-36.10	ASTM A 333 GR.6	BE, SEAMLESS	PI24617Z5	
PIP	PIPE	10	10	20.6	B-36.10	ASTM A 333 GR.6	BE, SEAMLESS	PI24617Z5	
NIP	NIPPLE	.5	1.5	M	B-36.10	ASTM A 333 GR.6	PBE, SEAMLESS	PN24667Z5	
Flange Group									
FLG	FLNG.WN	.5	2	M	B-16.5	ASTM A 350 GR.LF2 CL.1	1500, RTJ/63AARH	FWCD789Z5	
FLG	FLNG.WN	3	10	M	B-16.5	ASTM A 350 GR.LF2 CL.1	900, RTJ/63AARH	FWCD779Z5	
FLB	FLNG.BLIND	.5	2		B-16.5	ASTM A 350 GR.LF2 CL.1	1500, RTJ/63AARH	FBCD789Z5	
FLB	FLNG.BLIND	3	10		B-16.5	ASTM A 350 GR.LF2 CL.1	900, RTJ/63AARH	FBCD779Z5	
FEF	FLNG.FIG.8	.5	8		ASME-B16.48	ASTM A 350 GR.LF2 CL.1	900, RTJ/63AARH	FGKD779Z5	
FEF	SPCR&BLND	10	10		ASME-B16.48	ASTM A 350 GR.LF2 CL.1	900, RTJ/63AARH	FCKD779Z5	
Fitting Group									
ELB90	ELBOW.90	.5	1.5	M	B-16.9	ASTM A 350 GR.LF2 CL.1	BW, 1.5D	WAGT74Z15	
ELB90	ELBOW.90	2	10	M	B-16.9	ASTM A 420 GR.WPL6	BW, 1.5D	WAGB44Z15	
ELB45	ELBOW.45	.5	1.5	M	B-16.9	ASTM A 350 GR.LF2 CL.1	BW, 1.5D	WBGT74Z15	
ELB45	ELBOW.45	2	10	M	B-16.9	ASTM A 420 GR.WPL6	BW, 1.5D	WBGB44Z15	
TEQ	T.EQUAL	.5	1.5	M	B-16.9	ASTM A 350 GR.LF2 CL.1	BW	WEGT74ZZ5	
TEQ	T.EQUAL	2	10	M	B-16.9	ASTM A 420 GR.WPL6	BW	WEGB44ZZ5	
TRED	T.RED	.5	1.5	M, M	B-16.9	ASTM A 350 GR.LF2 CL.1	BW	WRGT74ZZ5	
REDC	REDUC.CONC	.5	1.5	M, M	B-16.9	ASTM A 350 GR.LF2 CL.1	BW	WUGT74ZZ5	
REDC	REDUC.CONC	2	10	M, M	B-16.9	ASTM A 420 GR.WPL6	BW	WUGB44ZZ5	

Package : **IPMCS**
Report No. : **50**

EA4A

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Client : GAIL (INDIA) LIMITED	**Dept./Sect. :** 83-41
Project : GANDHAR COMPRESSOR PROJECT	
Location : GUJARAT	**Pipe Class : EA4A** Sheet 4 of 4

Note :(The shaded portion of PMS body shows Field Fabricated Items)

Input Id.	Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch/ Thk (mm)	Dmn. STD	Material	Description	Commodity Code	Note No
Fitting Group									
REDE	REDUC.ECC	.5	1.5	M, M	B-16.9	ASTM A 350 GR.LF2 CL.1	BW	WVGT74ZZ5	
REDE	REDUC.ECC	2	10	M, M	B-16.9	ASTM A 420 GR.WPL6	BW	WVGB44ZZ5	
CAP	CAP	.5	1.5	M	B-16.9	ASTM A 350 GR.LF2 CL.1	BW	WFGT74ZZ5	
CAP	CAP	2	10	M	B-16.9	ASTM A 420 GR.WPL6	BW	WFGB44ZZ5	
O'let Group									
WLT	WELDOLET	.5	3	M, M	MSS-SP97	ASTM A 350 GR.LF2 CL.1	BW	YWST74ZZ5	
Bolt Group									
BOS	BOLT.STUD	.5	14		B-18.2	BOLT:A320 GR.L7, NUT:A194 GR.4		BS42007Z5	124
Gasket Group									
GAS	GASKET	.5	2		B-16.20-ANSI B16.5	SOFT IRON	OCT-RING, 1500	GK67238Z5	
GAS	GASKET	3	14		B-16.20-ANSI B16.5	SOFT IRON	OCT-RING, 900	GK67237Z5	

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गेल (इंडिया) लिमिटेड

GAIL (INDIA) LIMITED

गांधार कम्प्रैसर परियोजना

GANDHAR COMPRESSOR PROJECT

ANNEXURE-I

PIPING MATERIAL SPECIFICATION GENERAL NOTES (PIPELINE ENGINEERING)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
1	06.09.19	REVISED & ISSUED FOR ENGINEERING	TLP	RSB	MSG
0	21.06.19	ISSUED FOR ENGINEERING	TLP	RSB	MSG

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2.0	CODES AND STANDARDS
3.0	MATERIAL SPECIFICATIONS
4.0	CLASS DESIGNATION CODES
5.0	PIPELINE
6.0	PIPES
7.0	FITTINGS
8.0	BENDS
9.0	FLANGES
10.0	GASKETS
11.0	BOLTING AND THREADS
12.0	THREAD SEALANT
13.0	VALVES
14.0	QUICK OPENING END CLOSURE
15.0	HYDROTESTING VENTS AND DRAINS
16.0	PIPELINE SPECIALITY ITEMS
TABLE-1	MAIN PIPELINE DETAILS
TABLE-2	PIPELINE SPECIALITY ITEMS
APPENDIX-I	LIST OF ATTACHMENTS

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1.0 SCOPE

1.1 This specification (PMS) covers various piping classes for process and utility piping and minimum requirements for various piping/ pipeline materials necessary for the design of piping/ pipeline facilities coming under Gandhar Compressor Project of M/s GAIL(India) Limited).

This specification shall be read in conjunction with various Codes and Standards as applicable.

2.0 CODES AND STANDARDS

2.1 Pipeline and pipeline terminal facilities envisaged as part of this project shall be designed and engineered primarily in accordance with the provisions of the latest edition of the following codes:

(i) **PNGRB G.S.R. 808(E)** - Petroleum and Natural Gas Regulatory board

(ii) **ASME B 31.8** - Gas Transmission and Distribution Piping System

(iii) **OISD Standard 226** - Natural Gas Transmission Pipelines and City Gas Distribution Networks

2.2 All codes, standards and specifications referred herein shall be the latest edition of such documents.

2.3 For sake of brevity the initials of the society to which the codes are referred may be omitted in the specifications, for example, B16.5 is a code referring to ASME, A106 is a code referring to ASTM.

2.4 In addition, EIL specifications and standards for various piping and pipeline materials shall also be applicable.

3.0 MATERIAL SPECIFICATIONS

Individual piping class has been generally designed to cover a set of services operating within pressure-temperature combination as per ASME B16.5/ B16.34 or part of it. The PMS shall be strictly adhered to in design, requisitioning, purchasing, fabrication and testing of the piping system. However, deviations of material from class specifications may occur due to specific design conditions and/ or availability. These deviations are permissible if they equal or better the individual class requirements and shall be subjected to approval on case-to-case basis.

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All materials shall conform to detailed specifications listed in Annexure-II as applicable.

4.0 CLASS DESIGNATION CODE

The piping class designation shall generally consist of four digits in the format of Letter-Letter-Number-Letter e.g. AA1A, AA4A, DA1A, DA4A, EA1A, EA4A etc. as follows:

I) First letter indicates ASME class rating, e.g.:

A - 150 Class;
B - 300 Class;
D - 600 Class;
E - 900 Class

II) The Second letter (A) refers to same Piping Classes for different Sub-Jobs and is for internal EIL reference only. In some of the documents, the Second letter may not have been indicated altogether. For such cases, the equivalence of classes may be noted as below:-

A1A	~	AA1A
A1K	~	AA1K
A3A	~	AA3A
A4A	~	AA4A
B1A	~	BA1A
B1K	~	BA1K
B3A	~	BA3A
B4A	~	BA4A
D1A	~	DA1A
D1K	~	DA1K
D4A	~	DA4A
E1A	~	EA1A
E4A	~	EA4A

III) The third character is a number and it indicates differences in the specifications & Service within the same Material & Class Rating, e.g.:

No.	Material	Corrosion Allowance
1	Normal	1.5 mm [For CS] 0.0 mm [For SS]
3	Normal (for Utilities)	1.5 mm
4	Low Temperature Service	1.5 mm

IV) The last letter indicates type of material, e.g.:

A - Carbon steel;
K – Stainless Steel type 304, 304H, 304L

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5.0 PIPELINE

5.1 Line pipe material grade and wall thickness details are indicated in Table-1.

5.2 All branch connections on main pipeline shall be minimum 2 inch size, and only Weldolets or Tees or Flow-Tees shall be used for branch connections on main pipeline in Above ground section.

5.3 In Buried pipeline section, O'lets shall not be used. All branch connections shall be via Tees or Flow-Tees only, and subsequent reduction in size, if required, shall be achieved by reducers.

5.4 Flow Tees shall be used for branch connections in piggable sections of main pipeline, if the branch connection size is ≥ 25% of Mainline size.

6.0 PIPES

6.1 Carbon steel pipe shall be made by open hearth, electric furnace or basic oxygen process only. The steel used shall be fully killed and made with fine grain structure. The grade and wall thickness of various sizes of pipes shall be as per piping material specification for the applicable class.

6.2 Pipe dimensions shall be in accordance with ASME B 36.10 for carbon steel ASTM standard pipes & API 5L for carbon steel API 5L grade pipes.

6.3 All pipe threads shall conform to American Standard taper as per ASME B 1.20.1 NPT, unless otherwise specified.

6.4 For butt weld end, bevel shall be in accordance with API specification 5L or ASME B16.25 as applicable.

7.0 FITTINGS

7.1 Fully killed carbon steel shall be used in the manufacture of fittings. The fitting shall have carbon equivalent not exceeding 0.45, based on check analysis.

7.2 Threaded joints, if used, shall conform to American Standard taper as per ASME B1.20.1 NPT.

7.3 Dimensions of socket welded/ screwed fittings shall conform to ASME B 16.11. Swage shall be as per BS 3799.

7.4 Dimensions of steel butt welded fittings shall be as per ASME B 16.9/ MSS-SP-75, as applicable.

7.5 Bore of socket welded fittings shall suit outside diameter (OD) of pipe and its thickness.

7.6 Butt welding ends shall conform to API specification 5L or ASME B 16.25 as applicable. In case of difference in thickness of matching ends, requirements of ASME B 31.8 shall apply.

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7.7 Integrally reinforced forged branch fittings such as Sockolet, Weldolet etc. shall be as per MSS-SP-97. Fittings not covered in ASME B16.9 and MSS-SP-97 shall conform to manufacturer's standard.

7.8 Fittings thickness tolerances shall match pipe thickness tolerance.

7.9 Weldolets connected to the main pipeline shall be as per Table-2.

8.0 BENDS

8.1 Unless otherwise specified for process piping, only elbow of radius R = 1.5D shall be used.

8.2 In order to accommodate changes in vertical and horizontal alignment in piggable section of pipeline, Elastic bends/ Cold field bends/ Hot formed long radius bends shall be used.

For 18" Main line, Minimum Elastic Bend radius of 300 m shall be used.

Cold field bends with radius R = 40D shall be used.

Limited use of Long radius Bends with R = 6D (shop bends) may be permitted for reason of space constraints.

(D = Specified Outside Diameter)

8.3 Miters shall not be used both in Pipeline and Terminal Piping.

9.0 FLANGES

9.1 Pressure Temperature rating of flanges shall conform to B16.5/ B16.47 Series A, as applicable.

9.2 Dimensions of flanges shall be in accordance with B16.5/ B16.47 Series A, as applicable.

9.3 Neck of weld neck (WN) flanges shall suit pipe bore and thickness.

9.4 Bore of socket welded (SW) flanges shall suit pipe O.D. and its thickness.

9.5 Threads for screwed flanges, if used, shall conform to American Standard taper as per ASME B 1.20.1 NPT.

9.6 Sizes for blind flanges shall be indicated by nominal pipe size.

9.7 Finish of steel flange faces shall be as follows:

125 AARH : Serrations with 125-250 µin AARH

63 AARH : 32 to 63 µin AARH

9.8 Butt welding ends of WN flanges shall conform to ASME B 16.25.

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9.9 Brinnel hardness for RTJ groove shall be at least 20 BHN more than that of corresponding gasket as specified.

9.10 Spectacle blind/ spacer & blind of size upto 24" shall be in accordance with ASME B 16.48. For 26" and above manufacturer's standard shall be followed.

9.11 Two jack screw, 180^0 apart shall be provided in spectacle blind or spacer & blind assemblies as per EIL standard No. 7-44-0252.

10.0 GASKETS

10.1 Spiral wound gaskets with Grafoil filler shall conform to ASME B 16.20. All spiral wound gaskets shall be provided with carbon steel centering ring. Spiral wound gasket shall be self aligning type.

10.2 Octagonal ring joint gasket shall conform to B 16.20.

11.0 BOLTING & THREADS

11.1 Nuts for stud bolts shall be American Standard Hexagon Heavy Series and double chamfered.

11.2 Dimension and tolerances for stud bolts and nuts shall be as per ASME B 18.2.1 and 18.2.2 with full threading to ASME B 1.1 Class 2A thread for bolts and Class 2B for nuts. Diameter and length of stud bolts shall be as per ASME B 16.5/ ASME B16.47 with full threading.

11.3 Threads for nuts shall be as per ASME B 1.1

Nuts for stud bolts dia ¼" to 1"	:	UNC-2B
Nuts for stud bolts dia 1⅛" to 3¼"	:	8UN-2B

11.4 Threads for stud bolts shall be as per ASME B 1.1, as follows:

Stud bolts dia ¼" to 1"	:	UNC-2A
Stud bolts dia 1⅛" to 3¼"	:	8UN-2A

11.5 Threads for threaded pipe, fitting, flanges and valve shall be in accordance with B 1.20.1 taper threads, unless specified otherwise.

11.6 Stud bolts shall be fully threaded with two hexagonal nuts.

11.7 All Nuts & Bolts shall be Hot Dip Galvanized as per ASTM A153.

12.0 THREAD SEALANT

12.1 Threaded joints shall be made with 1" wide PTFE jointing tape.

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13.0 **VALVES**

13.1 Valves shall be as per relevant valve data sheets for various piping classes.

13.2 Sectionalizing valves, Block valves and other isolation valves installed on the main pipeline shall be ball valves with butt welding ends. All inline isolation valves on the mainline (pipeline) shall be full bore valves to allow smooth passage of cleaning as well as intelligent pigs. All Valves directly connected to main pipeline shall have butt welded ends.

13.3 All buried valves shall be provided with stem extension, sealant, vent/ drain and shall have butt welded ends as per relevant specification/ data sheet. Wherever underground valves are provided, valves shall be provided with stem extension in such a way that the center line of the rim of the hand wheel on a horizontal shaft or center of power is at approximately 1.0 m above the finished ground level. Valve surface shall be provided with corrosion protection coating.

13.4 Flange dimensions and face finish of flanged end valves shall conform to clause 9.0 of this specification.

13.5 Butt welding ends of Butt Welded valves shall conform to ASME B 16.25. However, all soft seated butt welded ball valves shall be provided with pup pieces as per relevant specifications.

13.6 Face-to-face and end-to-end dimensions shall conform to applicable standards.

13.7 Valves shall conform to following standards unless specified otherwise in piping material specification for various piping class.

Flanged/ Socket Welded end valves (1½" and below)

Design STD. for Process lines

Gate Valves	:	ISO EN 15761/ API 602
Globe Valves	:	ISO EN 15761
Ball Valves	:	ISO EN 17292
Plug Valves	:	BS 5353

Flanged/Butt Welded end valves (2" and above)

Design STD. for Process Lines

Gate Valves	:	API 6D
Globe Valves	:	BS 1873
Check Valves	:	API 6D
Ball Valves	:	API 6D
Plug Valves	:	API 6D

13.8 All manual operated valves shall be provided with wrench/ hand wheel or gear operator as specified herein below.

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13.8.1 **Gate/ Globe Valves**

For ASME class 150 and 300	-	Hand wheel operated for size ≤ 10" NB. Gear operated for size ≥ 12" NB.
For ASME class 600	-	Hand wheel operated for size ≤ 8" NB. Gear operated for size ≥ 10" NB.
For ASME class 900	-	Hand wheel operated for size ≤ 4" NB. Gear operated for size ≥ 6" NB.

13.8.3 **Ball valves & Plug Valves**

For ASME class 150, 300, 600, 900	-	Wrench operated for size ≤ 4" NB. Gear operated for size ≥ 6" NB.

13.8.4 **Direct Gas Actuated Valves**

Direct Gas actuated valves shall be as per P & IDs. The actuator shall have provision for remote operation as per P & IDs. All actuated valves shall have additional provision of hand wheel operation.

14.0 QUICK OPENING END CLOSURE

Quick opening end closure to be installed on Scraper Traps and Cold Vents shall be designed in accordance with Section VIII of ASME Boiler and Pressure Vessel Code and equipped with safety locking devices in compliance with Section VIII, division 1, UG-35.2.

15.0 HYDROTESTING VENTS AND DRAINS

In terminal piping, high point vents and low point drains required for the purpose of hydrotesting shall be of size 0.75". Vents & drains shall consist of ball valve duly welded with pup piece with blind flange assembly. For 900# rating, vents & drains shall consist of double ball valves duly welded with pup piece with blind flange assembly.

16.0 PIPELINE SPECIATLITY ITEMS

Pipeline specialty items viz. Scraper Traps, Flow-Tees, Insulating Joints, LR Bends etc. shall be as per Table-2.

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TABLE – 1

MAIN PIPELINE DETAILS
(FOR NEW SECTIONS ONLY)

Pipeline		Pipeline Details				
From	To	Outer Diameter, (inch)	Outer Diameter, mm	Material API 5L Grade	Wall Thickness, mm	Corrosion Allowance, mm
GPU, Gandhar	NTPC, Jhanore	12”	323.8	X60 PSL2	11.1	1.5
NTPC, Jhanore	Vemar	14”	355.6	X60 PSL2	9.5	0.5
GPU, Gandhar	NTPC, Jhanore	18”	457	X70 PSL2	9.5	1.5
Hazira	Vijaipur	36”	914	X70 PSL2	20.6	1.5
Dahej	Vijaipur	42”	1067	X70 PSL2	23.8	1.5
Dahej	Vijaipur	48”	1219	X70 PSL2	25.4	1.5

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TABLE-2
PIPELINE SPECIALITY ITEMS

MAINLINE (FROM SCRAPER LAUNCHER TO SCRAPER RECEIVER)	
ITEM	**MATERIAL DESCRIPTION**
MOTHER PIPE FOR LONG RADIUS BENDS (R=6D)	12":- API 5L Gr. X-60 PSL2, Seamless/EFSW, 11.1 mm wall thk. 14":- API 5L Gr. X-60 PSL2, Seamless/EFSW, 9.5 mm wall thk. 18":- API 5L Gr. X-70 PSL2, LSAW, 9.5 mm wall thk.
FLOW TEES	12"X12":- Tee: MSS-SP-75 Gr. WPHY-60; Ends: ASTM A694 Gr.F60 (CHARPY) 14"X14":- Tee: MSS-SP-75 Gr. WPHY-60; Ends: ASTM A694 Gr.F60 (CHARPY) 18"X18":- Tee: MSS-SP-75 Gr. WPHY-70; Ends: ASTM A694 Gr.F70 (CHARPY)
INSULATING JOINTS ON PIPELINES	Monoblock type 18" Pipeline:- Body:- MSS-SP-75 Gr. WPHY-70/ ASTM A694 Gr. F70 (CHARPY)
FLANGES ON MAINLINE	12", FLANGE WN, B-16.5, ASTM A 694 GR.F-60 (CHARPY), 600#, RF/125AARH, 11.1mm THK. 14", FLANGE WN, B-16.5, ASTM A 694 GR.F-60 (CHARPY), 600#, RF/125AARH, 9.5mm THK. 18", FLANGE WN, B-16.5, ASTM A 694 GR.F-70 (CHARPY), 600#, RF/125AARH, 9.5mm THK.
SCRAPER LAUNCHER & RECEIVER	12" & 14" Pipelines:- Body:- API 5L Gr. X-60 PSL2 Neck:- API 5L Gr. X-60 PSL2 Reducer:- MSS-SP-75 WPHY-60 QOEC:- ASTM A694 Gr. F60 (CHARPY)
	18" Pipelines:- Body:- API 5L Gr. X-70 PSL2 Neck:- API 5L Gr. X-70 PSL2 Reducer:- MSS-SP-75 WPHY-70 QOEC:- ASTM A694 Gr. F70 (CHARPY)
WELDOLETS CONNECTED TO MAINLINE	12", 14" & 18" Pipelines:- MSS-SP97 ASTM A694 GR. F70 (CHARPY), BW, 2.0 INCH to 6.0 INCH - XXS

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APPENDIX-I

LIST OF ATTACHMENTS

SL. NO.	DESCRIPTION	STANDARD NO.	REV. NO.	NO. OF SHEETS
1.	Pressure gauge instruments connection	B011-910-83-41-45001 Sht. 1 of 2	0	1
2.	Vents & Drains	B011-910-83-41-45001 Sht. 2 of 2	0	1
3.	Wells Installations 1½" Diameter Taps	7-44-0353	4	2
4.	Skin type & welded temperature instruments connection	Shall be as per Instrumentation Standards	-	-
5.	Dimensions for handle projection for Spacers and Blinds, 1/2"-24" NB (150CL,300CL, & 600CL FF)	7-44-0166	4	1

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गेल (इंडिया) लिमिटेड

GAIL (India) LIMITED

गांधार कम्प्रैसर परियोजना

GANDHAR COMPRESSOR PROJECT

ANNEXURE – II

PIPING MATERIAL SPECIFICATION
LIST OF SPECIFICATIONS & DATA SHEETS
(PIPELINE ENGINEERING)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
1	06.09.19	Revised & ReIssued for Engineering	TLP	RSB	MSG
0	21.06.19	Issued for Engineering	TLP	RSB	MSG

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TABLE OF CONTENTS

1.0 LIST OF SPECIFICATIONS

2.0 LIST OF DATA SHEETS

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1.0 LIST OF SPECIFICATIONS

Following detailed EIL specifications shall be used for procurement of materials against various piping classes and for pipeline.

S.No.	Title	Specification No.
1.0	Standard Specification for Submerged Arc Longitudinal welded (SAWL) Line pipe (Onshore)	6-71-0001
2.0	Standard Specification for Submerged Arc Helical welded (SAWH) line pipe (Onshore)	6-71-0004
3.0	Standard Specification for 3 Layer Polyethylene Coating of Linepipes	6-71-0041
4.0	Standard Specification for Pipeline Ball valves (Onshore)	6-71-0014
5.0	Standard specification for Pipeline Lubricated Plug valves (Onshore)	6-71-0016
6.0	Addendum to Standard Specification for Plug valves for pipeline system (Onshore)	B240-910-83-41-AD-0016
7.0	Standard specification for check valves for pipelines system (onshore)	6-71-0017
8.0	Addendum to Standard Specification for check valves for pipeline system (onshore)	B240-910-83-41-AD-0017
9.0	Standard Specification for Long Radius Bends	6-71-0021
10.0	Standard Specification for Flanges and welded Fittings {450mm (18”) NB and above}	6-71-0023
11.0	Standard Specification for Seamless Fittings and Flanges up to 400(16”)NB	6-71-0024
12.0	Specification for Flow Tees	6-71-0025
13.0	Specification for Insulating Joints (onshore)	6-71-0026
14.0	Standard specification for Scraper Traps for onshore pipelines	6-71-0031
15.0	Standard Specification for Pig Signallers (onshore)	6-71-0033
16.0	Standard specification for Quick opening End closure (Blow down lines)	6-71-0034
17.0	Technical Notes for Pipes	6-44-0051
18.0	Technical Notes for Valves	6-44-0052
19.0	Technical notes for flanges, spectacle blinds and drip rings	6-44-0053
20.0	Technical notes for butt welded, socket welded and screwed fittings.	6-44-0054
21.0	Technical Notes for Gaskets	6-44-0056

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22.0	Technical Notes for Bolts & Nuts	6-44-0057

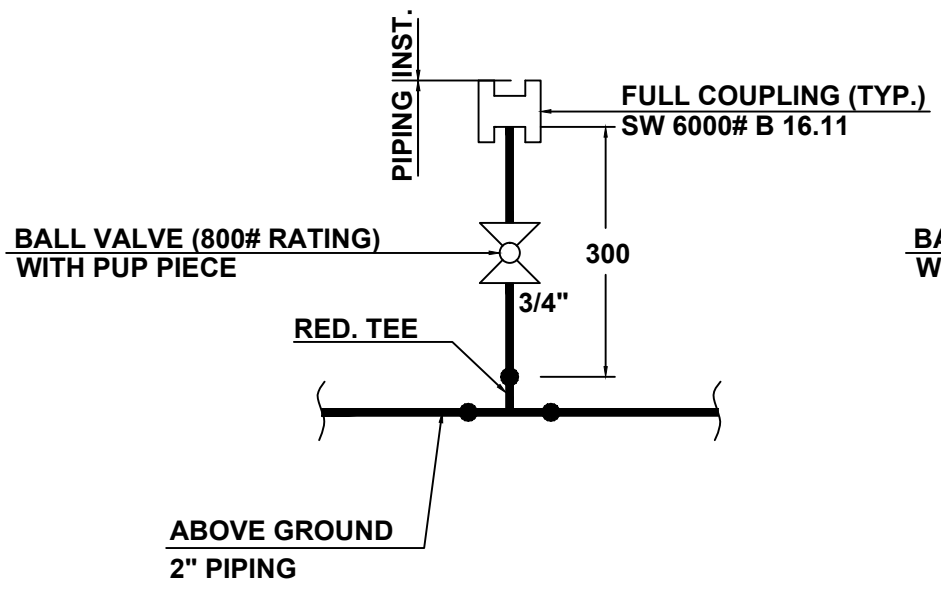
2.0 LIST OF DATA SHEETS

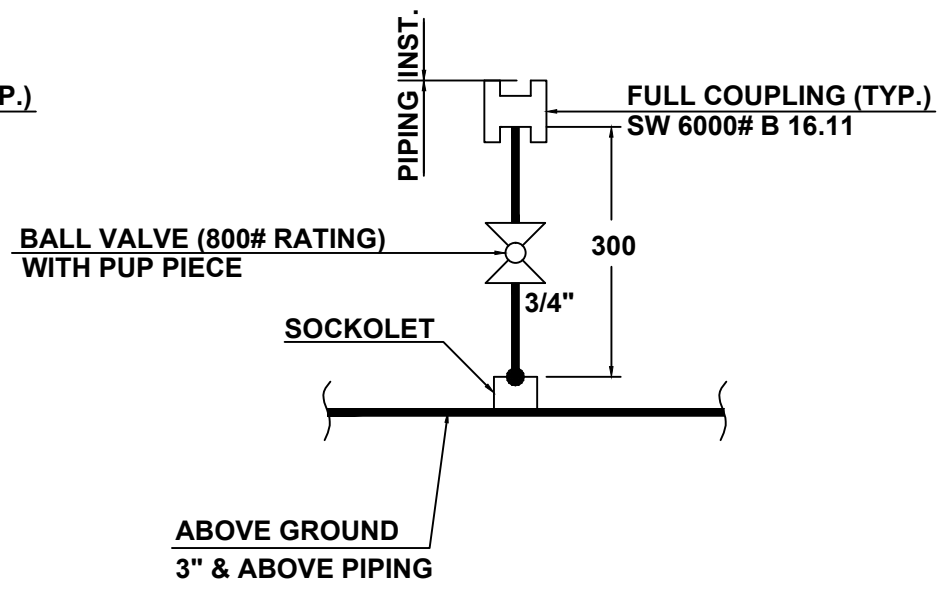
Following EIL data sheets shall be used for procurement of piping materials:

S.No.	Title	Data Sheet No.
1.	Data sheet for Ball Valves	B240-000-83-41-DS-0011 to 0030 & 0101 to 0130
2.	Data sheet for Insulating Joints	B240-000-83-41-DS-0061 to 0063
3.	Data sheet for Flow Tees	B240-000-83-41-DS-0051 to 0054
4.	Data sheet for Scraper Traps	B240-000-83-41-DS-0001 to 0003
5.	Datasheet for Pig-Signallers	B240-000-16-51-DS-9235
6.	Datasheet for QOEC	B240-000-83-41-DS-0004
7.	Data sheet for Plug Valves	B240-000-83-41-DS-0031 to 0040
8.	Data sheet for Check Valves	B240-000-83-41-DS-0041 to 0045
9.	Data sheet for Globe Valves	B240-000-83-41-DS-0046 to 0050
10.	Data sheet for Strainers	B240-000-83-41-DS-0071 & 0072
11.	Data sheet for Globe Valves (<2” NB)	Sheet Nos. 52001, 52101 of Specification No. 6-44-0006
12.	Data sheet for Gate Valves (<2” NB)	Sheet No. 51001, 51101 of Specification No. 6-44-0006
13.	Data sheet for Ball Valves (<2” NB)	B011-000-83-41-DS-0081 & 0085
14.	Data sheet for Plug Valves (<2” NB)	B011-000-83-41-DS-0091 to 0095

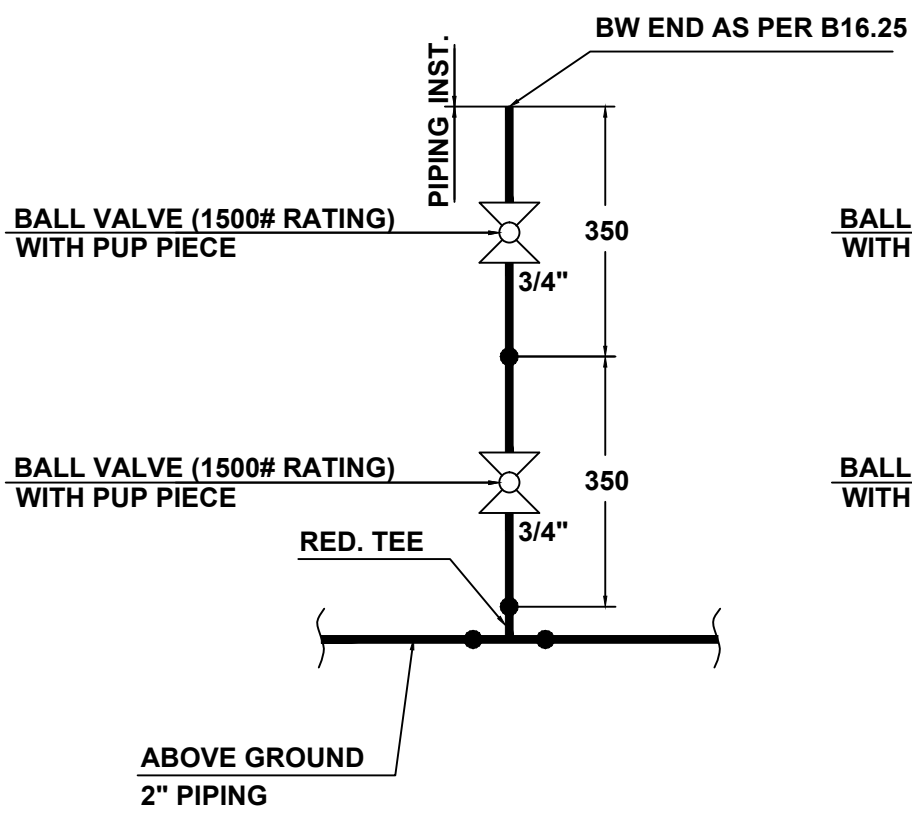
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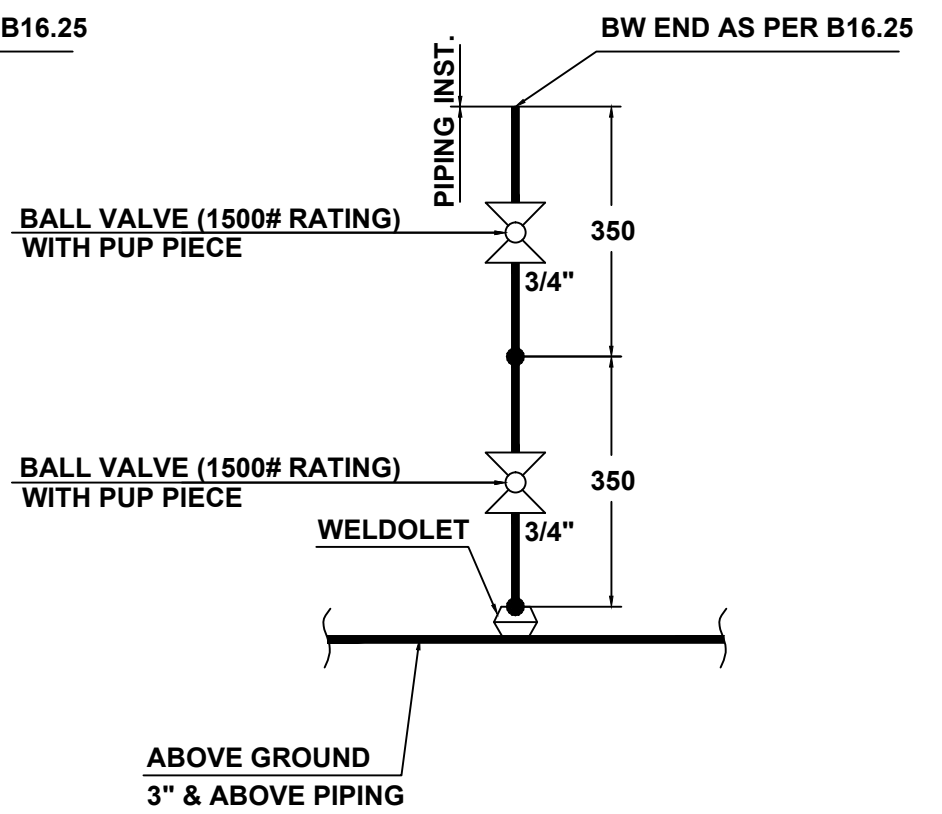
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JOB No. : B240	0	08.04.19	ISSUED WITH PMS	TLP	RSB	MSG	
CLIENT : GAIL (INDIA) LTD.							





150#, 300# & 600#





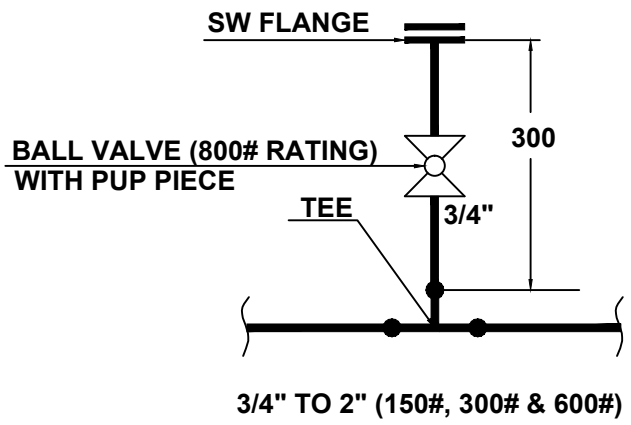
900#

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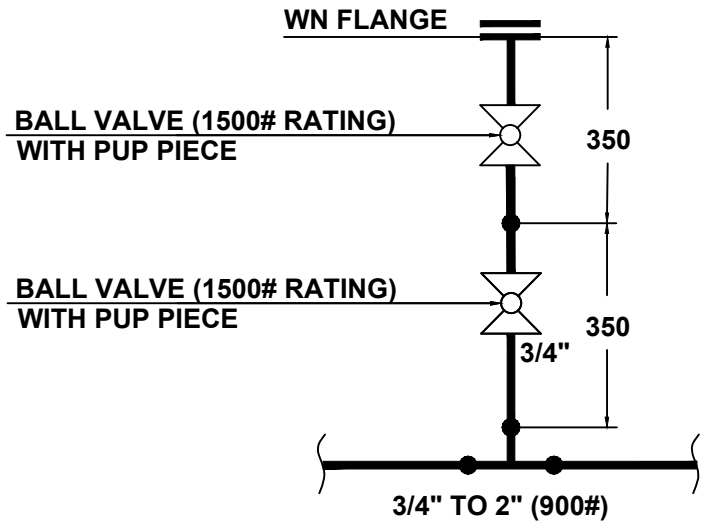
ENGINEERS INDIA LIMITED NEW DELHI	PRESSURE GAUGE INSTRUMENTS CONNECTION DETAILS	DRAWING NO.	REV.
		B240-910-83-41-45001	0
		Sheet 1 of 2	

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JOB No. : B240	0	08.04.19	ISSUED WITH PMS	TLP	RSB	MSG	
CLIENT : GAIL (INDIA) LTD.							

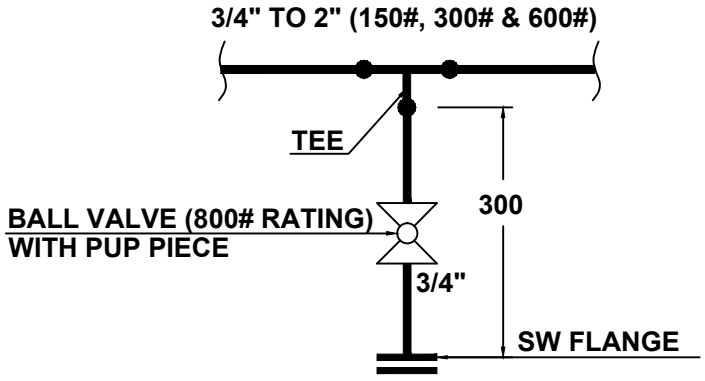
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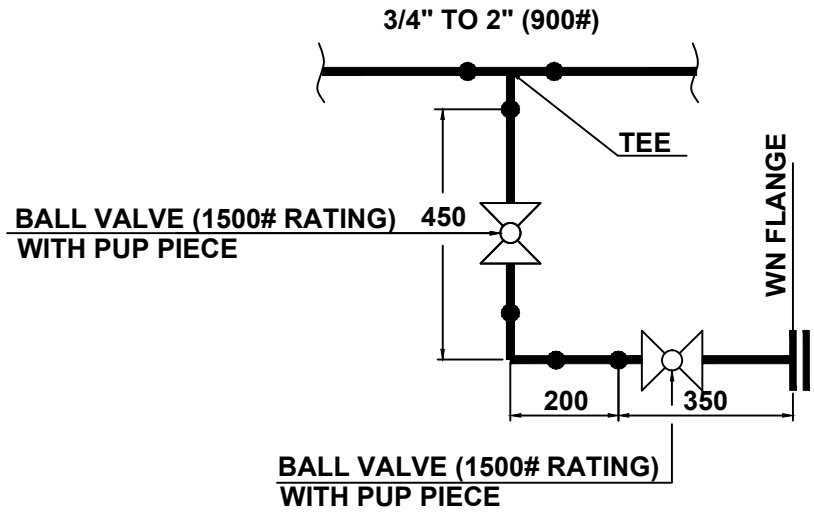


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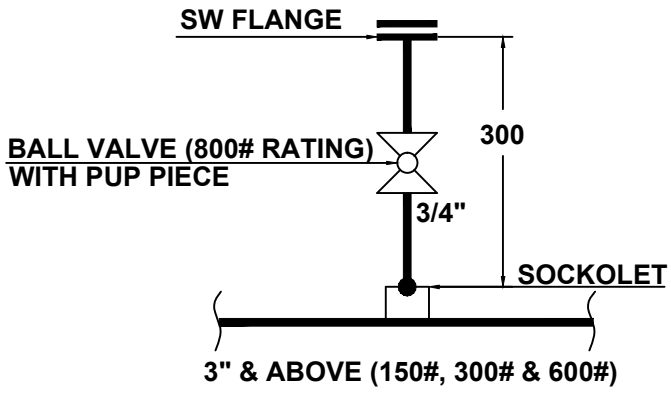


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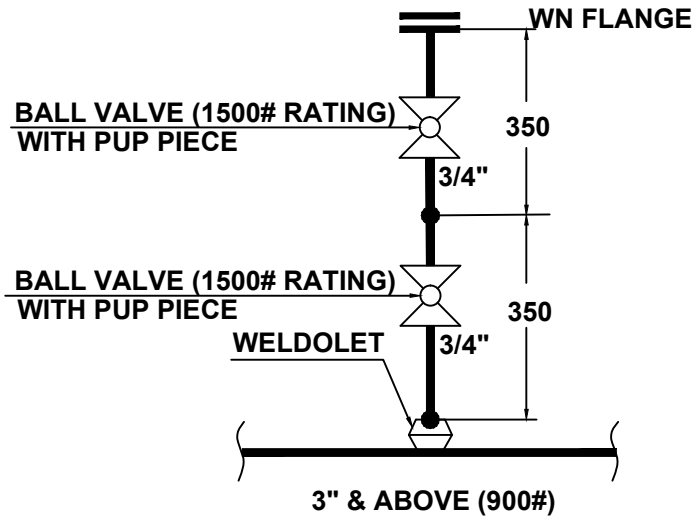




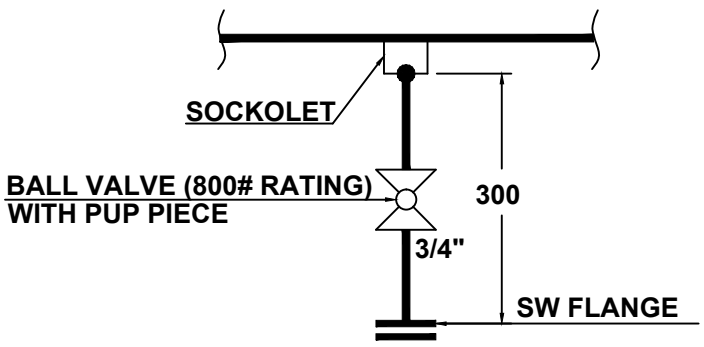
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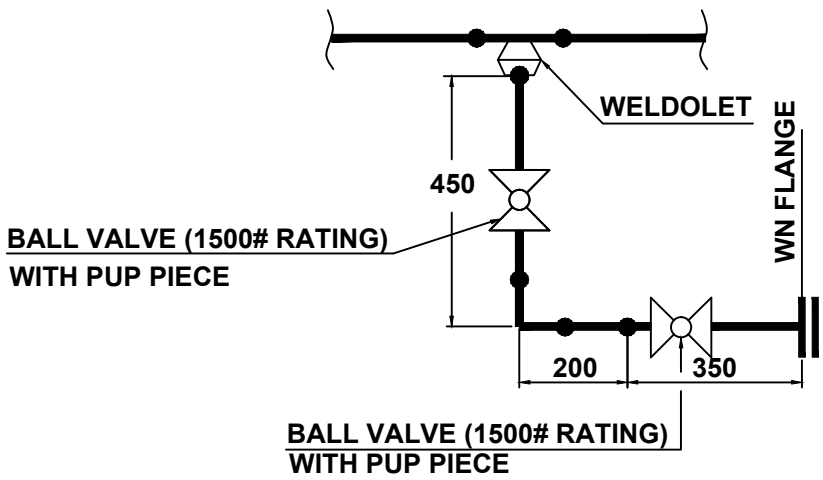


3" & ABOVE (150#, 300# & 600#)



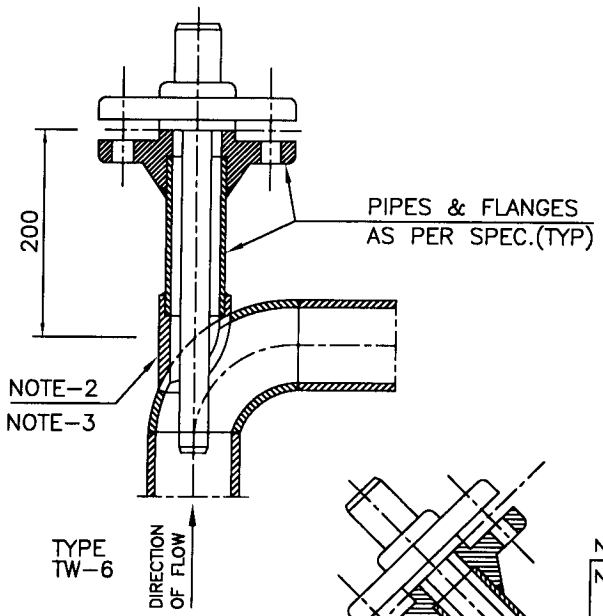
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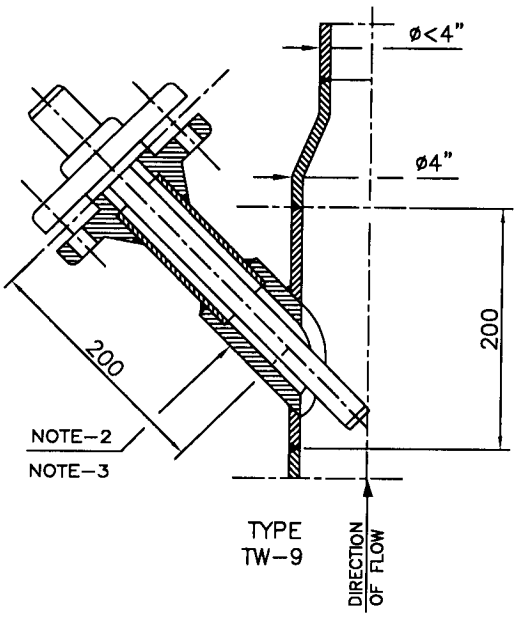


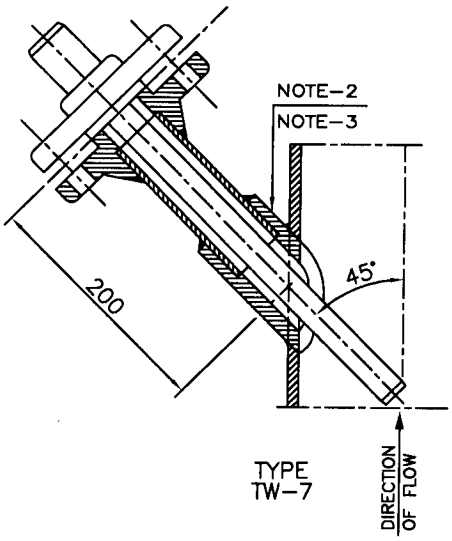


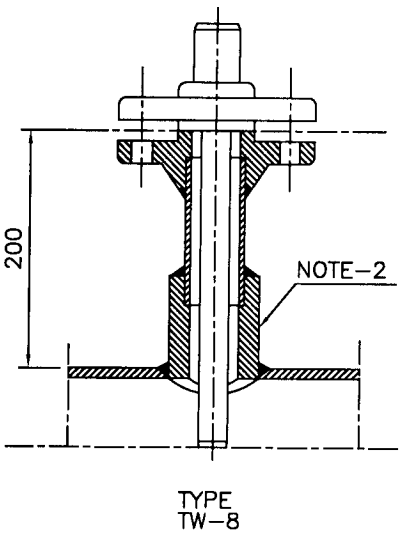
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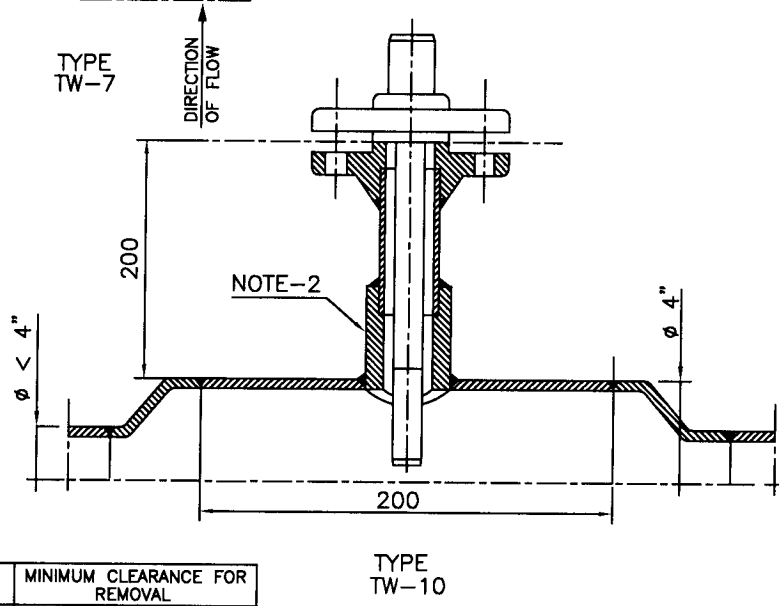
ENGINEERS INDIA LIMITED NEW DELHI	PROCESS VENT & DRAIN CONNECTION DETAILS	DRAWING NO.	REV.
		B240-910-83-41-45001	0
		Sheet 2 of 2	











LINE DIA.	MINIMUM CLEARANCE FOR REMOVAL
4"	630
6"	630
8"	670
10"	670
12"	670
14"	670
16"	670
18"	670
20" AND LARGER	750
VESSELS	750

NOTES:–

1 BOLTS, NUTS AND GASKETS BY PIPING.
2 BRANCH FITTING SHALL BE AS PER PMS
3 IF BRANCH FITTING IS A COUPLING, IT SHALL BE OF SPECIAL LENGTH.

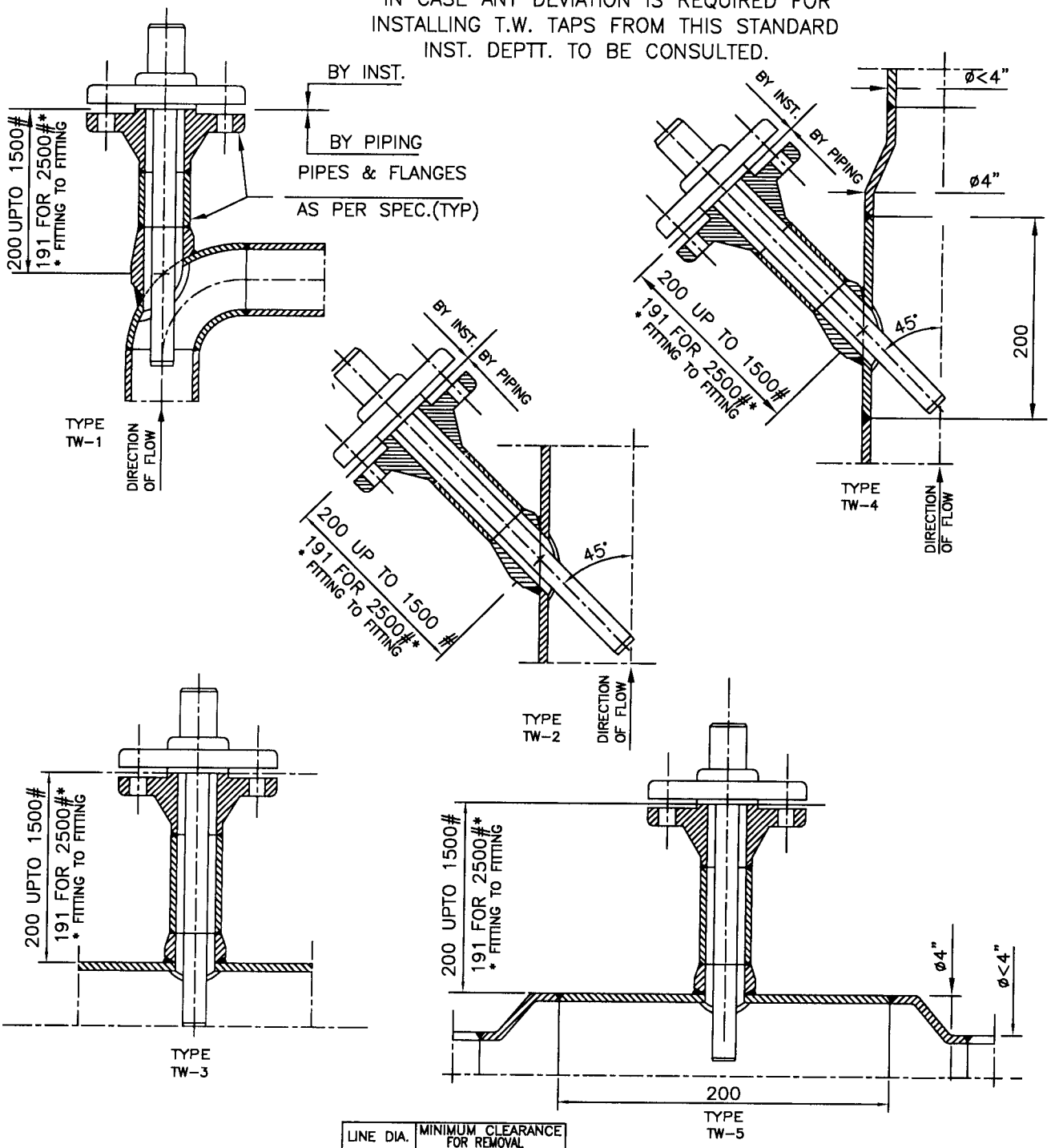
TYPE TW–6 : ELBOW MIN. 4" DIA. OR LARGER
TYPE TW–7 : VERTICAL LINE 4" DIA. OR LARGER
TYPE TW–8 : HORIZONTAL LINE 4" DIA. OR LARGER
TYPE TW–9 : VERTICAL LINE DIA. LESS THAN 4"
TYPE TW–10: HORIZONTAL LINE DIA. LESS THAN 4"

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
4	21.10.14	REVISED & ISSUED AS STANDARD	SH	AK	RN /ATD	SC
3	29.06.09	REAFFIRMED & ISSUED AS STANDARD	PK	RN	SC	ND

Approved by

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IN CASE ANY DEVIATION IS REQUIRED FOR INSTALLING T.W. TAPS FROM THIS STANDARD INST. DEPTT. TO BE CONSULTED.



LINE DIA.	MINIMUM CLEARANCE FOR REMOVAL
4"	630
6"	630
8"	670
10"	670
12"	670
14"	670
16"	670
18"	670
20" & ABV	750
VESSELS	750

NOTES:-

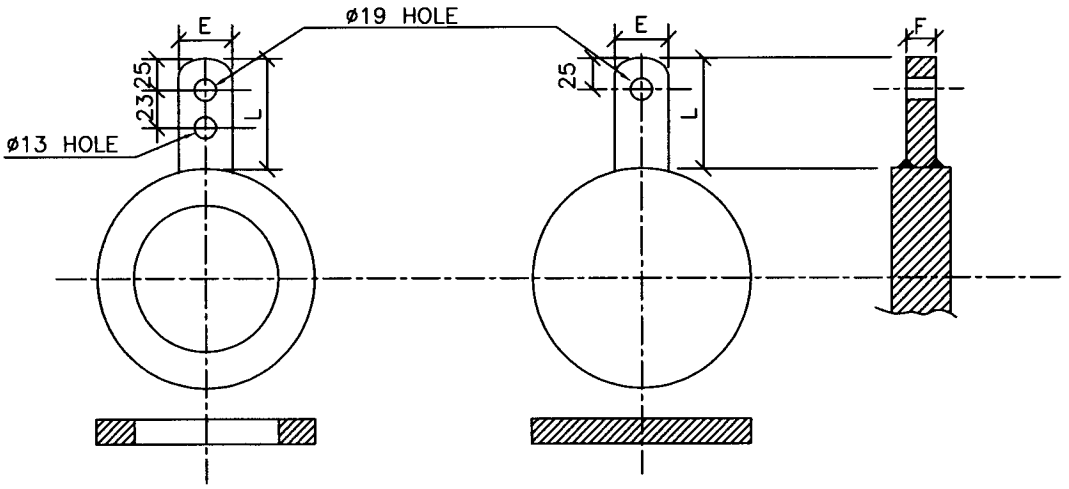
1 BOLTS, NUTS AND GASKETS BY PIPING.
2 BRANCH FITTING SHALL BE AS PER PMS.

TYPE TW-1 : ELBOW MIN. 4" ø OR LARGER
TYPE TW-2 : VERTICAL LINE 4" ø OR LARGER
TYPE TW-3 : HORIZONTAL LINE 4" ø OR LARGER
TYPE TW-4 : VERTICAL LINE DIA. LESS THAN 4"
TYPE TW-5 : HORIZONTAL LINE DIA. LESS THAN 4"

Rev. No	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
4	21.10.14	REVISED & ISSUED AS STANDARD	SH	AK	RN /ATD	SC
3	29.06.09	REAFFIRMED & ISSUED AS STANDARD	PK	RN	SC	ND

Approved by

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PIPE SIZE INCH	150CL FF			300CL FF			600CL FF		
	E	F	L	E	F	L	E	F	L
1/2"	25	3	100	25	6	100	25	6	110
3/4"	25	3	100	25	6	100	25	6	110
1"	25	3	100	25	6	100	25	6	110
1 1/2"	25	6	100	25	6	100	25	6	110
2"	25	6	100	25	6	100	25	6	110
2 1/2"	25	6	100	25	6	110	25	6	110
3"	40	6	105	40	6	110	40	8	110
4"	40	6	105	40	6	110	40	8	110
6"	40	6	105	40	6	110	40	8	115
8"	40	6	105	40	8	110	40	10	125
10"	40	8	105	40	10	110	40	10	125
12"	40	8	110	40	10	120	40	15	125
14"	40	10	120	40	15	120	40	15	145
16"	40	10	120	40	15	130	40	20	140
18"	40	10	120	40	20	130	40	20	140
20"	40	14	120	40	20	140	40	25	140
24"	50	16	120	50	20	140	50	25	145

NOTES :

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. ALL OTHER DIMENSIONS SHALL BE AS PER ASME B16.48.
3. MATERIAL SHALL BE AS PER MR.
4. THE HANDLE MAY BE INTEGRAL OR ATTACHED TO THE LINE BLANK/SPACER BY WELDING. IN CASE OF ATTACHMENT OF HANDLE BY WELDING, HEAT TREATMENT AND WELDING SHALL BE IN ACCORDANCE WITH ASME B31.3.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
4	10.09.18	REAFFIRMED AND ISSUED AS STANDARD	PK	SH	MI	RKT
3	31.07.13	REAFFIRMED & ISSUED AS STANDARD	UK	SH	RN	ATD DM

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Valve Manufacturer		----	
Actuator Manufacturer		Not Applicable	
Valve Tag No.		-	
Purchaser's Spec. No.	6-44-0052	**ANSI Rating**	300#
Design Standard	API 6D	**EIL Piping Class**	BA1K
Size, mm (inch) NB	50 (2) to 400 (16)	**Valve Bore**	Reduced Bore
Ends	Both Ends Flanged as per ASME B 16.5, RF	**Face Finish of Flanges**	125 AARH
VALVE DESIGN CONDITIONS			
Corrosion Allowance, mm	NIL	**Temperature, °C**	-29 to 65
Service	Fuel Gas	**Installation**	Above Ground
Design Factor	0.5		
CONNECTING PIPE DETAILS			
Diameter (NB), mm	Not applicable		
Grade	Not applicable		
Wall Thickness, mm	Not applicable		
VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of operator	Manual/Gear Operator	**Stem Extension**	Not Required
Operator Spec. no.	-	**Length of stem extension, m**	-
Operator Data Sheet	-		

VALVE MATERIAL SPECIFICATION (Equivalent or Superior)		
PART DESCRIPTION	**MATERIAL**	**MATERIAL OFFERED**
Body	ASTM A351 Gr.CF8	
Ball	SS304/SS316	
Body Seat Rings	AISI 410	
Seat seal	VITON	
Stem	SS304/SS316/AISI 410 (No casting)	
Stem Seal	PTFE/ VITON/GRAFOIL	
Stud Bolts	ASTM A 193 Gr. B7	
Nuts	ASTM A 194 Gr. 2H	

Note:

1. Separate wrench shall be provided with each wrench operated valve.
2. The data sheets shall be read in conjunction with valve specification.
3. Ball valves shall be trunion mounted type.
4. Minimum body thickness shall be as per ASME B 16.34.
5. With Soft Seat design, valves shall be fire safe design as per API 6FA.
6. All testing shall be as per API 6D.
7. All valves shall be bi-directional type.
8. All casting shall be solution heat treated.
9. Stem seal/body seal materials shall be provided with corrosion inhibitor.
10. Compressed asbestos filler (CAF) shall not be used for body sealing/ gasket materials.
11. All stud bolts and nuts shall be hot-dipped galvanised as per ASTM A 153.

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
A	08.04.19	Issued for Bids	TLP	RSB	MSG

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Valve Manufacturer/Manufacturing Plant			
Actuator Manufacturer			
Valve Tag No.		Refer Table-1 (Page 2 of 2)	
Purchaser's Spec. No.	6-71-0014	**ANSI Rating**	600#
Design Standard	API 6D	**EIL Piping Class**	DA1A
Size, mm (inch) NB	500 (20")	**Valve Bore**	Reduced Bore
Ends	Both Ends Flanged as per ASME B 16.5, RF	**Face Finish of Flanges**	125 AARH (Smooth Finish)
VALVE DESIGN CONDITIONS			
Corrosion Allowance, mm	1.5	**Temperature, °C**	(-) 29 to 65
Service	Natural Gas	**Installation**	Above Ground
CONNECTING PIPE DETAILS			
Diameter (NB), mm	Not Applicable		
Wall Thickness, mm/ Schedule	Not Applicable		
VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of operator	Gas Powered Actuator	**Stem Extension**	Not Required
Operator Spec. no.	B240-000-83-41-SP-0004	**Length of stem extension, m**	Not Applicable
Operator Data Sheet	B240-000-83-41-DS-0019		

VALVE MATERIAL SPECIFICATION (Equivalent or superior)		
PART DESCRIPTION	**MATERIAL SPECIFIED**	**MATERIAL OFFERED**
Body	ASTM A216 Gr.WCB/ ASTM A 105 N	
Ball	(ASTM A216 Gr.WCB/ ASTM A 105 N) + 0.003"ENP	
Body Seat Rings	(AISI 4140 + 0.003" ENP) / AISI 410	
Seat Design (Note-3)	Metal Seat/ Soft Seat	
Secondary Seat seal (In case of Primary Metal to Metal Seat Design) (Note-3)	VITON/ RPTFE	
Primary Seat Seal (In case of Primary Soft Seat Design) (Refer Notes-2 & 3)	DEVLON V API	
Stem (No Casting)	(AISI 4140 + 0.003" ENP) / AISI 410	
Stem Seal	VITON/ RPTFE	
Stud Bolts	ASTM A 193 Gr. B7 (Galvanized)	
Nuts	ASTM A 194 Gr. 2H (Galvanized)	

Notes:-

1. The valve data sheet shall be read in conjunction with Valve Specification, Actuator Specification and Actuator Datasheet enclosed with the bid.

A	06.09.2019	Issued for Bids	TLP	RSB	MSG
Rev	Date	Revisions	By	Chk	Approved

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2. With Soft seat design, valves shall be fire safe design as per API 6FA.
3. If Vendor proposes primary Metal Seat design, then Vendor shall provide details for 'Secondary Seat Seal' and the column for 'Primary Seat Seal' is not applicable.
   If Vendor proposes Primary Soft Seat Design, then Vendor shall provide details for 'Primary Seat Seal' and the column for 'Secondary Seat Seal' is not applicable.
4. Surface preparation & painting shall be as per EIL specification no. 6-71-0014.
5. Compressed asbestos filler (CAF) shall not be used for body sealing/ gasket materials.
6. All stud bolts and nuts shall be hot-dipped galvanised as per ASTM A 153.
7. All Valves are Gas Actuated and shall have provision for hand operation.
8. Remote/Local Operation of Actuators shall be as per Specification No. B240-000-83-41-SP-0004 and Datasheet No. B240-000-83-41-DS-0019.
9. Valve Timing of Actuated Valves covered in this Datasheet are as follows:-

Table-1: Valve-Timing & Tag. Nos.

S. No.	Size (inch)	Maximum Valve Operation Time (Seconds)	Tag Nos.	Actuator Operation
1	20	60-100	910-AV-1111	Remote Actuated (Local as well as Remote Actuated)

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Valve Manufacturer/Manufacturing Plant			
Actuator Manufacturer			
Valve Tag No.		Refer Table-1 (Page 2 of 2)	
Purchaser's Spec. No.	6-71-0014	**ANSI Rating**	600#
Design Standard	API 6D	**EIL Piping Class**	DA4A
Size, mm (inch) NB	50 (2") to 600 (24")	**Valve Bore**	Reduced Bore
Ends	Both Ends Flanged as per ASME B 16.5, RF	**Face Finish of Flanges**	125 AARH (Smooth Finish)
VALVE DESIGN CONDITIONS			
Corrosion Allowance, mm	1.5	**Temperature, °C**	(-) 45 to 65
Service	Natural Gas	**Installation**	Above Ground
CONNECTING PIPE DETAILS			
Diameter (NB), mm	Not Applicable		
Wall Thickness, mm/ Schedule	Not Applicable		
VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of operator	Gas Powered Actuator	**Stem Extension**	Not Required
Operator Spec. no.	B240-000-83-41-SP-0004	**Length of stem extension, m**	Not Applicable
Operator Data Sheet	B240-000-83-41-DS-0019		

VALVE MATERIAL SPECIFICATION (Equivalent or superior)		
PART DESCRIPTION	**MATERIAL SPECIFIED**	**MATERIAL OFFERED**
Body	ASTM A350 LF2 CL.1/ ASTM A352 Gr. LCB	
Ball	SS 304/ SS 316	
Body Seat Rings	(AISI 4140 + 0.003" ENP) / AISI 410	
Seat Design (Note-3)	Metal Seat/ Soft Seat	
Secondary Seat seal (In case of Primary Metal to Metal Seat Design) (Note-3)	VITON/ RPTFE	
Primary Seat Seal (In case of Primary Soft Seat Design) (Refer Notes-2 & 3)	DEVLON V API	
Stem (No Casting)	SS304/SS316/AISI 410	
Stem Seal	VITON/ RPTFE	
Stud Bolts	ASTM A 320 GR.L7, GALVANIZED	
Nuts	ASTM A 194 GR.4, GALVANIZED	

Notes:-

1. The valve data sheet shall be read in conjunction with Valve Specification, Actuator Specification and Actuator Datasheet enclosed with the bid.

B	13.09.2019	Revised & Re-Issued for Bids	SS/TLP	RSB	MSG
A	06.09.2019	Issued for Bids	TLP	RSB	MSG
Rev	Date	Revisions	By	Chk	Approved

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2. With Soft seat design, valves shall be fire safe design as per API 6FA.
3. If Vendor proposes primary Metal Seat design, then Vendor shall provide details for 'Secondary Seat Seal' and the column for 'Primary Seat Seal' is not applicable.
   If Vendor proposes Primary Soft Seat Design, then Vendor shall provide details for 'Primary Seat Seal' and the column for 'Secondary Seat Seal' is not applicable.
4. Surface preparation & painting shall be as per EIL specification no. 6-71-0014.
5. Compressed asbestos filler (CAF) shall not be used for body sealing/ gasket materials.
6. All stud bolts and nuts shall be hot-dipped galvanised as per ASTM A 153.
7. All Valves are Gas Actuated and shall have provision for hand operation.
8. Remote/Local Operation of Actuators shall be as per Specification No. B240-000-83-41-SP-0004 and Datasheet No. B240-000-83-41-DS-0019.
9. Valve Timing of Actuated Valves covered in this Datasheet are as follows:-

Table-1: Valve-Timing & Tag. Nos.

S. No.	Size (inch)	Maximum Valve Operation Time (Seconds)	Tag Nos.	Actuator Operation
1	To be sized by Compressor Vendor	3 to 5 seconds per Inch dia (to be firmed up by Compressor Vendor)	910-AV-1109, 910-AV-1110	Local Actuated

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Valve Manufacturer/Manufacturing Plant			
Actuator Manufacturer		Not Applicable	
Valve Tag No.		Not Applicable	
Purchaser's Spec. No.	6-71-0014	**ANSI Rating**	900#
Design Standard	API 6D	**EIL Piping Class**	EA1A
Size, mm (inch) NB	50 (2") to 450 (18")	**Valve Bore**	Full Bore
Ends	Both Ends Flanged as per ASME B 16.5, RTJ	**Face Finish of Flanges**	63 AARH (Smooth Finish)
VALVE DESIGN CONDITIONS			
Corrosion Allowance, mm	1.5	**Temperature, °C**	(-) 29 to 65
Service	Natural Gas	**Installation**	Above Ground
CONNECTING PIPE DETAILS			
Diameter (NB), mm	Not Applicable		
Wall Thickness, mm/ Schedule	Not Applicable		
VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of operator	Manual (Note-7)	**Stem Extension**	Not Required
Operator Spec. no.	Not Applicable	**Length of stem extension, m**	Not Applicable
Operator Data Sheet	Not Applicable		

VALVE MATERIAL SPECIFICATION (Equivalent or superior)		
PART DESCRIPTION	**MATERIAL SPECIFIED**	**MATERIAL OFFERED**
Body	ASTM A216 Gr.WCB/ ASTM A 105 N	
Ball	(ASTM A216 Gr.WCB/ ASTM A 105 N) + 0.003"ENP	
Body Seat Rings	(AISI 4140 + 0.003" ENP) / AISI 410	
Seat Design (Note-3)	Metal Seat/ Soft Seat	
Secondary Seat seal (In case of Primary Metal to Metal Seat Design) (Note-3)	VITON/ RPTFE	
Primary Seat Seal (In case of Primary Soft Seat Design) (Refer Notes-2 & 3)	DEVLON V API	
Stem	(AISI 4140 + 0.003" ENP) / AISI 410	
Stem Seal	VITON/ RPTFE	
Stud Bolts	ASTM A 193 Gr. B7 (Galvanized)	
Nuts	ASTM A 194 Gr. 2H (Galvanized)	

Notes:-

1. The valve data sheet shall be read in conjunction with valve Specification enclosed with the bid.
2. With Soft seat design, valves shall be fire safe design as per API 6FA.

A	06.09.2019	Issued for Bids	TLP	RSB	MSG
Rev	Date	Revisions	By	Chk	Approved

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3. If Vendor proposes primary Metal Seat design, then Vendor shall provide details for 'Secondary Seat Seal' and the column for 'Primary Seat Seal' is not applicable.
   If Vendor proposes Primary Soft Seat Design, then Vendor shall provide details for 'Primary Seat Seal' and the column for 'Secondary Seat Seal' is not applicable.
4. Surface preparation & painting shall be as per EIL specification no. 6-71-0014.
5. Compressed asbestos filler (CAF) shall not be used for body sealing/ gasket materials.
6. All stud bolts and nuts shall be hot-dipped galvanised as per ASTM A 153.
7. Requirement of manual operator (Wrench/ Hand wheel/ Gear Operator) shall be as per Specification No. 6-71-0014.
8. Separate wrench shall be provided with each wrench-operated valve.
9. Valves shall have Lock Open/ Lock Close provision as per P&IDs.
10. These Valves shall be located on the upstream of PSV Tag Nos. 910-PSV-1401A & 910-PSV-1401B. Sizing of these Valves shall be done by Compressor Vendor.

A	06.09.2019	Issued for Bids	TLP	RSB	MSG
Rev	Date	Revisions	By	Chk	Approved

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Valve Manufacturer/Manufacturing Plant			
Actuator Manufacturer		Not Applicable	
Valve Tag No.		Not Applicable	
Purchaser's Spec. No.	6-71-0014	**ANSI Rating**	150#
Design Standard	API 6D	**EIL Piping Class**	AA4A
Size, mm (inch) NB	50 (2") to 450 (18")	**Valve Bore**	Full Bore
Ends	Both Ends Flanged as per ASME B 16.5, RF	**Face Finish of Flanges**	125 AARH (Smooth Finish)
VALVE DESIGN CONDITIONS			
Corrosion Allowance, mm	1.5	**Temperature, °C**	(-) 45 to 65
Service	Natural Gas	**Installation**	Above Ground
CONNECTING PIPE DETAILS			
Diameter (NB), mm	Not Applicable		
Wall Thickness, mm/ Schedule	Not Applicable		
VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of operator	Manual (Note-7)	**Stem Extension**	Not Required
Operator Spec. no.	Not Applicable	**Length of stem extension, m**	Not Applicable
Operator Data Sheet	Not Applicable		

VALVE MATERIAL SPECIFICATION (Equivalent or superior)		
PART DESCRIPTION	**MATERIAL SPECIFIED**	**MATERIAL OFFERED**
Body	ASTM A350 LF2 CL.1/ ASTM A352 Gr. LCB	
Ball	SS 304/ SS 316	
Body Seat Rings	(AISI 4140 + 0.003" ENP) / AISI 410	
Seat Design (Note-3)	Metal Seat/ Soft Seat	
Secondary Seat seal (In case of Primary Metal to Metal Seat Design) (Note-3)	VITON/ RPTFE	
Primary Seat Seal (In case of Primary Soft Seat Design) (Refer Notes-2 & 3)	DEVLON V API	
Stem (No Casting)	SS304/SS316/AISI 410	
Stem Seal	VITON/ RPTFE	
Stud Bolts	ASTM A 320 GR.L7, GALVANIZED	
Nuts	ASTM A 194 GR.4, GALVANIZED	

Notes:-

1. The valve data sheet shall be read in conjunction with valve Specification enclosed with the bid.
2. With Soft seat design, valves shall be fire safe design as per API 6FA.

A	06.09.2019	Issued for Bids	TLP	RSB	MSG
Rev	Date	Revisions	By	Chk	Approved

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3. If Vendor proposes primary Metal Seat design, then Vendor shall provide details for 'Secondary Seat Seal' and the column for 'Primary Seat Seal' is not applicable.
   If Vendor proposes Primary Soft Seat Design, then Vendor shall provide details for 'Primary Seat Seal' and the column for 'Secondary Seat Seal' is not applicable.
4. Surface preparation & painting shall be as per EIL specification no. 6-71-0014.
5. Compressed asbestos filler (CAF) shall not be used for body sealing/ gasket materials.
6. All stud bolts and nuts shall be hot-dipped galvanised as per ASTM A 153.
7. Requirement of manual operator (Wrench/ Hand wheel/ Gear Operator) shall be as per Specification No. 6-71-0014.
8. Separate wrench shall be provided with each wrench-operated valve.
9. Valves shall have Lock Open/ Lock Close provision as per P&IDs.
10. These Valves shall be located on the downstream of PSV Tag Nos. 910-PSV-1401A & 910-PSV-1401B. Sizing of these Valves shall be done by Compressor Vendor.

A	06.09.2019	Issued for Bids	TLP	RSB	MSG
Rev	Date	Revisions	By	Chk	Approved

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Valve Manufacturer/Manufacturing Plant			
Actuator Manufacturer			
Valve Tag No.		Refer Table-1 (Page 2 of 2)	
Purchaser's Spec. No.	6-44-0052	**ANSI Rating**	600#
Design Standard	API 6D	**EIL Piping Class**	DA1K
Size, mm (inch) NB	300 (12") & 500 (20")	**Valve Bore**	Reduced Bore
Ends	Both Ends Flanged as per ASME B 16.5, RF	**Face Finish of Flanges**	125 AARH (Smooth Finish)
VALVE DESIGN CONDITIONS			
Corrosion Allowance, mm	1.5	**Temperature, °C**	(-) 29 to 65
Service	Natural Gas	**Installation**	Above Ground
CONNECTING PIPE DETAILS			
Diameter (NB), mm	Not Applicable		
Wall Thickness, mm/ Schedule	Not Applicable		
VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of operator	Gas Powered Actuator	**Stem Extension**	Not Required
Operator Spec. no.	B240-000-83-41-SP-0004	**Length of stem extension, m**	Not Applicable
Operator Data Sheet	B240-000-83-41-DS-0019		

VALVE MATERIAL SPECIFICATION (Equivalent or superior)		
PART DESCRIPTION	**MATERIAL SPECIFIED**	**MATERIAL OFFERED**
Body	ASTM A351 Gr.CF8/ ASTM A182 Gr. F304	
Ball	SS304/ SS316	
Body Seat Rings	AISI 410	
Seat Design (Note-3)	Metal Seat/ Soft Seat	
Secondary Seat seal (In case of Primary Metal to Metal Seat Design) (Note-3)	VITON/ RPTFE	
Primary Seat Seal (In case of Primary Soft Seat Design) (Refer Notes-2 & 3)	DEVLON V API	
Stem (No Casting)	SS304/SS316/AISI 410	
Stem Seal	PTFE/ VITON/ GRAFOIL	
Stud Bolts	ASTM A 193 Gr. B7 (Galvanized)	
Nuts	ASTM A 194 Gr. 2H (Galvanized)	

Notes:-

1. The valve data sheet shall be read in conjunction with Technical Notes of Valves, Actuator Specification and Actuator Datasheet enclosed with the bid.

Rev	Date	Revisions	By	Chk	Approved
B	13.09.2019	Revised & Re-Issued for Bids	SS/TLP	RSB	MSG
A	06.09.2019	Issued for Bids	TLP	RSB	MSG

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2. With Soft seat design, valves shall be fire safe design as per API 6FA.
3. If Vendor proposes primary Metal Seat design, then Vendor shall provide details for 'Secondary Seat Seal' and the column for 'Primary Seat Seal' is not applicable.

   If Vendor proposes Primary Soft Seat Design, then Vendor shall provide details for 'Primary Seat Seal' and the column for 'Secondary Seat Seal' is not applicable.
4. Ball valves shall be trunnion-mounted type.
5. Minimum body thickness shall be as per ASME B 16.34.
6. All testing shall be as per API 6D.
7. All casting shall be solution heat treated.
8. Stem seal/body seal materials shall be provided with corrosion inhibitor.
9. Compressed asbestos filler (CAF) shall not be used for body sealing/ gasket materials.
10. All stud bolts and nuts shall be hot-dipped galvanised as per ASTM A 153.
11. All Valves are Gas Actuated and shall have provision for hand operation.
12. Remote/Local Operation of Actuators shall be as per Specification No. B240-000-83-41-SP-0004 and Datasheet No. B240-000-83-41-DS-0019.
13. Valve Timing of Actuated Valves covered in this Datasheet are as follows:-

Table-1: Valve-Timing & Tag. Nos.

S. No.	Size (inch)	Maximum Valve Operation Time (Seconds)	Tag Nos.	Actuator Operation
1	20	60-100	910-AV-1301	Local Actuated
2	12	36-60	910-AV-1112, 910-AV-1113, 910-AV-1202	• For Tag nos. 910-AV-1112, 910-AV-1113 Remote Actuated (Local as well as Remote Actuated) • For Tag no. 910-AV-1202 Local Actuated
3	To be sized by Compressor Vendor	3 to 5 seconds per Inch dia (to be firmed up by Compressor Vendor)	910-AV-1107, 910-AV-1108	Local Actuated

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गेल (इंडिया) लिमिटेड

GAIL (India) LIMITED

गांधार कम्प्रैसर परियोजना

GANDHAR COMPRESSOR PROJECT

DATA SHEET

FOR

GAS POWERED VALVE ACTUATORS

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
C	18.09.2019	Revised & Re-Issued for Bids	SS/TLP	RSB	MSG
B	11.09.2019	Revised & Re-Issued for Bids	SS/TLP	RSB	MSG
A	06.09.2019	Issued for Bids	TLP	RSB	MSG

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DATA SHEET FOR GAS POWERED ACTUATORS

Actuator Manufacturer : _____

Specification for Gas Powered Actuator : B240-000-83-41-SP-0004

Vendor to take the following data for sizing the actuator and furnish the filled in torque figures in Table-1 after sizing the actuator.

1.	Tag Nos.	:	Refer Table-1
2.	Service	:	Natural Gas
3.	Actuator Valve Description	:	Refer Table-1
4.	Process Conditions:		
	Power Gas	:	Natural Gas
	Gas Temperature	:	Refer Table-1
	Line gas Pressure	:	Refer Table-1
	Molecular Weight	:	17.884-19.916
	Cp/Cv	:	Refer Table-1
	Compressibility Factor	:	Refer Table-1
5.	Actuator Type	:	As per Specification
6.	Power Gas feed from Connection from Mainline	:	3/4" NPT
7.	Actuator Remote Operation (for open/close)	:	Refer Table-1
8.	Valve Position Limit Switch	:	2 nos. of Limit Switches are Required for Open & close positions (DPDT contact for open and close positions separately)
9.	Local/ Remote Selector Switch	:	Required for all Actuators (and its Status contact shall be wired upto junction box as per circuit diagram)
10.	Pneumatic Limit Valves and Solenoid, pilot valves to shut off Gas supply to actuator when valve reaches one of its end positions.	:	Required
11.	Self Retaining System for retaining Momentary open and close signals in the control circuit	:	Required

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12.	Electrical Conduit connection (Cable entry to junction box for Purchaser's cable)	:	1" NPT
13.	Operating Voltage:		
	a) Solenoid Valves	:	24 V DC ± 15 %
	b) Relays	:	24 V DC ± 15 %
14.	Contact Rating:		
	a) Limit Switches	:	2 Amp at 24 V DC
	b) L/R switch (status)	:	2 Amp at 24 V DC
15.	Pad Lock with L/R Switch	:	Required
16.	Enclosure for:		
	a) Actuator	:	Certified Weather Proof as per IP 65
	b) Electrical Items like Limit Switches, Solenoid Valves, Junction Boxes, Relays, Cable Glands and control units etc.	:	Certified Weather Proof as per IP 65 and Flame Proof certified suitable for IEC Zone-1, Gas Group II A & IIB, Temp. Class T3
17.	Area Classification	:	IEC Zone-I, Gas Group II A & IIB, Temp. Class T3
18.	Material of Construction for all Tubing, valves, piping and fittings	:	SS 316
19.	Accessories Required	:	Required as per Specification
20.	Manual/Hydraulic Override	:	Required as per Specification
21.	Maximum time required to open/close the valve	:	As per Data Sheets.

Notes:-

1. Complete actuator including control panel/ systems shall be manufactured and supplied by actuator manufacturer only. All circuit diagram/ documents/ drawings pertaining to actuator shall be furnished by actuator manufacturer. All inspection and testing shall be carried out at actuator manufacturer's shop as per Cl 6.1 of spec. no. B240-000-83-41-SP-0004.

2. **The proposed supplier of Gas Powered Valve actuators shall have designed, manufactured, tested and supplied at least one (1) number valve actuator of similar type/ model, as being offered, within the last seven (7) years reckoned from the bid due date.**

3. **Successful Bidder shall furnish documentary evidence to establish the above criteria, including reference list of previous supplies supported by copies of**

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purchase order & inspection release note of relevant previous supplies with typical sectional drawings etc..

4. Successful Bidder shall submit duly filled up, signed and stamped Form-T, Datasheet for Torque values, in the attached Format.

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TABLE- 1

Sl. No.	Tag no.	Size/ Class	Description of Valve	Line no.	Gas temp (°C)		Line Gas pressure (kg/cm2g)		Delta "P" Shut off (kg/cm2)	Compressibility Factor	C_p/C_v	Remarks
					Design		Inlet	Max.				
1	910-AV-1111	20"/ 600#	Ball Valve, Reduced Bore, Flanged	20"-P-910-5101-DA1A	-29	75	25-39	52	52	0.899-0.936	1.34 to 1.41	Remote Operation (Local as well as Remote actuated)
2	910-AV-1301	20"/ 600#	Ball Valve, Reduced Bore, Flanged	20"-P-910-1104-DA1A	-29	75	25-39	95.6	95.6	0.899-0.936	1.34 to 1.41	Local Operation (But Local/Remote Switch Required)
3	910-AV-1112	12"/ 600#	Ball Valve, Reduced Bore, Flanged	12"-P-910-1105-DA1K	-29	75	25-39	95.6	95.6	0.899-0.936	1.34 to 1.41	Remote Operation (Local as well as Remote actuated)
4	910-AV-1113	12"/ 600#	Ball Valve, Reduced Bore, Flanged	12"-P-910-1106-DA1K	-29	65	86-91.8	95.6	95.6	0.83-0.87	1.52 to 1.57	Remote Operation (Local as well as Remote actuated)
5	910-AV-1202	12"/ 600#	Ball Valve, Reduced Bore, Flanged	12"-P-910-1203-DA1K	-29	65	86-91.8	95.6	95.6	0.827-0.866	1.34 to 1.41	Local Operation (But Local/Remote Switch Required)
6	910-AV-1107	<HOLD> / 600#	Ball Valve, Reduced Bore, Flanged	H"-FL-910-1108-DA1K	-29	65	86-91.8	95.6	95.6	0.83-0.87	1.52 to 1.57	Local Operation (But Local/Remote Switch Required)
7	910-AV-1108	<HOLD> / 600#	Ball Valve, Reduced Bore, Flanged	H"-FL-910-1108-DA1K	-29	65	<4.0	95.6	95.6	BY GTC VENDOR	BY GTC VENDOR	Local Operation (But Local/Remote Switch Required)
8	910-AV-1109	<HOLD> / 600#	Ball Valve, Reduced Bore, Flanged	H"-FL-910-1107-DA4A	-45	75	<4.0	52	52	BY GTC VENDOR	BY GTC VENDOR	Local Operation (But Local/Remote Switch Required)
9	910-AV-1110	<HOLD> / 600#	Ball Valve, Reduced Bore, Flanged	H"-FL-910-1107-DA4A	-45	75	25-39	52	52	0.899-0.936	1.34 to 1.41	Local Operation (But Local/Remote Switch Required)

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Valve Manufacturer		----	
Actuator Manufacturer		Not Applicable	
Valve Tag No.		-	
Purchaser's Spec. No.	6-44-0052	**ANSI Rating**	300#
Design Standard	BS EN ISO 17292	**EIL Piping Class**	BA1K
Size, inch NB	0.5 to 1.5	**Valve Bore**	Full Bore
Ends	Both Ends Flanged as per ASME B 16.5, RF	**Face Finish of Flanges**	125 AARH (Smooth Finish)
VALVE DESIGN CONDITIONS			
Corrosion Allowance, mm	NIL	**Temperature, °C**	-29 to 65
Service	Fuel Gas	**Installation**	Above Ground
Design Factor	0.5		
CONNECTING PIPE DETAILS			
Diameter (NB), mm	Not applicable		
Grade	Not applicable		
Wall Thickness, mm	Not applicable		
VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of operator	Manual	**Stem Extension**	Not Required
Operator Spec. no.	-	**Length of stem extension, m**	-
Operator Data Sheet	-		

VALVE MATERIAL SPECIFICATION (Equivalent or Superior)		
PART DESCRIPTION	**MATERIAL**	**MATERIAL OFFERED**
Body	ASTM A 182 Gr. F 304	
Ball	SS304/SS 316	
Body Seat	RPTFE	
Gland	SS304/SS316	
Stem	13% Cr Steel / SS316 (No Casting)	
Stem Seal	GRAFOIL/PTFE V-RING+GRAFOIL	
Body Seal	PTFE/ GRAFOIL	
Stud Bolts	ASTM A 193 Gr. B7	
Nuts	ASTM A 194 Gr. 2H	

Note:

1. Valves shall have ball position indicator.
2. Stops shall be provided to ensure positive alignment of ball with ports and ensure proper installation of handle.
3. Stem seal/body seal materials shall be provided with corrosion inhibitor.
4. All tests shall be as per BS EN 12266-1&2.
5. Material test certificates and Hydrostatic test reports shall be furnished prior to dispatch.

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6. Detailed dimensional drawings showing cross section with part numbers and materials shall be submitted for information at the time of bidding.

7. The above mentioned drawings shall also be submitted for Purchaser's approval prior to manufacture of the valves.

8. Valves shall be Fire Safe design. Fire safe test shall be as per (BS 6755 Part II/ BS EN ISO 10497)/ (API 607 / ISO 10497)/ API 6FA.

9. Floating ball valve shall be provided with pressure equalization seats to relieve the body bonnet cavity pressure to the upstream side.

10. All valves shall be bi-directional type.

11. Valves shall be wrench operated. Each valve shall be supplied with one wrench.

12. Gland packing assembly shall permit repair of gland packing under full line pressure.

13. Stem seal shall be renewable with valve open on stream.

14. The data sheet shall be read in conjunction with technical notes for valves.

15. The bidder shall furnish soft seat details and type, grade & class selected for RPTFE from ASTM D4745 with manufacturer's recommendations like pressure-temperature rating curve/table.

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DATA SHEET FOR STRAINERS

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
B	12.09.19	REVISED & RE-ISSUED FOR BIDS	SS/TLP	RSB	MSG
A	19.06.19	ISSUED FOR BIDS	TLP	RSB	MSG

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STRAINER-20" (Strainer on Suction Line of GT Compressor 910-K-901 at Gandhar)

SIZE (NB), inch		20"
Fluid Handled		Compressed Natural Gas
Design Factor		0.5
DESIGN CONDITIONS		
Body	Design Pressure, kg/cm^2 (g)	104.11
	Design Temperature (°C)	-29 to 65
	Hydrostatic Test Pressure, kg/cm^2 (g)	156.20
Process details	Flow Rate	As per Process data sheet for GT Compressor
	Density	
	Viscosity	
	Vapour Pressure	
	State of Fluid	

SPECIFICATIONS		
End Connections	ANSI Rating	600 #
	End Type	Flanged
Material	Flange	ASTM A 182 GR. F 304, RF/125AARH (600#)
	Blind Flange	ASTM A 182 GR. F 304, RF/125AARH (600#)
	Body	ASTM A403 GR.WP 304-WX,
	Internals	SS 304
	Gaskets	SP.WND SS316+GRAFIL+ I RING
	Bolts & Nuts	Bolt : ASTM A193 Gr. B7 Nut : ASTM A194 Gr. 2H
Screen Mesh Size/ Specification	By GTC Vendor (Note-3)	
Dimension Standard	As per Std. 7-44-0304 (Note-3)	
Strainer Specification	B240-000-83-41-SP-0003	
Drain Connection	Size, Plug Material, Plug Rating	3/4", 80S, ASTM A 312 TP304 , Plain End

Note :

1. Allowable pressure drop for strainers shall not exceed 0.5 kg/cm^2.
2. Flanges & fittings shall be as per Standard Spec. No. 6-71-0024.
3. The mesh size/ specification shall be specified by Compressor vendor meeting the requirement of the allowable pressure drop. The mesh specification & pressure drop calculations shall be submitted to owner for review. Mesh specification indicated in 7-44-0304 are not applicable.

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DATA SHEET FOR STRAINERS

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
B	12.09.19	REVISED & RE-ISSUED FOR BIDS	SS/TLP	RSB	MSG
A	19.06.19	ISSUED FOR BIDS	TLP	RSB	MSG

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STRAINER-<Size Hold> (Strainer on Fuel Gas Line of GT Compressor 910-K-901 at Gandhar)

SIZE (NB), inch		Hold
Fluid Handled		Fuel Gas
Design Factor		0.5
DESIGN CONDITIONS		
Body	Design Pressure, kg/cm^2 (g)	50.58
	Design Temperature (°C)	-29 to 65
	Hydrostatic Test Pressure, kg/cm^2 (g)	75.87
Process details	Flow Rate	As per Process data sheet for GT Compressor
	Density	
	Viscosity	
	Vapour Pressure	
	State of Fluid	

SPECIFICATIONS		
End Connections	ANSI Rating	300 #
	End Type	Flanged
Material	Flange	ASTM A182 Gr. F304, RF, 125 AARH
	Blind Flange	ASTM A182 Gr. F304, RF, 125 AARH
	Body (Seamless)	ASTM A403 Gr. WP304-S
	Internals	SS 304
	Gaskets	SP.WND SS316+GRAFIL+ I RING
	Bolts & Nuts	Bolt : ASTM A193 Gr. B7 Nut : ASTM A194 Gr. 2H
Screen Mesh Size/ Specification	By GTC Vendor (Note-3)	
Dimension Standard	As per Std. 7-44-0303/0304 (Note-3)	
Strainer Specification	B240-000-83-41-SP-0003	
Drain Connection	Size, Plug Material, Plug Rating	3/4”, ASTM A182 GR.F304, 3000#

Note :

1. Allowable pressure drop for strainers shall not exceed 0.5 kg/cm^2.
2. Flanges & fittings shall be as per Standard Spec. No. 6-71-0024.
3. The mesh size/ specification shall be specified by Compressor vendor meeting the requirement of the allowable pressure drop. The mesh specification & pressure drop calculations shall be submitted to owner for review. Mesh specification indicated in 7-44-0303/0304 are not applicable.

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Client : Engineers India Ltd.	**Dept./Sect.** : 16/43
Project : Std. Specification	
Location : New Delhi	**Tag No: 52045** **Sheet No. 1 of 1**

GLOBE VALVE SPECIFICATION

TAG NO. : **52045**
RATING : 800
SIZE RANGE : 0.5" TO 1.5"
PIPING CLASS : A1K, A3K, B1K, D1K,
STANDARD : API 602/ ISO 15761
ENDS : SW 3000 TO B-16.11

MANUFACTURER
STANDARD:
MFGRS CAT/FIG:
RATING: **ENDS:**

DESCRIPTION	CONSTRUCTION	MATERIAL	CONSTRUCTION	MATERIAL
BODY	FORGED	ASTM A 182 GR.F304		
BONNET	BOLTED	ASTM A 182 GR.F304		
STEM	RISING	SS 304/ SS 316; (NO CASTING)		
DISC	LOOSE PLUG TYPE	STELLITED		
BODY SEAT RING	RENEWABLE/NON RENEWABLE	STELLITED		
STEM PACKING	RENEWABLE WITH VALVE OPEN ON STREAM	CORROSION INHIBITED DIE FORMED FLEXIBLE GRAPHITE WITH BRAIDED ANTI EXTRUSION RINGS		
HAND WHEEL	RISING	MALLEABLE IRON/CAST ST/FAB.ST/DUCT. IRON		
BONNET BOLTS		ASTM A193 GR B7		
BONNET NUTS		ASTM A194 GR.2H		
BONNET GASKET		SP WND SS316-GRAFOIL FILLER		
OTHERS	O S & Y			
SPECIAL SERVICE CONDITION		MAX TEMP 454 DEG. C.		
BACK SEAT & SHOULDER	INTEGRAL			
HYDROSTATIC TEST PRESSURE	BODY : 2900 PSIG	SEAT : 2125 PSIG		
TEST PRESSURE WITH AIR	80 PSIG			

NOTES

1 THIS VALVE SPEC SHEET SHALL BE READ IN CONJUNCTION WITH TECHNICAL NOTES FOR VALVES.
2 ONLY IN THE CASE OF CATEGORY - II MRs,BIDDER SHALL CLEARLY WRITE ALL/ ANY DEVIATION AGAINST EACH PART/ MATERIAL OF VALVE IN THE SPACE PROVIDED FOR AND WHEREVER BIDDER AGREES WITH EIL'S SPEC BIDDER SHALL INDICATE "AGREED".
3 NO CUTTING/ OVERWRITING BY BIDDER ON EIL'S SPEC IS ALLOWED.

SIGNATURE & SEAL OF MANUFACTURER

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FORM - T

DATA SHEET FOR TORQUE VALUES

(TO BE FILLED SEPARATELY BY EACH PROPOSED ACTUATOR MANUFACTURER)

SR. NO.	TAG NOS.	DATA FROM BALL VALVE VENDOR FOR			BALL VALVE TORQUE FIGURES WITH A SAFETY FACTOR OF 1.25		ACTUATOR GENERATED TORQUES (NOTE 1)		ACTUATOR MODEL SELECTED (8)
		BREAK TORQUE [Nm] (1)	RUNNING TORQUE [Nm] (2)	MAX ALLOWABLE VALVE STEM TORQUE [Nm] (3)	BREAK TORQUE [Nm] (4)	RUNNING TORQUE [Nm] (5)	BREAK TORQUE [Nm] (6)	RUNNING TORQUE [Nm] (7)	
1	910-AV-1111								
2	910-AV-1109, 910-AV-1110								
3	910-AV-1301								
4	910-AV-1112, 910-AV-1113, 910-AV-1202								
5	910-AV-1107, 910-AV-1108								

NOTES:

1. **Column numbers 1 to 5 shall be filled by the valve manufacturer. Column numbers 6, 7 & 8 shall be filled by Actuator manufacturer**.
2. These figures shall be used as basis for testing the actuator performance during factory testing. The actuator acceptance would be carried out after verifying successful testing complete ball valve with actuator assembly.

3. Actuator running torque under col. (7) shall be greater than or equal to minimum required torque indicated under col. (5) and actuator Break torque under col. (6) shall be greater than or equal to minimum required torque under col. (4).

4. Actuator Break torque shall be less than max allowable torque for valve stem. Valve manufacturer shall ensure that valve stem is designed to withstand actuator Break torque.

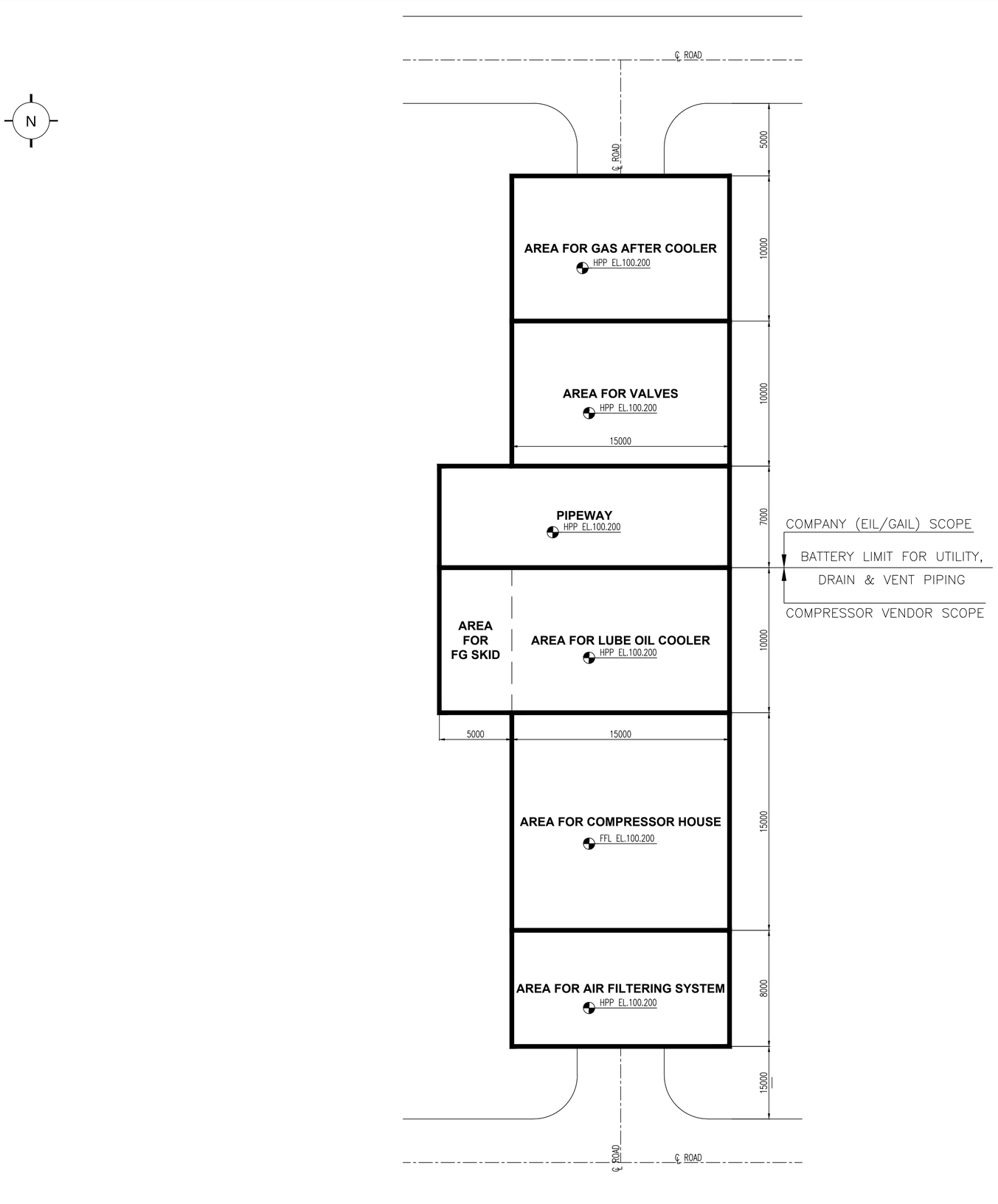
5. All values shall be indicated in Nm.

Actuator Manufacturer's seal **Signature of Actuator Manufacturer**

Bidder's seal **Signature of Bidder**

प्रस्तुत आरेख एवं इसमे निहित डिजाइन इंजीनियर्स इंडिया लिमिटेड की संपत्ति है। ये मात्र उधार दिए गए है और उपहारकर्ता ने यह स्पष्ट समझौता किया है कि न तो उन्हे पूरा, प्रतिलिपि किया जाएगा, न नकल की जाएगी, न उधार दिए जाएंगे, न प्रदर्शित किए जाएंगे और न ही तृतीय पक्षों के लिखित रूप मे दी गई सहमति से होगा ।
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B240-910-83-41-11901



REF. DWG. NO.	REFERENCE DRAWING TITLE

GENERAL NOTES :

1. ALL DIMENSIONS ARE IN MM AND LEVELS ARE IN METERS UNLESS NOTED OTHERWISE.
2. REFERENCE LEVEL 100.000 CORRESPONDS TO FGL
3. FINAL FGL, NORTHING/ EASTING CO-ORDINATES, TRUE NORTH/ PLANT NORTH ETC BE FINALIZED DURING DETAILED ENGINEERING PHASE.
4. THIS DRAWING IS BEING PROVIDED TO GIVE A GENERAL IDEA OF THE LAYOUT AND AREA AVAILABLE FOR PROPOSED FACILITIES. THE ENTIRE LAYOUT & DIMENSIONS ARE TENTATIVE AND SHALL BE OPTIMIZED DURING DETAILED ENGINEERING PHASE BASED ON FINAL DIMENSIONS OF COMPRESSOR SYSTEM & OTHER FACILITIES.
5. LUBE OIL CONSOLE, SEAL GAS SKID, FIRE SUPPRESSOR CO2 SYSTEM ETC. SHALL BE LOCATED INSIDE THE COMPRESSOR HOUSE.
6. COMPRESSOR VENDOR SHALL PROVIDE LAYOUT OF COMPRESSOR HOUSE AND OTHER FACILITIES IN HIS SCOPE FOR REVIEW TO COMPANY. COMPANY SHALL REVIEW THE LAYOUT FOR INTERFERENCE WITH PROCESS PIPING. MODIFICATIONS REQUIRED, IF ANY, SHALL BE UPDATED BY VENDOR.
7. UNDERLINED DIMENSIONS ARE NOT TO SCALE.

LEGEND :

———	PROPOSED FACILITIES
◔	LEVEL/ELEVATION
●	FINISHED GRADE LEVEL (FGL)
HPP	HIGHEST PAVEMENT POINT
FFL	FINISHED FLOOR LEVEL
FGL	FINISHED GRADE LEVEL
PN	PLANT NORTH
TN	TRUE NORTH
▨	FLOOR/PAVED AREA

REV.	DATE	REVISIONS	BY	CHKD	APPD	PEM/PC
A	08.04.19	ISSUED FOR BIDS	ISH	TLP/RSB	MSG	

इंजीनियर्स इंडिया लिमिटेड (भारत सरकार का उद्यम) ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

गेल (इंडिया) लिमिटेड
GAIL (INDIA) LIMITED

विजयपुर औरइया पाइपलाईन परियोजना	GANDHAR COMPRESSOR PROJECT
उपकरण विन्यास ईन्टरमीडिएट पिगिंग स्टेशन-1 पिरौंथ	EQUIPMENT LAYOUT GANDHAR COMPRESSOR STATION

SCALE	JOB NO.	UNIT	DEPT.	SECT.	DWG. NO.	REV.
1:150	B 2 4 0	9 1 0	8 3	4 1	1 1 9 0 1	A

3-1641-0501 REV.2 A1-841x594

VENDOR DATA REQUIREMENTS
FOR
PIPING FOR COMPRESSOR STATION

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
A	12-APR-2019	Issued for Bids	TLP	RSB	MSG

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VENDOR DATA REQUIREMENTS

The following drawings/documents marked "✔" shall be furnished by the bidder.

GAS TURBINE COMPRESSOR & ASSOCIATED FACILITIES

S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Piping General Arrangement Drawings (GADs) for fuel gas, lube oil, buffer gas for dry gas seals, Instrument air, plant air, inert gas, vent, drain & interface connections between all skids/ equipments.		✔		✔	
2.	Isometric drawings for all vendor supplied piping			✔	✔	
3.	Support drawings including bill of material for all vendor supplied piping including vent piping.		✔		✔	
4.	Bill of material with complete description of all the piping items under the vendor's scope of supply & as per EIL Piping Material Specifications.		✔		✔	
5.	General Arrangement Drawings for Gas Turbine Compressor Skid		✔		✔	
6.	General Arrangement Drawings for Fuel Gas Conditioning Skid		✔		✔	
7.	General Arrangement Drawings for Lube Oil Coolers		✔		✔	
8.	General Arrangement Drawings for Seal Gas Skid		✔		✔	
9.	General Arrangement Drawings for Lube Oil Console		✔		✔	
10.	General Arrangement Drawings for Permanent Strainer drawings		✔		✔	
11.	Allowable External Forces & Moments for Compressor Suction & Discharge Nozzles		✔		✔	
12.	Piping GADs indicating Battery Limit details & locations		✔		✔	
13.	Flexibility Analysis Calculation for Lube Oil Cooler Piping including Expansion Bellows & Spring Support Design (where applicable)		✔		✔	
14.	Insulation & Painting Specification			✔	✔	
15.	Fabrication, welding, erection, testing, flushing, cleaning specification (for skids)			✔	✔	
16.	Painting procedure for piping & equipment			✔	✔	
17.	Procedure of rust prevention for piping & equipment			✔	✔	

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S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
18.	Information concerning erection of compressors, associated accessories & piping, namely the following: - List of the equipment & their weights (including weight of packages) - Tonnage of pre-fabricated piping which needs to be assembled at site - Total inch-dia of field welding involved in piping system			✔	✔	

PIPELINE VALVES (BALL/CHECK/PLUG/GLOBE/GATE)

S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	General arrangement Drawing with overall Dimensions and cross sectional Drawing		✔		✔	
2.	Seat Arrangement		✔		✔	
3.	Number of Turn In Case of Gear Operated Valve			✔	✔	
4.	Copy of valid API 6D Certificate, if applicable		✔			
5.	Incase of soft seated valves copy of fire safe test certificateof qualifying valve as per API 6FA carried out in last 10 years			✔	✔	
6.	Details of support foot including dimension and distance from valve centre line to bottom of support foot		✔		✔	
7.	List of recommended spares required during start up and commissioning & 2 year of normal operation and maintenance			✔	✔	
8.	Installation, Operation & Maintenance manuals containing all certified drawing and documents including prolonged storage procedure				✔	
9.	Quality Assurance Plan		✔		✔	
10.	Test certificates : Material Test Certificates				✔	*(Required during Inspection)*
11.	Test certificates : Non destructive test reports				✔	*(Required during Inspection)*
12.	Test certificates : Hydrostatic Test Certificate				✔	*(Required during Inspection)*
13.	Test certificates : Mechanical Performance Test Reports				✔	*(Required during Inspection)*
14.	Test certificates : Type Test certificate for electrical items				✔	*(Required during Inspection)*
15.	Test certificates : Dimensional check				✔	*(Required during Inspection)*
16.	Test certificates : Any other Test report				✔	*(Required during Inspection)*
17.	Bill of Materials			✔	✔	
18.	Painting Procedure			✔		

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S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
19.	As built drawings				✔	
20.	Weight of assembly			✔	✔	
21.	Other Electrical / Instrumentation Documents					

Notes :

1. "TICK" denotes applicability.
2. Post order, drawing / document review shall commence only after approval of Document Control Index (DCI).
3. All post order documents shall be submitted / approved through EIL eDMS portal.
4. Final documentation shall be submitted in hard copy (Six prints) and soft (two CDs/DVDs) in addition to submission through EIL eDMS.
5. Refer - 6-78-0001: Specification for quality management system from Bidders.
6. Refer - 6-78-0002: Specification for documentation requirements from Contractors.
7. Refer - 6-78-0003: Specification for documentation requirement from Suppliers.
8. All drawings & documents shall be submitted in A4 or A3 paper sizes. Documents in higher paper size shall be submitted in exceptional circumstances or as indicated in the MR/Tender.
9. Post order- The schedule of drawing / data submission shall be mutually agreed between EIL & the bidder / contractor / supplier during finalization of Document Control Index (DCI).
10. "@" indicates submission of documents to Inspection Agency.
11. Bill of Material shall form part of the respective drawing.
12. Also refer other department's VDR :-
13. Electrical
14. Instrumentation
15. Packaged Equipment
16. Static Equipment
17. Rotating Equipment
18. General Civil
19. Piping
20. Structures
21. Offshore Engineering
22. Architecture
23. Pipeline
24. Heat & Mass Transfer

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गेल (इं डया) ल मटेड

GAIL (INDIA) LIMITED

गांधार कम्प्रैसर परियोजना

GANDHAR COMPRESSOR PROJECT

SPECIFICATION FOR STRAINERS

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
A	08.04.19	ISSUED AS JOB SPECIFICATION	TLP	RSB	MSG

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1.0 SCOPE

This specification cover the material, design, fabrication, inspection & testing, marking and documentation requirements for permanent Strainers to be used in piping system handling hydrocarbons in gas phase. Vendor shall supply Strainers in accordance with the specification and details specified in the Data Sheet for Strainers.

2.0 MATERIALS

2.1 Material of construction of body, flanges, stud/bolts & nuts, gaskets and internals shall be as per data sheet. For parts not mentioned in the data sheet, vendor shall guarantee the material supplied is suitable for the service conditions specified.

2.2 The material composition, physical properties, mandatory tests, dimensions & tolerances and marking for various components of strainers shall conform to the applicable specifications/technical notes as specified herein below:

2.3

S No.	Title	Doc. No.
1	Standard Specification for Flanges and Welded Fittings (Size DN 450 mm (18”) and above)	6-71-0023
2	Standard Specification for Seamless Fittings and Flanges (Size Up to DN 400 mm (16”))	6-71-0024
3	Technical Notes for Flanges, Spectacle Blinds and Drip Rings	6-44-0053
4	Technical Notes for Butt Welded, Socket Welded and Screwed Fittings	6-44-0054
5	Technical Notes for Gaskets	6-44-0056
6	Technical Notes for Bolts & Nuts	6-44-0057
7	Piping Material Specification	B240-000-83-41-SP-0001
8	Strainer Mesh	Datasheet for Strainer

List of ITPs:-

S. No.	Item	Title	Doc. No.
1.	Bolting Materials	Inspection & test plan for bolting material	6-81-0007
2.	Gaskets	Inspection & test plan for gaskets	6-81-0008
3.	Fittings & Flanges	Inspection & test plan for onshore CS flanges and seamless fittings (upto 16” NB)	6-81-0091
4.	Fittings & Flanges	Inspection and test plan for onshore CS flanges and welded fittings (18 inch NB and above)	6-81-0090
5.	Strainer	Inspection & test plan for strainers	6-81-0133

3.0 DESIGN & CONSTRUCTION REQUIREMENTS

3.1 Design and fabrication of strainers shall be based on EIL Standard for T-type Permanent strainers (No. 7-44-0304)/ Manufacturer’s standard (for class 900#) as indicated in attached data sheets. In case of conflict, requirement specified in data sheet shall govern.

3.2 Ends of body shall be Flanged and shall be as per Standard ASME B16.5.

3.3 Flange face finish and Type of Gaskets shall be as specified in data sheets.

3.4 The blind flange of strainer shall be drilled with a hole of specified size for connections to piping to be used for draining of strainer. The location of hole shall be

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such that product from the strainer can be completely drained off. A pipe nipple of size as indicated in strainer data sheet in place of plug shown in standard no. 7-44-0304 shall be welded for further hook up of drain piping. Nipple shall extend outside the blind flange for a length of 200 mm or diameter of drain pipe whichever is more. Temporary cap shall be used during testing of strainer in manufacturer's works.

3.5 For welding of dissimilar materials required for strainer assembly, welder qualification procedure shall be done prior to welding.

3.6 Dimension Standards for various components are as follows:

Body	-	7-44-304/ ASME B16.9
Flanges	-	ASME B16.5
Gaskets	-	ASME B16.20
Bolts & Nuts	-	ASME B18.2.1 & B18.2.2 respectively

3.7 For strainers with ring type joint flanged ends the hardness shall be as follows:-

Flange Material	Min. Hardness of Groove (BHN)	Max. Gasket Hardness (BHN)
Carbon Steel	140	90
1% Cr to 5% Cr	150	130
Type 304, 316, 321, 347	160	140
Type 304L, 316L	140	120

3.8 For strainers with flanged ring type joint ends, the hardness shall be recorded in the test report.

3.9 Weld joints shall be stress relieved as per the requirement specified in the Strainer MR Attachment.

3.10 Charpy V notch impact test requirement shall be as follows:-

Material		**Impact Test Temperature**	**Energy Absorption Value**
Type	**Standard**		
Carbon Steel	MSS SP-75	-29^0C	Average 27 J Minimum 22 J
	ASTM A694		
Low Temperature Carbon Steel/Alloy Steel	ASTM A350	Material Standard's impact test requirement temperature or -45^0C, whichever is lower	Material Standard's impact test requirement
	ASTM A860		
	ASTM A320		
	ASTM A420		
	ASTM A333		
	ASTM A194		

3.11 Gaskets:

Ring type and Spiral wound gasket shall be self-aligning type. Spiral wound gaskets shall be with inner & outer rings.

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3.12 Bolting:

All bolts shall conform to B18.2.1, nuts to B18.2.2. Reference shall also be made to B16.5 for studs.

Threads shall be unified (UNC for upto 1" dia and 8UN for > 1" dia) as per ANSI B.1.1 with class 2A fit for studs and M/C bolts and class 2B fit for nuts.

Nuts for Bolts & Studs shall be the American Standard Hexagon Heavy Series.

4.0 INSPECTION & TESTS

4.1 Visual & dimension checks on all strainers shall be carried out by manufacturer as per Purchaser approved drawings.

4.2 Manufacturer shall review & check all material test certificates and mandatory inspection & test reports for the compliance to the requirements of applicable material specifications/technical notes.

4.3 All strainers shall be hydrostatically tested at test pressure specified in data sheet.

4.4 All BW joints shall be 100% radiographed and Fillet welds shall be 100% DP/MP checked.

4.5 The bevel Ends of all Butt Welded strainers shall undergo 100% MP/DP test.

4.6 Purchaser reserves the right to carry out stage wise inspection of all strainers prior to despatch. Manufacturer shall give reasonable access and facilities to purchaser's inspector for carrying out such inspection.

In no case shall any action of purchaser or his inspector shall relieve the Manufacturer of his responsibility for material, design, quality or operation of strainers.

Inspection and tests performed/witnessed by the Purchaser's inspector shall in no way relieve the Manufacturer's obligation to perform the required inspection and tests.

5.0 TEST CERTIFICATES

Manufacturer shall submit the following certificates:

a) Material test certificates (Physical Properties, Chemical Composition & heat treatment report).

b) Test certificates of hydrostatic test carried out for strainers.

c) Test report of radiography & other NDT performed.

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6.0 PAINTING, MARKING & SHIPMENT

6.1 Each strainer shall be legibly and conspicuously marked on the body, in accordance with the requirements of applicable standards.

6.2 Each strainer shall have a corrosion resistant tag giving Size, ANSI rating and Type of strainer, securely attached on the body.

6.3 Paint or ink for marking shall not contain any harmful metal or metallic salts such as Zinc, Lead or Copper which causes corrosive attack on heating.

6.4 All items shall be dry, clean and free from moisture, dirt and loose foreign material of any kind.

6.5 All items shall be protected from rust, corrosion, and mechanical damage during transportation, shipment and storage.

6.6 Rust preventive, on machined surfaces to be welded, shall be easily removable with a petroleum solvent or shall not be harmful to welding.

6.7 After testing, one coat of inorganic zinc silicate (minimum DFT 65 to 75 microns) shall be applied as primer over the external surface for carbon steel/ alloy steel strainers.

6.8 All open ends shall be provided with covers (wooden or plastic) to prevent ingress of dust & other foreign materials into the strainer assembly during shipment & storage.

7.0 DOCUMENTATION

7.1 After placement of order the manufacturer shall submit the four copies of following documents:

a) Detailed fabrication drawing giving following details as a minimum:

i. overall dimension

ii. materials of various components including internals

iii. welding details

iv. inspection & testing requirements etc.

b) Pressure drop calculation across the strainer under clean and dirty condition.

Approval on above documents shall be obtained from Purchaser. Any change in design, material & method of manufacture shall not be allowed after Purchaser's approval.

7.2 Prior to shipment the manufacturer shall submit one reproducible and six copies of the following documents:

a) All tests certificates as per clause 5.0 of this specification

b) Installation instruction

c) All documents approved by Purchaser

Manufacturer shall also submit the electronic files (in pdf & native formats) for all above (7.1 & 7.2 above).

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गेल (इंडिया) लिमिटेड

GAIL (India) LIMITED

गांधार कम्प्रैसर परियोजना

GANDHAR COMPRESSOR PROJECT

SPECIFICATION

FOR

GAS POWERED VALVE ACTUATORS

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
1	12.09.2019	Revised & Re-Issued as Job Specification	TLP	RSB	MSG
0	06.09.2019	Issued As Job Specification	TLP	RSB	MSG

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1.0 SCOPE

1.1 This specification, together with the applicable data sheet, covers the minimum requirements for the design, manufacture, Inspection, testing and shipping of valve actuators complete with accessories for quarter turn ball valves.

1.2 This specification indicates the minimum supply requirements and does not relieve the vendor from his responsibilities concerning the design and the safe operation of the supplied equipment.

1.3 The valve manufacturer shall also be responsible for proper operation of the actuator that shall develop a torque or a thrust sufficient to conveniently open and close the valve always with in the limits established by the resistance of the mechanical elements of the valve itself.

1.4 Valve and actuator shall be supplied as a single assembly complete in all respect and ready for installation at site.

2.0 REFERENCE DOCUMENTS

Reference is made in this specification to the latest edition of the following codes, standards and specifications:

Codes and Standards

a.	ASME B31.8	:	Gas Transmission and Distribution Piping Systems.
b.	ASME B16.5	:	Steel Pipe Flanges and Flanged Fittings.
c.	ASME B16.47	:	Large dia Steel Flanges : NPS 26 through NPS 60
d.	ASME SEC. VIII	:	Boiler and Pressure Vessels Code.
e.	ANSI B2.1	:	Pipe Threads, General Purpose
f.	NEC	:	National Electric Code
g.	IEC	:	International Electrotechnical Commission

Purchaser Specification

6-71-0014	:	Standard Specification for Ball Valves (Onshore)
6-44-0052	:	Technical Notes for Valves

In case of conflict between the requirements of this specification and above referred documents, the requirements of this specification shall govern.

3.0 ACTUATOR SIZING

3.1 For sizing the actuator, Valve manufacturer shall furnish to the actuator manufacturer the following information:

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a) The maximum break-away torque or thrust required at the valve stem with manual/remote operation to open and close a valve at the shut off pressure in the line. The actuator shall be sized at 10 kg/cm^{2}g gas pressure and meeting the safety factor of 1.25 as required by the valve operation at the shut-off pressure in the line.

b) The temperature correction factor.

c) The pressure correction factor.

d) As a result of points (a) to (c) the minimum required torque or thrust output of the actuator.

e) Maximum allowable torque or thrust output of the actuator depending on the type and size of valve.

3.2 The maximum time required to open and close a ball valve shall be as indicated in the data sheet.

3.3 Actuator manufacturer shall provide the complete model no. decoding for actuators, limit switches and solenoid valves.

3.4 Complete details of Gas/Hydraulic circuit with complete sequencing of port from open to close and close to open position shall be furnished in the offer for review.

3.5 Manufacturer shall furnish the detailed calculation for actuator sizing after placement of order. The calculation so furnished by manufacturer shall satisfy the sizing criteria as per above clauses. Manufacturer shall agree to upgrade the actuators offered to meet the sizing criteria without any price and schedule impact.

4.0 DESIGN FEATURES

4.1 The actuator shall be powered by Natural Gas from the Piping header on which valve is to be installed. The gas powered actuator shall operate at 10 kg/cm^2(g). A typical scheme for tapping the gas from mainline with pressure reduction is shown in SKETCH-1. Actuator electrical/hydraulic circuit shall be developed as per the SKETCH-2 enclosed.

4.2 Actuator shall be direct gas operated scotch yoke or rotary vane type with manual hydraulic override. The actuator shall be provided with a hydraulic pump for manual operation. If there is no gas pressure available to actuator it shall be possible to actuate Direct Pneumatic Actuator by means of Nitrogen bottles or similar pressure source. Actuator manufacturer shall furnish the capacity and set pressure of nitrogen bottles for at least two opening and two closing strokes of the actuator.

4.3 The actuator shall be suitable for gas operating conditions and ambient temperature as specified in data sheets. The presence of methanol in the gas shall not affect the service of the Actuator.

4.4 All materials in contact with natural gas shall be suitable for the gas composition attached with this specification.

4.5 The actuator and its accessories shall be suitable for outdoor installation and have weather proof enclosure as per IP 65 as minimum.

All compartments and housing containing electrical devices such as switches, contactors, relay, fuses, terminal box etc. shall be explosion proof suitable for IEC Zone-1, gas group IIA/IIB, temperature class T3 or equivalent. The cable glands shall be 1" NPT thread. The unused cable entries must be plugged off with solid metal plugs.

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Solenoid valves shall be of explosion proof design certified for IEC Zone-1, gas group IIA/IIB, temperature class T3 or equivalent with moulded continuous duty coils and stainless steel valve body.

4.6 All pressure containing parts shall be designed to ASME Section VIII.

4.7 a) The actuator shall be suitable for direct mounting to the valve without changing the standard top works of the valve and shall have the capability to be mounted or removed from the valve when the valve is in service. The actuator shall be flanged and bolted directly on the valve body or extension. The connection between actuator and the valve or between the operator, the outer casing of the extension and the valve shall be such that there is no movement between these connections when the valve is actuated by the actuator under any load.

b) Actuator shall be suitable for installation on a vertical stem unless otherwise specified in the data sheet.

4.8 Provision shall be made to prevent accidental pressure build up in the actuator.

4.9 The construction of the actuator and its controls shall be such that proper manual operation and maintenance can be carried out by skilled personnel without the risk of being injured e.g. by moving parts.

4.10 A position indicator on the actuator shall show the valve in the open, closed or partially open positions.

4.11 Bearings shall be factory packed with grease and shall not require additional lubrication for the life of the actuator.

4.12 Unless specified otherwise in the data sheet, the actuator shall be equipped with limit valves which immediately shut off the gas supply to actuator when the valve reaches one of its end positions.

4.13 Actuator shall be provided with pressure gauges for pneumatic and hydraulic systems. The pressure gauges for the hydraulic system shall be in circuit with the pressure relief system.

4.14 In selection of pressure regulator due consideration shall be given to the effect of cooling of gas at the regulator and its downstream section.

4.15 A high pressure dehydrating filter cartridge shall be provided to remove condensate, moisture, foreign particles and any corrosive contaminants from pipeline gas.

4.16 The sound level of the gas escaping into the atmosphere when the actuator is in operation shall not exceed 90 dBA, measured at a distance of 10 metres.

4.17 The actuator shall be operated by either of the following two methods:

a) For the remote control, the actuator shall have a solenoid valve, limit switches, relays, etc. and shall be suitable for remote and local operation as per description in the attached Actuator Data Sheet(s).

Electrical signal supplied is a momentary type with 1 sec duration signal. Actuator shall have a self retaining system of the above signal in its control circuit.

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b) For the local-control the actuator shall be suitable for local operation with line gas feed lines or through nitrogen bottles. The devices and accessories, which do not require electricity for their operation, shall be provided in the actuators as per this specification. The actuator shall have a hand pump in conjunction with the oil circuit to achieve local control with hydraulic shock functionality.

4.18 a) Actuators shall be provided with limit switches for open and close positions. The position of switches shall be adjustable near the valve open and close positions. The limit switches shall be wired upto terminal block and shall be numbered for proper identification. The limit switches shall have 2 sets of contacts for each open and close position. The contact rating shall be as specified in the data sheet. The power to solenoid valves shall be cut-off when the actuator has travelled to extreme positions (close and open).

b) The limit switches shall be wired in the actuator control circuit by the vendor so as to cut off power to the actuator once the end positions of the valve are reached. This is required to de-energize the solenoid valves in the steady state condition and failure of electrical power will not affect the valve position.

4.19 Actuator's open/close command shall be potential free momentary contacts & the same shall not be powered.

4.20 The stroke of the Actuator shall be easily adjustable in steps of maximum 0.5° for Ball valves.

4.21 Speed control nozzles for adjusting the valve speed over a wide range shall be provided.

4.22 If remote control is required, a local/remote switch shall be installed to prevent remote control during maintenance work. This switch shall be provided with a hole 12 mm in diameter for locking with pad lock in either position. This local/remote switch shall be wired upto the junction box as per circuit diagram.

4.23 All control accessories, pneumatic and hydraulic, shall be mounted in an enclosure and shall be fully wired and tubed. The enclosure shall be weatherproof as per IP 65.

4.24 All bleed and vent connections wherever required shall be piped outside the actuator cabinet so as to prevent gas pocketing inside the actuator cabinet. The actuator will be of an automatic self purging design such that any gas pocket in the actuator will be eliminated.

4.25 Vendor shall be responsible for integrating the potential free NO or NC contacts of Remote Telemetry Unit (RTU's) for open and close command in interlock circuit. These commands will be of momentary type with 1 sec. duration.

4.26 All mounting accessories needed for installing the actuator, tanks etc. are in manufacturer's scope of supply.

4.27 The interconnecting cabling, interconnecting pipework between the actuator and the valve, adapters, tubing, cable glands, junction box are in manufacturer's scope of supply.

4.28 The actuator shall be supplied totally self-contained, wired, tubed and mounted on ball valve. In case of a separate control box, wiring and tubing between control box and actuator is in the vendor's scope. Three metres of 3/4" tubing set including all connectors between the actuator and the control box and three metres of interconnecting piping work upstream & downstream of the valve and the control box shall be provided. Owner shall provide 20 mm (3/4") SW tapping on process main line for line gas tapping.

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4.29 Threading connections shall be NPT as per ANSI B 2.1 and flange connection as per ANSI B 16.5/ANSI B 16.47. The tubing, fittings and valves shall be stainless steel with Swage Lock fittings or equivalent.

5.0 COATING

The actuator, including gear boxes and piping, shall be coated as described below:

5.1 Removal of all rust by means of emery cloth or wire brush.

5.2 Shot blast as per Swedish Standard No. SIS 055900 latest edition SA 2.5 one layer Primer Epoxy-Polyamide DFT 75 microns intermediate layer Epoxy-Polyamide DFT 25 microns, final layer Epoxy-Polyamide DFT 75 microns. Total DFT 175 microns and colour RAL 5012 (light blue).

6.0 INSPECTION AND TESTS

6.1 Test at the Actuator Manufacturer's Shop

a) Electrical and mechanical operating tests.

b) Seal test of hydraulic circuits.

c) Check of required functions.

d) Check of operating time control.

e) Check of limiting device operation.

f) Check of the actuator torque or thrust.

6.2 Test at the Valve Manufacturer's Shop

a) Test and check covered by point 6.1 after assembly with ball.

b) No load test (DP=0) or load (DP max) Operations with the minimum required feeding pressure (10 kg/cm^2g).

c) Check of the limiting device operation.

d) Various tests on the valve according to provisions of specific documentation.

e) Testing shall conform to actual field operating conditions.

6.3 All actuators shall be visually inspected.

6.4 Dimensional check on actuators shall be carried out as per the Purchaser approved drawings.

6.5 Purchaser reserves the right to perform inspection as indicated above at Manufacturer's works prior to shipment. Manufacturer shall give reasonable access and facilities required for inspection to the Purchaser's Inspector.

In no case shall any action of Purchaser or his inspector relieve the Manufacturer of his responsibility for material, design, quality or operation of actuators.

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7.0 NAME PLATE

Actuator shall have a SS name plate attached firmly to it at a visible place and reporting the following information:

a) Instrument tag number as per Purchaser's data sheets.

b) Manufacturer's model, trade mark, serial no. etc.

c) Max. allowable operating pressure or voltage.

d) Area classification in which the equipment can be used.

e) Actuator characteristics data.

f) Inspection agency name or logo

8.0 SHIPPING

8.1 All threaded and flanged opening shall be suitably protected to prevent entry of foreign material.

8.2 The actuator shall be supplied pre-assembled except piping/tubing, actuator, actuator control unit, tanks and other accessories shall be packed separately.

8.3 Protective grease oil coating shall be applied on the surface to protect them from rusting.

8.4 Package shall be marked legibly with suitable marking ink with the following details:

a) Order number
b) Package number
c) Manufacturer's name
d) Model No. & Thrust
e) Tag number
f) Inspection agency name or logo

9.0 DOCUMENTATION

9.1 At the time of bidding the manufacturer shall submit the following documents in accordance with EN10204 3.2:

a) A detailed specification sheet for valve actuator providing all the details regarding type, materials of construction for various parts etc.

b) Schematic diagrams showing the complete actuator control circuit.

c) A detailed dimensional drawing.

d) Installation drawing complete with valve assembly.

f) Actuator sizing calculations including relation between required torque of valve and actuator output torque.

f) Information asked for vide section 3.0 of this specification and actuator sizing as per Actuator Data Sheet.

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g) Drawing showing connections by Purchaser (piping, electrical etc.).

h) Wiring diagram (actuator electrical circuitry) incorporating latching of momentary signals, remote/local switch, limit switches.

i) Junction box terminal block nos. for I/O signals.

j) Parts list.

k) Recommended spare parts with prices.

l) Assembly details (Valve & Actuator).

m) Information regarding the past experience on similar actuators including (a) Size (b) Numbers (c) Name of Installation (d) Owner (e) Name of Contact Person (f) Date of Installation.

n) Technical Catalogue giving detailed technical specification and other information for each type of actuator and its accessories covered in the bid.

9.2 Upon receipt of Purchase order, manufacturer shall submit copies of the following for Purchaser's review and approval.

a) Documents and specifications as listed in Clause 9.1 of this specification.

b) Test certificates and certificates from statutory bodies.

c) Manual for installation, erection instructions, maintenance and operation instructions.

d) Complete assembly drawing of the ball valve matching with the actuator offered.

The approval of these drawings/documents will not absolve vendor of the responsibility with respect to correct operation of the actuator. Manufacturer's quotation, catalogues, drawings, operating and maintenance manuals etc. shall be in English language.

10.0 SPARES AND ACCESSORIES

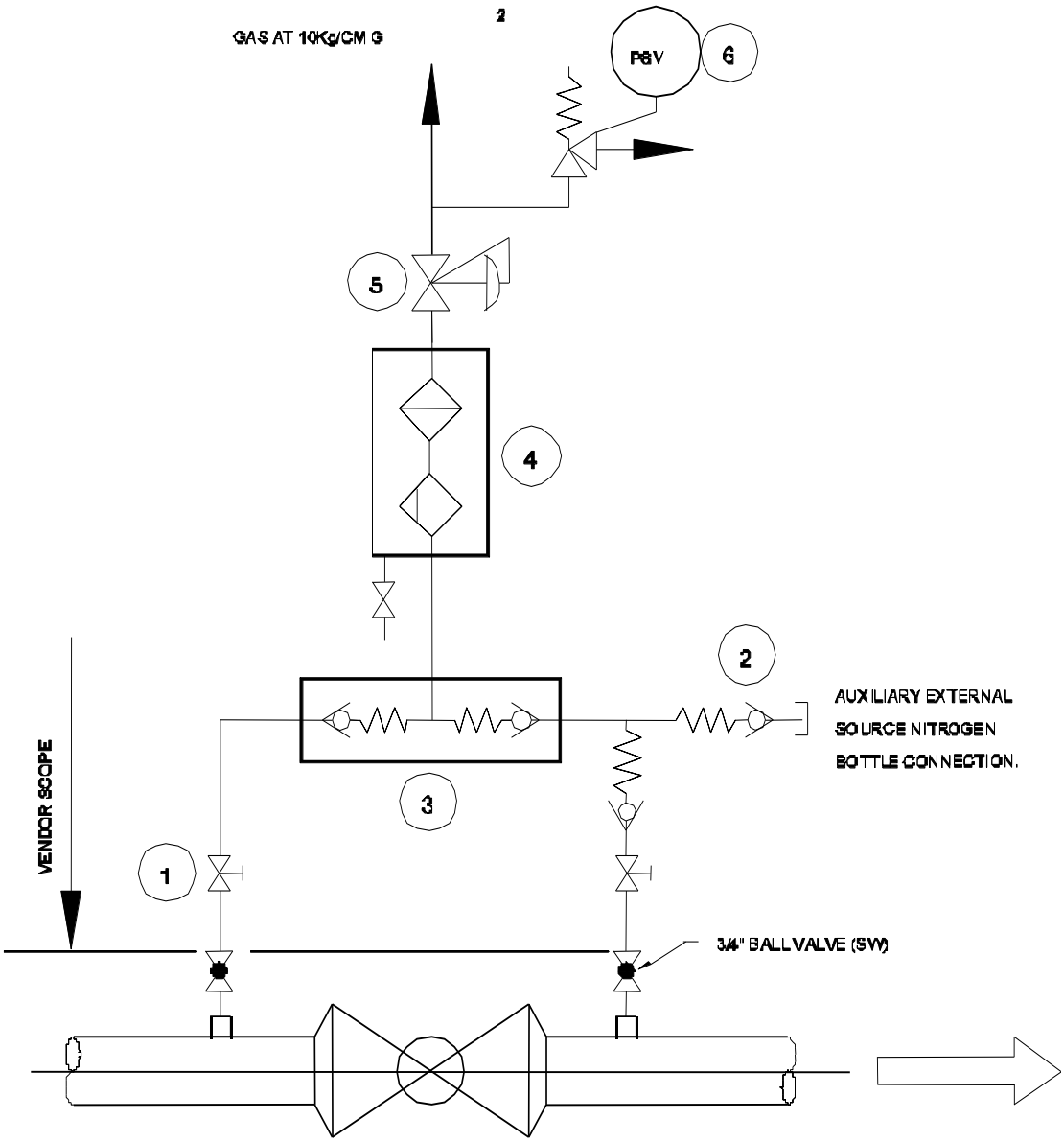
10.1 Manufacturer shall furnish list of recommended spares and accessories for actuators required during start-up and commissioning.

10.2 Manufacturer shall furnish list of recommended spares and accessories required for two years of normal operation and maintenance of actuators.

10.3 Manufacturer shall quote for spares and accessories as per Material Requisition.

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SKETCH 1



1 STOP VALVE(3/4" NPT)
2 CHECK VALVE
3 HIGH PRESSURE SHUTTLE VALVE
4 FILTER SEPARATOR & GAS DEHYDRATOR
5 SELF ACTUATED PRESSURE REGULATOR
6 SAFETY RELIEF VALVE

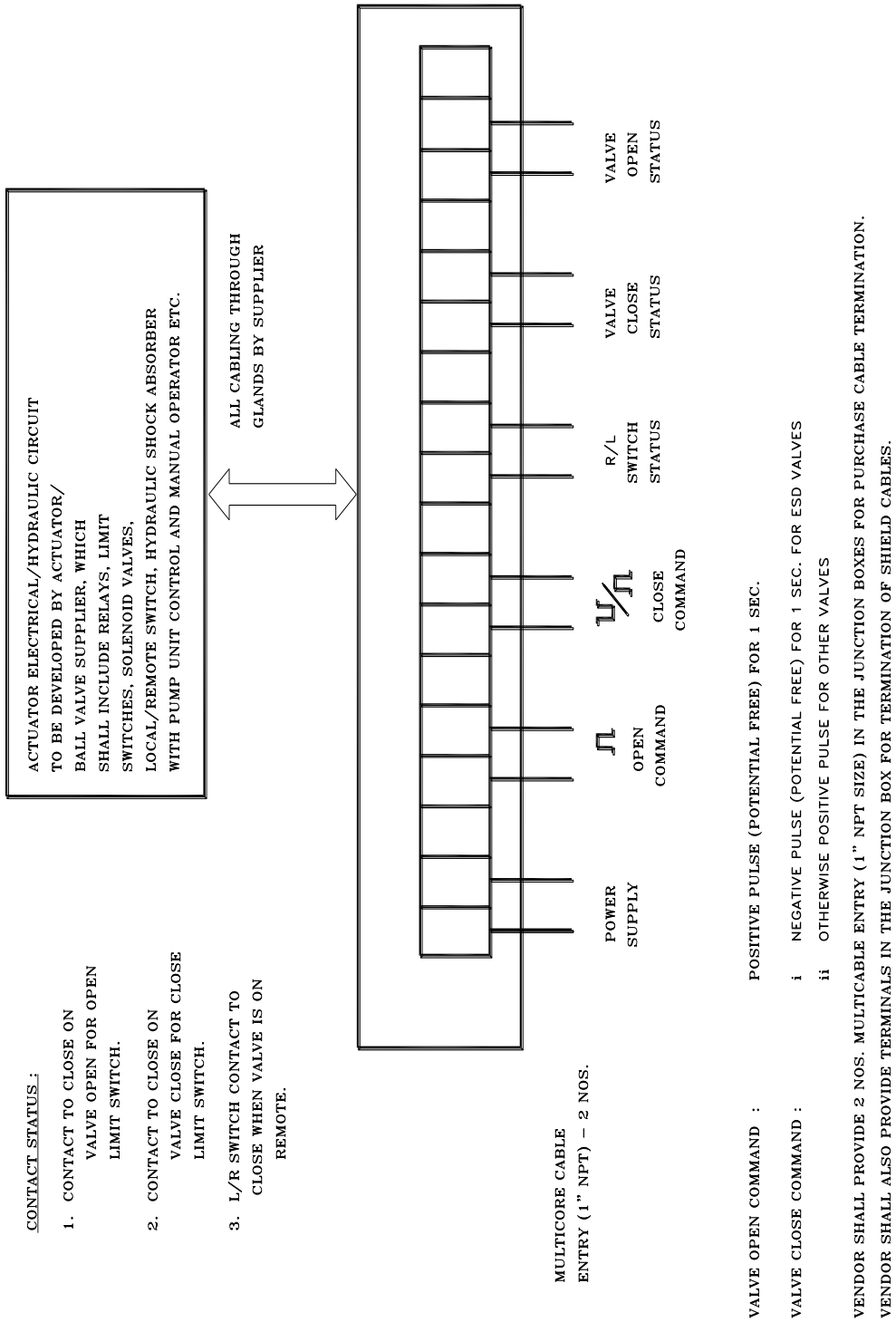
NOTES :-

THIS SCHEME SHOWS OUTLINE OF POWER GAS FEEDING SYSTEM.
VENDOR SHALL DEVELOP AND SUPPLY THE SUITABLE SYSTEM
IN ACCORDANCE WITH THE SPECIFICATION.

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Vendor to develop Actuator electrical/hydraulic circuit as per the sketch below and provide junction box housing terminal blocks for customer cable termination.

SKETCH – 2



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GAS COMPOSITION

(COMPOSITIONS OF GAS TO DVPL I/II AND HVJ)

S.No.	Component	Gas Composition Mol%	
		GPU Gandhar Running	GPU Gandhar Stopped
1.	C1	90.35	85.73
2.	C2	5.93	5.06
3.	C3	1.06	3.74
4.	C4	0.05	1.79
5.	C5	0.00	0.56
6.	C6+	0.00	0.48
7.	CO2	2.36	2.47
8.	N2	0.23	0.16
9.	H2S	10-20 ppmw	10-20 ppmw
10.	H2O	NIL	Fully Saturated
	Total Sulphur	10-20 ppmw	10-20 ppmw
	Total	100	100

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WELDING SPECIFICATION FOR PIPING CLASSES

PROJECT : GANDHAR COMPRESSOR PROJECT

CLIENT : GAIL (INDIA) LIMITED

JOB NO. : B240

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
0	8.04.2019	Issued for Tender	S S Pandey	P Chowdhary	H K Parmar

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1.0 SCOPE

The requirements stated herein shall be followed for the fabrication of all types of welded joints of Carbon Steel piping.

The welded pipe joints shall include the following:

a) Circumferential butt-welded.

b) Attachments of castings, forgings, flanges and other supports to pipes.

c) Welded manifold headers and other sub-assemblies.

d) Welded branch connections.

e) Joints in welded / fabricated piping components.

f) The attachments of smaller connections for vents, drain drips and other instrument tappings.

Any approval granted by the CLIENT shall not relieve the CONTRACTOR of his responsibilities and guarantees.

1.1 Abbreviations

ANSI: American National Standards Institute

API: American Petroleum Institute

ASME: American Society of Mechanical Engineers

BS: British Standard

CRT: Cathode Ray Tube

GMAW: Gas Metal Arc Welding

GTAW: Gas Tungsten Arc Welding

HAZ: Heat Affected Zone

HV: Vickers Hardness

IIW: International Institute of Welding

IQI: Image Quality Indicator

ISO: International Organization for Standardisation

MPI: Magnetic Particle Inspection

PQR: Procedure Qualification Record

SMAW: Shielded Metal Arc Welding

UT: Ultrasonic Testing

UTS: Ultimate Tensile Strength

WPS: Welding Procedure Specification

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1.2 Applicable Codes, Standards and Specifications

All welding work, equipment for welding, heat treatment, other auxiliary functions and the welding personnel shall meet the requirements of the latest editions of the codes, standards and specifications listed below:

a) Code for Gas Transmission and Distribution Piping Systems, ANSI B 31.8.

b) Standard for welding of Pipelines and Related Facilities, API 1104-2013

c) Specification for welding Electrodes and Filler Materials ASME Sec. II Part C.

d) Non Destructive examination, ASME Sec. V.

e) Welding Specification Charts for Piping classes, B240-000-02-42-WSC-0001.

Welding Specification Charts specified anywhere in this document refer to B240-000-02-42-WSC-0001.

2.0 BASE MATERIAL

In general carbon steel and Stainless steels are used in this specification. The details of material specifications are given in the Welding Specification Charts attached along with other project data sheets. The CONTRACTOR will arrange and maintain the record of test certificates of all the materials for the reference of the welding engineer.

3.0 WELDING PROCESSES

3.1 Welding process is specified in the Welding Specification Charts. Any other welding processes may be used after obtaining approval of the Client/Engineer-in-charge.

4.0 WELDING CONSUMABLES

a) The CONTRACTOR shall provide at his own expense all the welding consumables necessary for the execution of the job such as electrodes, oxygen, acetylene etc. and these shall bear the approval of the CLIENT.

b) The welding electrodes / filler wires supplied by the CONTRACTOR shall conform to the class specified in the welding specification chart attached along with other project data sheets. The materials shall be of the make approved by the CLIENT.

c) The electrode shall be suitable for the welding process recommended and the base metal used. Physical properties of the welds produced by an electrode recommended for the welding of a particular base metal shall not be lower than the minimum values specified for the base metal unless otherwise specified in the Welding Specification Chart and shall correspond to the physical properties of the class of electrode adopted. The choice of electrode shall be made after conducting the required tests on

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the electrodes as per relevant standards, and shall be the sole prerogative of the CLIENT.

d) The CONTRACTOR shall submit batch test certificates from each electrode manufacturers giving details of physical and chemical tests carried out by them for each batch of electrodes to be used.

e) Electrode Qualification test records shall be submitted as per the Exhibit–A (attached) in respect of the electrodes tested by the CONTRACTOR for obtaining the approval of the CLIENT.

f) All electrodes shall be purchased in sealed containers and stored properly to prevent deterioration. The electrodes removed from the containers (except cellulosic coated electrodes) shall be kept in the holding ovens, at the temperature recommended by the electrode manufacturer. Ovens shall be used for the low hydrogen electrodes only. Out-of-the oven time of electrodes before they are consumed shall not exceed the limits recommended by the electrode manufacturer. The electrodes shall be handled with care to avoid any damage to the flux covering.

Different grades of electrodes shall be stored separately. Cellulosic electrodes used shall however be used as per the specific recommendations of manufacturer.

g) Manufacturer's recommendation for baking of low hydrogen electrodes shall be followed. All low hydrogen electrodes shall be used within four hours of issue. If low hydrogen electrodes are not used within four hours of issue or exposed to atmospheric conditions, shall be baked again in accordance with the manufacturer's recommendation. Electrodes are permitted to bake twice maximum. If these electrodes after the second baking are not used within four hours, they shall be discarded.

h) Diffusible hydrogen in any of the weld shall be limited to a maximum of 8 ml per 100 g of weld metal irrespective of the type of consumables or welding method. The method of determination shall be as per AWS A4.3 as indicated in AWS A5.1 or ISO 3690:2012.

h) The electrodes used shall be free from rust, oil, grease, earth and other foreign matter, which affect the quality of welding.

i) Shielding Gas

The composition and the purity of shielding gas when required by the welding processes other than shielded metal arc welding, when permitted by the CLIENT shall bear the approval of the CLIENT. Where appropriate, gases or gas mixture of the following quality shall be used.

1. Argon gas complying with BS 4365.
2. Carbon dioxide gas complying with type 1 specified in BS 4105

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3. Gas mixtures that have been proved to be satisfactory as a result of procedure approval tests.

When a gas mixture is used, which has specified additions, e.g. 2% O_2, 5% CO_2 the variation of such addition shall not exceed $\pm$10% of that stated. Moisture content shall correspond to a dew point of -30°C or lower. All shielding gas containers shall have clear identification labels which include the gas type.

j) The quality management system followed by the CONTRACTOR and Manufacturer/Agency shall be approved by the CLIENT to ensure that each batches of welding consumables used during welding can be traced whenever required.

5.0 EQUIPMENT & ACCESSORIES

5.1 The CONTRACTOR shall have sufficient number of welding and cutting equipment, auxiliaries and accessories of sufficient capacities to meet the target schedules.

5.2 All the equipment for performing the heat treatment, including transformers, thermocouples, pyrometers, automatic temperature recorders with suitable calibration arrangements, etc. shall be provided by the CONTRACTOR, at his own expense and these shall bear the approval of the CLIENT. Adequate means of measuring current and voltage shall be available.

5.3 Redoing of any work necessitated by faulty equipment or operation used by the CONTRACTOR, will be done at his own expense.

6.0 BEVEL CLEANING / BEVEL INSPECTION

Before welding, all the rust and the foreign matter shall be removed from the bevelled ends by power operated tools. This shall be effected inside and outside and for a minimum distance of 25 mm from the edge of the weld bevel. The bevels shall be thoroughly inspected at this stage. If any of the ends of the pipe joints are damaged to the extent that, in the opinion of the CLIENT, satisfactory weld spacing cannot be obtained and local repair by grinding cannot be successfully done, the damaged ends shall be cut and bevelled to the satisfaction of the CLIENT, with an approved bevelling machine. Manual cutting and weld repairs of bevels is not allowed. Should laminations, split ends or inherent manufacturing defects in the pipe be discovered, the lengths of pipe containing such defects shall be removed from the line to the satisfaction of CLIENT. On pipes, which have been cut back, a zone extending 25 mm back from the new field bevel, shall be ultrasonically tested to the requirement of the line pipe specification to ensure freedom from laminations. The new bevel shall be 100% visual and 100% dye penetrant/MPI tested. A report shall be written for all the testing and records kept.

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7.0 ALIGNMENT AND SPACING

Components to be welded shall be aligned and spaced as per the requirements laid down in applicable code. Special care must be taken to ensure proper fitting and alignment when the welding is performed by GTAW process. Flame heating for adjustment and correction of ends is not permitted unless specifically approved by the Engineer-in-Charge.

A wire spacer of suitable diameter may be used for maintaining the weld root opening while tacking but it must be removed after tack welding and before laying the root bead.

For pipes of wall thickness 5 mm and above, the ends to be welded shall be secured in position with the aid of couplers, yokes and 'C' clamps, to maintain perfect alignment. Yokes shall be detached after the completion of weld, without causing any surface irregularity. Any irregularity caused on the pipe surface must be suitably repaired to the satisfaction of the Engineer-in-Charge.

Tack welds, for maintaining the alignment, of pipe joints shall be made only by qualified welders using approved WPS. Since the tack welds become part of the final weldment they shall be executed carefully and shall be free from defects. Defective tack welds must be removed prior to the actual welding of the joints.

Tacks should be equally spaced. Minimum number of tacks shall be:

3 tacks - for 2 1/2" and smaller dia. pipes.
4 tacks - for 3" to 12" dia. pipes.
6 tacks - for 14" and larger dia. pipes.

Welding shall commence only after approval of fit-up by the Engineer-In-Charge.

8.0 WEATHER CONDITIONS

The parts being welded and the welding personnel shall be adequately protected from rain and strong winds. In the absence of such a protection no welding shall be carried out. The completed welds shall be suitably protected in case of bad weather conditions.

9.0 WELDING

Root Pass

(a) Root pass shall be made with electrodes/filler wires recommended in the welding specification chart. For fillet welding, root welding shall be done with consumables recommended for filler passes. The preferred size of the electrodes is 2.5 mm diameter (12 SWG) but in any case not greater than 3.25 mm (10 SWG).

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(b) Upward technique shall be adopted for welding pipe held fixed with its axis horizontal.

(c) The root pass of butt joints should be executed so as to achieve full penetration with complete fusion of the root edges. Weld projection inside the pipe shall be as per applicable code. It shall be limited 3mm max. when the applicable code does not place any restriction.

(d) Any deviation desired from the recommended welding technique and electrodes indicated in the welding specification charts should be adopted only after obtaining express approval of the Engineer-in-Charge.

(e) Welding shall be uninterrupted.

(f) While the welding is in progress care should be taken to avoid any kind of movement of the components, shocks, vibrations and stresses to prevent occurrence of weld cracks.

(g) Peening shall not be used.

Joint Completion

(a) Joint shall be completed using the class of electrodes recommended in the Welding Specification Chart.

(b) Two weld beads shall not be started at the same point in different layers.

(c) Butt joints shall be completed with a cover layer that would affect good fusion at the joint edges and a gradual notch free surface.

(d) Each weld joint shall have a workmanship like finish. Weld identification work shall be stamped clearly at each joint, just adjacent to the weld. Metal stamping shall not be used on thin pipe having wall thickness less than 3.5mm. Suitable paint shall be used on thin wall pipes for identification.

(e) Rust preventive/protective painting shall be done after the weld joint has been approved.

10.0 HEAT TREATMENT

10.1 Preheating

a) Preheating requirements for the various materials shall be as per the welding specification chart attached along with other project data sheets.

b) Preheating shall be performed using resistance or induction heating methods.

Pre-heating for tie-in welds, repair welds or welds at point spreads may be done using a propane gas burner ring with prior approval from CLIENT. The contractor may be asked to demonstrate the effectiveness of the arrangement.

c) Preheating shall extend uniformly to at least three times the thickness of the joint, but not less than 50 mm, on both sides of the weld.

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d) Preheating temperature shall be maintained over the whole length of the joint during welding. Temperature indicating crayons or other temperature indicating devices shall be provided by the CONTRACTOR to check the temperature.

10.2 Post Weld Heat Treatment

a) Post weld heat treatment, wherever required for joints between pipes and fittings, pipe body and supports shall be carried out by the CONTRACTOR at his expense as per the relevant specifications, applicable standards and the instructions of the CLIENT.

b) The heat treatment of welded joints shall be carried out as per the requirements laid down in ANSI B31.8 and other special requirements mentioned in welding specification chart.

c) The CONTRACTOR shall submit for the approval of the CLIENT, well before carrying out actual heat treatments the details of the post weld heat treatment procedure, as per Exhibit `B' attached, that he proposes to adopt for each of the materials/assembly/part involved.

d) Post weld heat treatment shall be done in a furnace or by using an electric resistance or induction heating equipment, as decided by the CLIENT.

e) While carrying out local post weld heat treatment, technique of application of heat must ensure uniform temperature attainment at all points of the portion being heat-treated. Care shall be taken to ensure that width of heated band over which specified post weld heat treatment temperature is attained is at least as that specified in the relevant applicable standards/codes.

f) The width of the heated band centered on the weld shall at least be equal to the width of weld plus 2" (50 mm). The temperature gradient shall be such that the length of the material on each side of the weld, at a temperature exceeding half the heat treatment temperature, is at least 2.5 rt where r is the bore radius and t is the pipe thickness at the weld.

g) Throughout the cycle of heat treatment, the portion outside the heat band shall be suitably wrapped under insulation so as to avoid any harmful temperature gradient at the exposed surface of pipe. For this purpose temperature at the exposed surface of the pipe shall not be allowed to exceed 400˚C.

h) The temperature attained by the portion under heat treatment shall be recorded by means of thermocouple pyrometers. Adequate number of thermocouples shall be attached to the pipe directly at equally spaced locations along the periphery of the pipe joint. The minimum number of thermocouples attached per joint shall be 2 up to

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10" dia and 3 for 12" dia and above. However, the CLIENT can increase the required minimum number of thermocouples to be attached if found necessary.

i) Automatic temperature recorders, which have been suitably calibrated, shall be employed. The calibration chart of each recorder shall be submitted to the CLIENT prior to starting the heat treatment operation and its approval shall be obtained.

j) Immediately on completion of the heat treatment, the post weld heat treatment charts/records along with the hardness test results on the weld joints (whenever required as per the welding specification chart) shall be submitted to CLIENT for its approval.

k) Each joint shall bear an identification number, which shall be maintained in the piping sketch to be prepared by the CONTRACTOR. The joint identification number shall appear on the corresponding post weld heat treatment charts. The same identification numbers shall also be followed for identification of corresponding radiographic films. The chart containing the identification number and the piping sketch shall be submitted to the CLIENT in suitable folders.

l) Vickers hardness/Brinel hardness of the heat affected zone as well as of the weld metal, after heat treatment shall be measured using a suitable hardness tester and shall not exceed the maximum hardness specified in the welding specification chart. The weld joint shall be subjected to reheat treatment, when hardness measured exceeds the specified limit, at the CONTRACTOR'S own expense.

m) The CONTRACTOR shall arrange for the hardness testing and shall maintain the records of all the joints tested. These records shall be checked by the plant CLIENT'S inspector.

11.0 WELDING QUALIFICATIONS

11.1 General

a) The CLIENT'S Inspector shall have free access to all the concerned areas, where the actual work is being performed. The CONTRACTOR shall also provide the CLIENT'S inspector all means and facilities necessary to carry out inspection.

b) The CLIENT is entitled to depute its own inspector to the shop or field where pre-fabrication and erection of pipelines are being done, with (but not limited to) the following objectives:

i) To check the conformance to relevant standards and suitability of various welding equipment and the welding performance.

ii) To supervise the welding procedure qualification.

iii) To supervise the welders performance qualification.

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iv) To check whether shop/field welding being executed is in conformity with the relevant specifications and codes of practice followed in pipeline construction.

c) CONTRACTOR shall intimate sufficiently in advance the commencement of the qualification tests, welding works and acceptance tests, to enable the CLIENT'S inspector to be present to supervise them.

11.2 Welding Procedure Qualification

a) Welding procedure qualification shall be carried out in accordance with the relevant requirements of API 1104 latest edition or other applicable codes and other job requirements by the CONTRACTOR at his expense. The CONTRACTOR shall submit the welding procedure specifications in format as per Exhibit-C (attached) immediately after the receipt of the order.

b) CLIENT'S inspector will review, check and approve the welding procedure submitted and shall release the procedure for procedure qualification tests. The procedure qualification tests shall be carried out by the CONTRACTOR under field conditions at his own expense. A complete set of the test results in format as per Exhibit-C (attached) shall be submitted to the CLIENT'S Inspector for approval immediately after completing the procedure qualification test and at least 2 weeks before the commencement of actual work. Standard tests as specified in the code shall be carried out in all cases. In addition to these tests, other tests like radiography, macro/micro examination, hardness test, dye penetrant examination, charpy v-notch etc. shall be carried out on the specimens. It shall be the responsibility of the CONTRACTOR to carry out all the tests required to the satisfaction of the CLIENT'S Inspector. The destructive testing of welded joints shall be as per Annexure – 1.

11.3 Welder's Qualification

a) Welders shall be qualified in accordance with the API 1104 or other applicable specifications by the CONTRACTOR at his expense. The butt weld test pieces of the qualification test shall meet the radiographic test requirements specified in Clause 12.3 and Annexure-4 of this specification for Manual and Semiautomatic welding process. Weld test samples prepared by Automatic welding process shall be inspected by Automated ultrasonic examination as per Annexure-3. The CLIENT'S inspector shall witness the test and certify the qualification of each welder/welding operator separately. Only those welders/welding operator who have been approved by the CLIENT'S inspector shall be employed for welding. CONTRACTOR shall submit the welder qualification test reports in the standard format as shown in Exhibit–D and obtain express approval, before commencement of the work. It shall be the responsibility of CONTRACTOR to carry out qualification tests of welders.

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b) The welders shall always have in their possession the identification card as shown in Exhibit-E and shall produce it on demand by the CLIENT'S Inspector. It shall be the responsibility of the CONTRACTOR to issue the identity cards after the CLIENT has duly certified it.

c) No welder shall be permitted to work without the possession of identity card.

d) If a welder is found to perform a type of welding or in a position for which he is not qualified, he shall be debarred from doing any further work. All welds performed by an unqualified welder shall be cut and redone by a qualified welder at the expense of the CONTRACTOR.

12.0 PRODUCTION WELD INSPECTIONS AND TESTING

12.1 Visual Inspection

CLIENT shall carry out inspection of all welds as per the latest editions of the applicable codes and specifications.

All finished welds shall be visually inspected for parallel and axial alignment of the work, excessive reinforcement, concavity, shrinkage, cracks, under-cuts, dimensions, surface porosity and other surface defects. The acceptance criteria shall be as given in Doc. No. 6-44-0016. Undercutting adjacent to the completed weld shall not exceed the limits specified in API 1104.

12.2 NDT Examinations

Radiography: All Butt welds, 100%. (as per Annexure 3)

Magnetic Particle Testing: All Socket Welds, 100%.

Dye penetrant test/ Magnetic Particle Testing: All fillet welds.

All butt welded golden joints shall be inspected by Ultrasonic Testing (as per Annexure 2), 100%.

Weld joints shall comply with all other NDT requirements specified in EIL Standard specification, 6-44-0016.

12.3 NDT Acceptance Criteria

The NDT acceptance criteria for Station/Terminal Piping weld joints shall be as per ASME B31.3 latest edition.

12.4 Destructive Testing

The CLIENT has the authority to order the cutting of up to 0.1% of the total number of welds completed for subjecting to destructive tests at no extra cost to CLIENT. The destructive testing of weld joints shall be made as per Annexure – 1.

In addition, welds already cut out for defects for any reason may also be subjected to destructive testing. The sampling and the re-execution of welds shall be carried out by the CONTRACTOR at his own expense. If the results are unsatisfactory, welding

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operations shall be suspended and may not be restarted until the causes have been identified and the CONTRACTOR has adopted measures, which guarantee acceptable results. If it is necessary in the CLIENT's opinion the procedure shall be re-qualified. The weld joint represented by unsatisfactory welds shall stand rejected unless investigation proves otherwise.

13.0 REPAIRS OF WELDS

13.1 Repair weld procedure

With the prior permission of CLIENT welds, which do not comply with the standards of acceptability, shall be repaired or the joint cut out and re-welded.

A separate welding procedure specification sheet shall be formulated and qualified by CONTRACTOR for repair welds simulating the proposed repair to be carried out. Separate procedures are required to be qualified for

(a) through thickness repair,

(b) external repair and

(c) internal repair.

Welders shall be qualified in advance for repairs. The root pass, for repairs opening the root, shall be replaced by the vertical uphill technique. The procedure shall be proven by satisfactory procedure test to API-1104 including the special requirements of the specification, and shall also be subjected to metallographic examination, hardness surveys and Charpy tests to determine the effects of repair welding on the associated structure.

Root sealing or single pass repair deposit shall not be allowed. Internal root defects shall be ground thoroughly and welded with a minimum of two passes. However, while grinding for repairs, care shall be taken to ensure that no grinding marks are made on the pipe surface anywhere.

The repair shall be subjected, as a minimum requirement to the same testing and inspection requirements as the original weld. After the repair of the circumferential weld, re-radiography of the full joint shall be carried out. A 100% ultrasonic test shall be done at the repaired area externally. Any repaired area that is wide, irregular or rough shall be rejected and a full cut out shall be done.

Repairs are limited to a maximum of 30% of the weld length. Not more than two repairs are permitted on the same location. All repairs shall be carried out the day after initial radiography/AUT or earlier. A full report of all repairs made shall be submitted every day to the CLIENT.

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13.2 Weld Rejected by Accumulation of Defects

Where a weld is rejected by the accumulation of defect clause, as defined by API-1104 and this specification, repairs within these limitations are permitted. Defects in the filling and capping passes shall be repaired preferentially.

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ANNEXURE – 1: DESTRUCTIVE TESTING OF WELDED JOINT - BUTT WELDS

1.0 Destructive Testing Of Welded Joint - Butt Welds

1.1 Preparation

Having passed the visual and the nondestructive inspection, the test weld shall be subjected to mechanical tests.

After satisfactory completion of all visual and non-destructive testing the procedure test weld shall be set-aside for a period not less than 24 hours. No further work on the test weld and no cutting of test specimens from the weld shall be performed until a period of at least 24 hours has expired.

Weld specimens shall be taken from the positions indicated in Figure1 & 1A of this specification from areas as free from defects as possible; for this reason it is necessary to take the previous nondestructive tests result into account. The minimum number of tests to be carried out is given in Table - 1 of this specification.

The test shall be carried out at laboratories approved by the CLIENT. The specimens shall be prepared in accordance with the figures given in the paragraphs that refer to the individual test.

1.2 Tensile Strength

Specimens shall be taken from the position indicated in Figure1 & 1A of this specification. Two ISO type specimens and two API-type specimens shall be taken.

The ISO test specimens are shown in fig.2 of this specification.

1.2.1 Method

The test shall be carried out in accordance with BS EN ISO 6892-1:2009.

TABLE 1

PIPE SIZE, OUT SIDE DIAMETER INCHES	NUMBER OF SPECIMENS									
	TENSILE API	TENSILE ISO	NICK BREAK	ROOT BEND	FACE BEND	SIDE BEND	MACRO	HARDNESS	IMPACT	TOTAL
	WALL THICKNESS ½ INCH (12.7 mm) AND UNDER									
UNDER 2	0	0	2	2	0	0	0	0	0	4
2 TO 4½ INCLUDING	0	0	2	2	0	0	0	0	0	4
OVER 4½ LESS THAN 12¾	2	0	2	2	2	0	2	2	12	24
12¾ AND OVER	2	2	4	4	4	0	2	2	24	44
	WALL THICKNESS OVER ½ INCH (12.7 mm)									
4½ AND SMALLER	0	2	0	0	0	2	0	0	0	4
OVER 4½ LESS THAN 12¾	2	0	2	2	2	0	2	2	12	24
12¾ AND OVER	2	2	4	0	0	8	2	2	24	44

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1.3 Nick-Break Test

1.3.1 Preparation

Specification for nick-break test with notches thus worked can break in the base metal, instead of in the fusion zone; therefore an alternative test piece may be used after authorization by the CLIENT with a notch cut in the reinforcement of outside weld bead to a maximum depth of 1.5mm, measured from the surface of the weld bead.

1.4 Macroscopic Inspection

1.4.1 Preparation

Specimens shall be taken from the positions indicated in Fig.1 of this specification and shall be prepared in accordance with ASTM E3-11.

The width of the macro section has to be at least three times the width of the weld. The section is to be prepared by grinding and polishing and etched to clearly reveal the weld metal and heat affected zone.

1.4.2 Method

Specimens shall be carefully examined under the microscope, with a magnification of at least 25 times (25:1). The CLIENT may ask for a macrograph with 5 times (5:1) magnification, for DOCUMENTATION purposes.

1.4.3 Requirements

Under macroscopic examination, the welded joints shall show good penetration and fusion, without any defect exceeding the limits stated in the evaluation criteria of the nick-break test.

1.5 Hardness Test

1.5.1 Preparation

The prepared macro section is to be used for hardness testing using the vickers method with 10 kg load indentations are to be made along traverses each approximately 1 mm below the surface at both side of the weld.

In the weld metal a minimum of 6 indentations equally spaced along the traverses are to be made. The HAZ indentations are to be made along the traverses for approximately 0.5 mm each into unaffected material, and starting as close to the fusion line as possible.

One indentation at each side of the weld along each traverse has to be made on parent metal. Reference is made to Fig. 3 of this specification. The indentations are to be made in the adjacent region as well as on the opposite side of the macro section along the specified traverses.

1.5.2 Method

The test shall be carried out in accordance with recommendation ISO 6507-1:2005, Vickers hardness, using a laboratory type machine controlled as pre-recommendation ISO 6507-2:2005 and using a diamond pyramid penetrator set at 2.37 rad (136") with a load of 10 kg.

1.5.3 Requirements

Hardness value shall not exceed the limit specified in welding specification charts. In case of a single reading strictly (+10HV) higher than the specified limit, further indentations shall be made to check if the high value was an isolated case.

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All the hardness values obtained from the heat-affected zone shall not exceed 100 HV with respect to the average hardness of the values obtained for the base metal. If these additional tests give hardness within the specification limit the slightly higher value may be accepted.

1.6 Charpy V-Notch Impact Test

1.6.1 Specimens shall be taken from the position indicated in Fig. 1 of this specification. The test specimens will be prepared in accordance with BS EN ISO 148-1:2009. Charpy V-Notch specimens shall have dimensions as given in Fig. 4 of the specification. Three test specimens shall be taken from each sample and they shall be cut and worked so that their length is transverse and perpendicular to the weld bead with the notch position as shown in Fig. 4 of this specification. The notch shall be perpendicular to the roller surface. The test specimen width shall depend upon the pipe wall nominal thickness as per the following table:

Nominal wall thickness (mm)	Test specimen width (mm)
Over 12	10
Over 9.5 and up to 12	7.5
From 7 up to 9.5	5
Less than 7	2.5

1.6.2 Test Method

The test shall be carried out as indicated in BS EN ISO 148-1:2009 or ASTM A 370-12a.

Test pieces shall be immersed in a thermostatic bath and maintained at the test temperature for at least 15 minutes. They shall then be placed in the testing machine and broken within 5 seconds of their removal from the bath. The test temperature shall be as mentioned in welding specification charts.

1.6.3 Requirements (Note 1)

The impact energy shall be as per the values given in the Welding Specification Charts for full-size test pieces. If subsize test pieces are used, the required minimum average (set of three test pieces) absorbed energy values shall be the required values for full-size test pieces times the ratio of the specified width of the subsize test piece to the specified width of the full-size test piece, with such derived values rounded to the nearest joule.

Note :

(1) These values are specified for resistance to brittle fracture only. Where additional requirements are specified in project data sheet (Ex. pipeline materials with arrest properties i.e. a higher upper shelf charpy V energy for resistance against propagating ductile fractures) the same shall be followed.

(2) Only one value is permitted to be lower than average value upto the value specified.

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1.7 Bend Test Requirements

The Bend test Specimens shall be made and tested as per the requirements of API 1104 latest edition. The acceptance criteria shall however be as per para 5.6.4.3 and 5.6.5.3 of API 1104.However, the dimensions of the Jig for guided bend test in Figure 8 (of API 1104) shall be modified as specified below:

Radius of the Plunger `A' = 2t

Radius of the die. `B' = 3t + 1.6 mm

Width of the die. `C' = 50.8

where t = thickness of specimen

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ANNEXURE – 2: ULTRASONIC TESTING

1.0 ULTRASONIC INSPECTION

In addition to the Radiography inspection, only mechanized UT which provides a permanent registration of the results (hard copy) shall be used. This section concerns manual Ultrasonic inspection. However Ultrasonic inspection by automatic equipment may be used if approved by the CLIENT.

1.1 GENERAL

The CONTRACTOR who carries out the Ultrasonic inspections shall have sufficient number of qualified personnel, equipment and instruments at his disposal to be able to effect the tests without hindering or delaying the pipeline assembly operations.

The CONTRACTOR appointed shall supply all the requisite instruments to carry out Ultrasonic inspection at site.

1.2 SPECIFICATION FOR ULTRASONIC TESTING PROCEDURE

The CONTRACTOR shall present a Specification describing the proposed Ultrasonic testing procedure qualification.

This specification shall state the following information including all the parameters described in API 1104 (latest edition):

a) Type of Ultrasonic testing equipment to be used

b) Type and dimensions of transducers

c) Frequency range

d) Details for calibration

e) Coupling medium

f) Inspection technique

g) Reference to the welding procedure where it is intended to adopt the specification

h) Temperature range of the joints to be inspected

I) Record details.

1.3 QUALIFICATION OF ULTRASONIC TESTING PROCEDURE

Before the actual inspection begins, the CLIENT shall require the qualification test of the Ultrasonic testing procedure. The qualification test shall be conducted under normal operating conditions on some weld made by the CONTRACTOR according to the same production procedure, where there are typical defects are intended to be detected. The qualification test shall be conducted in the presence of the CLIENT's representative. The Ultrasonic inspection procedure shall be approved by the CLIENT.

1.4 TEST PROCEDURE

Circumferential welds shall be inspected from both sides using angle probes.

The surface with which the probe comes into contact shall be free of metal spatter, dirt, iron oxide, and scales of any type. Therefore, it shall be necessary to clean a strip at least 50 mm wide on both sides of the weld with steel-wire brushes. The cleaned strip must be at least wide enough to allow one and a half skip examination.

If echoes of doubtful origin appear during the test, it shall be necessary to inspect a convenient area on the pipe surface close to the weld, with a straight beam transducer in order to check whether any manufacturing defects are interfering with the ultrasonic beam.

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The equipment shall include but not be limited to the following:

a) Ultrasonic equipment and coupling medium

b) Sample sections for calibration of instruments

c) Equipment for cleaning of surface to be examined

d) Rules calibrated in centimeters for exact location of the position of defects.

The characteristics of the above listed instruments and equipment shall guarantee:

a) The required standards of the inspection procedure previously established and approved by the CLIENT are satisfied

b) Continuous operation.

All the instruments and equipment shall be approved by the CLIENT before being used. The CLIENT has the authority to reject any item that is considered unsuitable. The decision of the CLIENT is final. The Agency/ CONTRACTOR appointed to carry out Ultrasonic inspections shall also ensure the operational efficiency and maintenance of the instruments and equipment, and shall immediately substitute any item rejected by the CLIENT.

All the instruments and equipment necessary for carrying out Ultrasonic inspection on site shall satisfy the requirements laid down by the public boards of institutions that regulate `safety at work'.

1.5 ULTRASONIC INSTRUMENTS

The Ultrasonic instruments shall have the following:

a) Pulse-echo type; able to generate, receive and display on the screen of a Cathode Ray Tube (CRT); pulse at frequencies between 1 and 6 MHz. The useful part of the CRT screen shall be at least 70mm wide and at least 50mm high.

Variable amplification, with steps of 1 or 2 dB over a range of a least 60 dB.

b) The regulation control shall be accurate to within ±1 dB and this accuracy shall be certified by the instrument manufacturer.

c) May be powered by a battery or an electric generator. In the first case, the autonomy of operation (endurance) of the instrument shall be sufficient to carry out work without frequent interruptions, and the instrument shall be equipped with an automatic switch, which switches if off when the battery runs down. In the second case, there must be a voltage stabilizing device with a tolerance of ±2 volts.

1.6 PROBES

The probes used shall have dimensions, frequencies, and a refraction angle suited to the type of steel, the diameter, and the thickness of the pipeline and to the joint design.

1.7 REFERENCE SAMPLE PIECES

The efficiency of the equipment, the effective refraction angle of the probe, and the beam output point shall be checked using a V_1 and V_2 sample block, IIW type or the calibration block ASTM E428-08.

For manual Ultrasonic testing and automated Ultrasonic testing, the reference sample pieces shall be as described in API 1104 (latest edition).

1.8 CALIBRATION

The calibration, qualification of the testing procedure shall be done as provided in API 1104 (latest edition).

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1.9 REGULATION OF AMPLIFICATION DURING PRODUCTION TESTING

Scanning sensitivity shall be as provided in API 1104 (latest edition).

1.10 QUALIFICATION OF ULTRASONIC TESTING OPERATORS

Before the actual inspection begins, the CLIENT shall require a qualification test for the ultrasonic equipment operators.

The operators shall be fully qualified as per a recognized standard (ASME Sec V or equivalent) and they shall have as minimum level II as described in para 11.4.3, API 1104 (21st edition) with addendum in place. The operators shall be able to:

a) Calibrate the equipment

b) Perform an operational test under production conditions

c) Interpret the screen picture

d) Evaluate the size and location of reflectors

e) Interpret the type of defects detected.

The CLIENT has the option of checking the ability of personnel employed for Ultrasonic testing by means of qualification tests.

1.11 EVALUATION OF INDICATIONS GIVEN BY ULTRASONIC TESTING

Each time that echoes from the weld bead appear during production testing, the instrument amplification shall be altered to coincide with the reference amplifications and the probe shall be moved until maximum response is obtained, paying attention all the time to the probe-tube coupling.

If, under these conditions, the height of the defect echo is equal to or greater than that of the reference echo, the defect shall be evaluated according to the clause 12.3 of this specification. If the defect has also been detected by the Radiography and/or Visual examination, the dimensions shall be judged according to the type of examination that detects the greater defect. Returns that are less than 50% of the reference echo will not be considered. If returns are above 50% but lower than 100% of the reference echo, and if the operator has good reasons to suspect that the returns are caused by unfavorably oriented cracks, he shall inform the CLIENT. Moreover, when there is a defect to be repaired, such defect shall be removed for a length corresponding to the one where no more return echo is given.

1.12 OTHER EQUIPMENT

The use of rules calibrated in centimeters, attached to the probe is recommended for the precise location of the position of welding defects. Defect location is effected by measuring the projection distance between the probe output and the reflecting surface.

The operators carrying out the tests may require other equipment besides the probing instrument, tools for cleaning the pipe surface viz. files, brushes etc., and coupling liquid or paste appropriate for the temperature of the section to be examined.

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ANNEXURE-3: RADIOGRAPHY

1.0 SCOPE

This annexure covers the radiographic inspection of all types of welded joints of the main pipeline.
The welded joints shall include the following:

i) Full girth welds on the mainline construction including double jointing of pipe, if adopted.

ii) Welds for installation of block valves, insulating joints and other appurtenances and tie-ins.

iii) Welds at scraper launching and receiving barrels.

iv) Terminal Piping

2.0 APPLICABLE STANDARDS

This specification shall apply in conjunction with the following (all latest edition):

i) API 1104, Standard for welding Pipelines and Related Facilities

ii) ANSI B 31.8, Code for Gas Transmission and Distribution Piping Systems.

iii) ANSI B 31.4, Code for Transportation System for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia and Alcohols.

iv) ASTM E94 - 04(2010) Standard Guide for Radiographic Examination

v) The American Society for Nondestructive Testing. Recommended Practice No. SNT-TC-1A Supplement A.

iv) DIN EN 462-1:1994-03: Non-destructive testing-Image quality of Radiographs-Part 1: Image quality Indicators (wire type)- Determination of image quality value.

3.0 PROCEDURE

3.1 The radiographic examination procedure to be adopted shall be submitted by the CONTRACTOR as per Exhibit-F.

3.2 The procedure of radiographic examination shall be qualified to the entire satisfaction of CLIENT prior to use. It shall include but not be limited to the following requirements:

i) Lead foil intensifying screens, at the rear of the film shall be used for all exposures.
ii) Type 2 and 3 films as per ASTM E94-04(2010) shall be used.
iii) A densitometer shall be used to determine film density. The transmitted film density shall be between 2.0 and 3.5 throughout the weld. The unexposed base density of the film shall not exceed 0.30.
iv) Radiographic identification system and documentation for radiographic interpretation reports and their recording system.

3.3 The CONTRACTOR shall qualify each procedure in the presence of the CLIENT prior to use.

3.4 The procedure of radiographic examination shall produce radiographs of sufficient density, clarity and contrast so that defects in the weld or in the pipe adjacent to the weld, are clearly discernible.

3.5 One Check shot of the full joint on main line welds shall be taken per 100 circumferential welds or one per day of the production which ever is more for cross checking the correctness of the radiographs of weld joints executed by the contractors. For taking

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check shots on completed/accepted sections, contractor has to separately mobilize either internal crawler/external X-ray unit, as appropriate.

3.6 All the girth welds of mainline shall be subjected to 100% radiographic examination. The CONTRACTOR shall furnish all the radiographs to the CLIENT, immediately after processing them, together with the corresponding interpretation reports on approved format. The details of the radiographs along with the joint identification number shall be duly entered in a register and signed by the CONTRACTOR and submitted to the CLIENT for approval.

3.7 When the radiation source and the film are both on the outside of the weld and located diametrically opposite each other, the maximum acceptable length of film for each exposure shall not exceed the values given. The minimum film overlap, in such cases, shall be 40mm. The ellipse exposure technique may be used on nominal pipe sizes of 2 inch and smaller provided that the source of film distance used is a minimum of 12 inch.

3.8 Three copies of each acceptable radiographic procedure (as per Exhibit-F) and three copies of radiographic qualification records, shall be supplied to CLIENT. One set of the qualifying radiographs on the job shall be kept by the CONTRACTOR's authorized representative to be used as a standard for the quality of production radiographic during the job. The other two sets shall be retained by CLIENT for its permanent record.

3.9 Three copies of the exposure charts relating to material thickness, kilo voltage, source of film distance and exposure time shall also be made available to CLIENT by the CONTRACTOR.

3.10 The CONTRACTOR shall, on a daily basis, record for each radiograph (1) radiograph's number, (2) approximate chainage of weld location, (3) whether or not the welds meet the specified acceptance standards and (4) the nature and approximate location of unacceptable defects observed. It must be possible to relate back to a particular butt weld and welder on piping drawing and pipeline alignment drawing.

3.11 Each day's production of processed radiographs shall be properly packaged separately, identified by at least the (1) date, (2) radiographic unit, (3) job locations, (4) starting and ending progress survey stations and (5) shall include original and three copies of the daily radiographic record. The package shall be submitted to the CLIENT daily when possible, but in no event later than noon of the following day.

3.12 The CONTRACTOR shall provide all the necessary facilities at site, such as a dark room with controlled temperature, film viewer etc. to enable the CLIENT to examine the radiographs.

3.13 The CONTRACTOR, if found necessary, may modify the procedure of radiographic examination suiting to the local conditions prevailing. This shall, however, be subject to the approval of the CLIENT.

3.14 CLIENT shall have free access to all the CONTRACTOR's work facilities in the field.

3.15 Any approval granted by the CLIENT shall not relieve the CONTRACTOR of his responsibilities and guarantees.

4.0 RADIATION SOURCE

4.1 Radiographic examination shall be carried out using X-radiations; radiographic examination by Gamma rays using slow speed films may be allowed, at the discretion of the CLIENT, in case of inaccessible joints. Radiography by Gamma ray for tie-in-joints shall be acceptable provided Type I of ASTM E1815-08 film or equivalent is used and the required sensitivity obtained.

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4.2 Whenever possible, pipeline welds will be inspected by placing the radiation source inside the pipe, on the pipeline axis, with a radiation of 6.28 red. (360).

If it is impossible to place the radiation source inside the pipe, the weld will be inspected with the source on the outside. An overlap of at least 40 mm at the ends of each film shall be required to ensure that the first and last location increment numbers are common to successive films and to establish that no part of a weld has been omitted.

5.0 LEVEL OF QUALITY

The quality level of Radiographic sensitivity required for radiographic inspection shall be at least equivalent to the values in Figure-5.

6.0 PENETRAMETERS

The Image Quality Indicator (IQI) shall be used for the qualification of the welding procedure and during normal line production. Radiography sensitivity shall be measured with the wire image quality indicator (Penetrameter). The Penetrameter shall be selected according to DIN EN 462-1:1994-03 or ISO 19232-1:2004. For radiographs made with the source on the outside, a Penetrameter shall be placed on each side of the film with the smaller wire of the Penetrameter turned towards the end of the film itself. When a complete weld is radiographed in a single exposure using a source inside the piping, four pentrameters approximately equally spaced around the circumference shall be used. During the procedure qualification, IQI shall be placed both on the source side and on the film side. The sensitivity obtained with IQI on the source side shall not be less than the values shown in Figure 5 of this specification.

The sensitivity limit may be considered to have been reached when the outline of the IQI, its identification number and the wire of the required diameter show up clearly on the radiograph.

The CLIENT may authorize use of types of IQI other than those planned, provided that they conform with recognized standards and only if the CONTRACTOR is able to demonstrate that the minimum sensitivity level required is obtained. For this demonstration, a test shall be carried out comparing the IQI specified and the CONTRACTOR's to show up the identification number and other details of the proposed IQI, which must be visible in the test radiograph.

7.0 FILM IDENTIFICATION MARKERS

All films shall be clearly identified by lead numbers, letters, and/or markers. The image of the markers shall appear on the films, without interfering with the interpretation. These markers positions shall also be marked on the part to be radiographed and shall be maintained during radiography.

8.0 PROTECTION AND CARE OF FILM

8.1 All unexposed films shall be protected and stored properly as per the requirements of API 1104 standard and ASTM E94-04(2010).

8.2 The exposed and unexposed film shall be protected from heat, light, dust and moisture. Sufficient shielding shall be supplied to prevent exposure of film to damaging radiation prior to and following the use of the film for radiographic exposure.

9.0 RE-RADIOGRAPHY

9.1 The weld joints shall be re-radiographed in case of unsatisfactory quality of the radiographs, at the expense of the CONTRACTOR.

9.2 All the repaired weld joints shall be re-radiographed at no extra cost to the CLIENT in the same manner as that followed for the original welds. In addition, the repaired weld

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areas shall be identified with the original identification number plus the letter R to indicate the repair.

9.3 When evaluating repair film, radiographers shall compare each section (exposure) of the weld with the original film to assure repair was correctly marked and original defect removed.

9.4 The CLIENT will review prior to any repair of welds, all the radiographs of welds that contain, according to the CONTRACTOR's interpretation, unacceptable defects. The final disposition of all unacceptable welds shall be decided by the CLIENT.

10.0 QUALIFICATION OF RADIOGRAPHERS

10.1 Pipeline radiographers shall be qualified in accordance with the requirement of API 1104 and to the full satisfaction of CLIENT.

10.2 Certification of all the radiographers, qualified as per 10.1 above, shall be furnished by the CONTRACTOR to the CLIENT before a radiographer will be permitted to perform production radiography. The certificate record shall include:

i) Background and Experience Record

ii) Training Course Record

iii) Technical Examination Record

iv) Doctor's report on radiographer's Jacque 0-1 acquity eye test

v) Date of qualification

10.3 The radiographers shall be required to qualify with each radiographic procedure they use, prior to performing the work assigned to him in accordance with the specification.

11.0 PRESERVATION OF RADIOGRAPHS

11.1 The radiographs shall be processed to allow storage of films without any discoloration for at least three years. All the radiographs shall be presented in suitable folders for preservation along with necessary documentation.

11.2 All radiographs shall become property of the CLIENT.

12.0 EQUIPMENT AND ACCESSORIES

12.1 CONTRACTOR shall make necessary arrangements at his own expense, for providing the radiographic equipment, radiographic films and all the accessories for carrying out the radiographic examination for satisfactory and timely completion of the job.

12.2 For carrying out the mainline radiographic examination the CONTRACTOR shall be equipped with suitable mobile/stationary type dark rooms.

These shall have all the required facilities for film processing. Film viewer used shall be equipped with the film illuminator that has a light source of sufficient intensity and suitably controlled to allow viewing film densities up to 4.0 without damaging the film.

13.0 RADIATION PROTECTION

13.1 CONTRACTOR shall be responsible for the protection and personnel monitoring of every man with or near radiation sources.

13.2 The protection and monitoring shall comply with local regulations.

13.3 In view of visual hazards in the handling of Radioactive source of material, CONTRACTOR shall be solely responsible for complying with all rules and regulations set forth by Atomic Energy Commission or any other Government agencies of India in this regard and CLIENT shall not be responsible and shall be kept indemnified by the CONTRACTOR for default (s) of whatever nature by the CONTRACTOR. Safety equipment as considered adequate by the CLIENT for all necessary personnel shall be

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made available for use and maintained for immediate and proper use by the CONTRACTOR.

14.0 DISPLAY OF SAFETY INSTRUCTIONS

14.1 The safety provisions shall be brought to the notice of all concerned by display on a notice board at prominent place at the work spot. The person responsible for the "Safety" shall be named by the CONTRACTOR.

15.0 ENFORCEMENT OF SAFETY REGULATIONS

15.1 To ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangement made by the CONTRACTOR shall be open to inspection by CLIENT or its representatives.

16.0 FIRST AID AND INDUSTRIAL INJURIES

16.1 CONTRACTOR shall maintain first aid facilities for its employees and those of sub-contractors.

16.2 CONTRACTOR shall make outside arrangements for ambulance service and for treatment of industrial injuries. Names of those providing these services shall be furnished to CLIENT prior to start of work and their telephone no. Shall be posted prominently in CONTRACTOR'S field office.

16.3 All critical industrial injuries shall be reported promptly to the CLIENT and a copy of CONTRACTOR's report covering each personal injury requiring the attention of physician shall be furnished to the CLIENT.

17.0 NO EXEMPTION

Notwithstanding the above there is nothing in these to exempt the CONTRACTOR from the operation of any other act or rules in force.

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EXHIBIT - A

Sheet 1 of 3

ELECTRODE QUALIFICATION TEST RECORD

A. Tested at (Site name) Date:

Manufacturer's Name :

Brand Name:

Batch Number & Size tested :

Classification & Code :

Intended for welding in position :

In combination with (if any) :

Code of Reference (used for testing) :

Special Requirements (if any) :

B. All-weld Tensile Test

Base Material used :

Pre-heat temperature :

Post weld heat treatment details :

Visual examination :

Radiographic examination results :

Tensile test results :

Identification No.	U.T.S.	Yield Point	Elongation	Remarks
1.				
2.				

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EXHIBIT - A

Sheet 2 of 3

C. Impact Test Results

Test Temperature : Notch in :

Type of Specimens (Charpy) : Size of Specimens :

Specimen No.	Impact Value	Average
1		
2		
3		
4		
5		

D. Chemical Analysis Results

Electrode Size Result :

Batch No. :

% C	%S	% P	% Si	% Mn	% Cr	%Ni	%Mo	Other

E. Fillet Weld Test Results :

Welding Positions :

Base Materials :

Size of electrode used :

Visual Inspection Results :

1)

2)

3)

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EXHIBIT - A

Sheet 3 of 3

Macro Test Results :

Fracture Test Results

Remarks :

F. Other Test Results :

1. Transverse tensile test :

In combination with :

Base material used :

Position of welding :

Preheat temperature :

Post weld heat treatment :

Radiography :

Identification No. U.T.S. Fracture in Remarks

2. Guided Bend Test :

Position	Identification No.	Root, Face or Side Bend	Remarks
	1		
	2		
	3		
	4		
	5		

G. Any other tests :

H. Conclusions :

PREPARED BY (CONTRACTOR)	REVIEWED BY (CONTRACTOR)	APPROVED BY (CLIENT)

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EXHIBIT - B

Sheet 1 of 1

STRESS RELIEF HEAT TREATMENT PROCEDURE SPECIFICATION

Name of the Heat-treater :

Name of the Project : Specification Reference No.

1. General Detail:

Name of the Equipment: Gas/Oil/Elect.

Name of the Assembly/Part: :

Drawing No:

Material:

2. Furnace Details

Type of Heating :

Res./Induction Type of Heating

Capacity (Size) :

Maximum Temp.(C) :

Method of temp. Measurement

Atmosphere Control :

3. Heat Treatment Cycle Details :

Charging Temp. C

Rate of heating, C/Hr

Soaking Temp. C

Soaking Time, hrs.

Rate of Cooling, C/Hr.

Mode of Cooling

4. Other Details, if any :

Notes:

The following documents shall be furnished along with the specifications:

i) Material test certificates

ii) Assembly/Part Drawing.

| --- | --- | --- |
| PREPARED BY (CONTRACTOR) | REVIEWED BY (CONTRACTOR) | APPROVED BY (CLIENT) |

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EXHIBIT - C

Sheet 1 of 3

Example of record form for welding procedure qualification test

Project/ Contract	Contractor			
Pipe and fitting material				
Process				
Outside diameter				
Pipe thickness				
Joint design (Sketch attached)				

	Make and type of filler metal	Diameter	Current	Voltage
Root				
Second run				
Other runs				
Other characteristics	electrical	a.c/d.c	Electrode negative/Positive	

Shielding gas		
Type of mixture		
Flow		
Shielding flux		
Position		

Direction of welding		:
Root	:	Vertical up*/ Vertical down
Second run	:	Vertical up*/ Vertical down
Other runs	:	Vertical up*/ Vertical down

Number of welders		:
Root		
Second run		
Other runs		

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EXHIBIT - C

Sheet 2 of 3

Time lapse between commencement of second run and commencement of other runs	
Minimum number of runs before joint allowed to cool	
Maximum time between commencement and completion of weld	
Type of line-up clamp	
Removal of clamp after run	
Lowering off after run	
Cleaning	
Preheating	
Minimum temperature C temperature C	Ambient
Type of heater to be used	
Interpass temperature	
Minimum C	Maximum C
Post weld heat treatment	
Speed of travel	
Test Results	
State acceptable ‘non-acceptable (with reasons) or give numerical results	
Non-destructive tests	
Visual	
Radiograph	

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EXHIBIT – C

Sheet 3 of 3

Destructive tests	**1**	**2**	**3**	**4**
Transverse tensile				
Tensile strength (with units)				
Fracture location				
Test temperature				
Macro-examination				
Fillet weld fracture				
Hardness survey :				
Type				
Hardness range :				
Parent metal				
Heat affected zone				
weld				
Charpy V-notch impact tests				
Specimen location and size				
Notch location				
Test temperature				
Results (with units)				

Additional test(s) and results. e.g. chemical analysis, micro-examination, CTOD tests, Bend tests, Nick Break test.

The statements in this record are correct. The test joints were prepared, welded and tested in accordance with the requirements of specification.

Contractor	Inspector
Position	Witnessed by
Date	Date

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EXHIBIT - D

Sheet 1 of 1

Example of record form for welder qualification test

Welder test certificate	Test no.
Project/Contract	Date
Contractor	Inspector
Welder's name	
Address	
Pipe material	
Pipe thickness	
Pipe outside diameter	
Welding process	Root
	Fill and cap
Electrode/wire	
Root Current	Voltage
Second run	Current Voltage
Fill and cap	Current Voltage
Direction of travel	Root : Vertical up*/ Vertical down
	Fill and cap : Vertical up*/ Vertical down
Reason for failure	
Visual	
Non-destructive testing	
Butt joint	
Fillet weld	
`Number of attempts	
Comments	
Accepted date/Time	Signed by Contractor
	Signed by Inspector

*Delete as necessary

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EXHIBIT - E

Welder's Identification Card

Name	:	
Identification	:	Photograph
Date of Testing	:	
Valid till	:	
Approval of Welding	:	
Welding Position	:	
Material	:	
Diameter	:	
Diameter range approved	:	
Wall thickness	:	
Thickness range approved	:	
Type of welding consumables	:	

Approved by :
with seal

Employers' Signature

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EXHIBIT - F

Sheet 1 of 1

Radiographic Procedure for Pipe Welding

1. Location
2. Date of Testing
3. Name of Supervised Contractor
4. Material
5. Dia & Thickness
6. Type of weld joint
7. Radiation Source (X-ray, iridium)
8. Type of equipment (External/Internal)
9. Intensifying screens and material
10. Filter type and placement mask, Diaphragm Lead screen etc. adjacent to radiation source or specimen.
11. Exposure Geomety (Source focal spot size, object to film distance, radiation angle with respect to weld and film).
12. Limit of film coverage
13. Film type and make
14. Exposure Conditions (ma, KV, time)
15. Processing (time temperature for development stop bath or rinse, fixation, washing, drying etc.)
16. Density
17. Sensitivity
18. Type of penetrameter
19. Essential wire to be seen on source side:
20. Essential wire accepted for film side viewing:

Approval of the CLIENT

Signature of CONTRACTOR with seal

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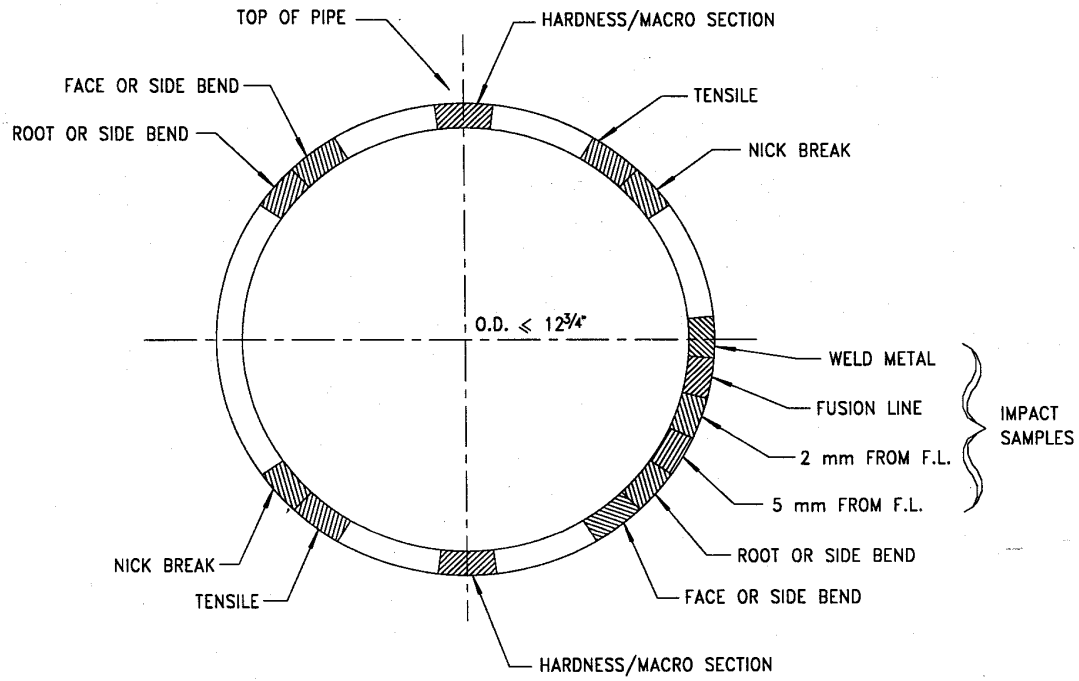


FIGURE 1. LOCATION OF SPECIMENS FOR WELD PROCEDURE QUALIFICATION FOR PIPE DIA. ≤ 12¾"

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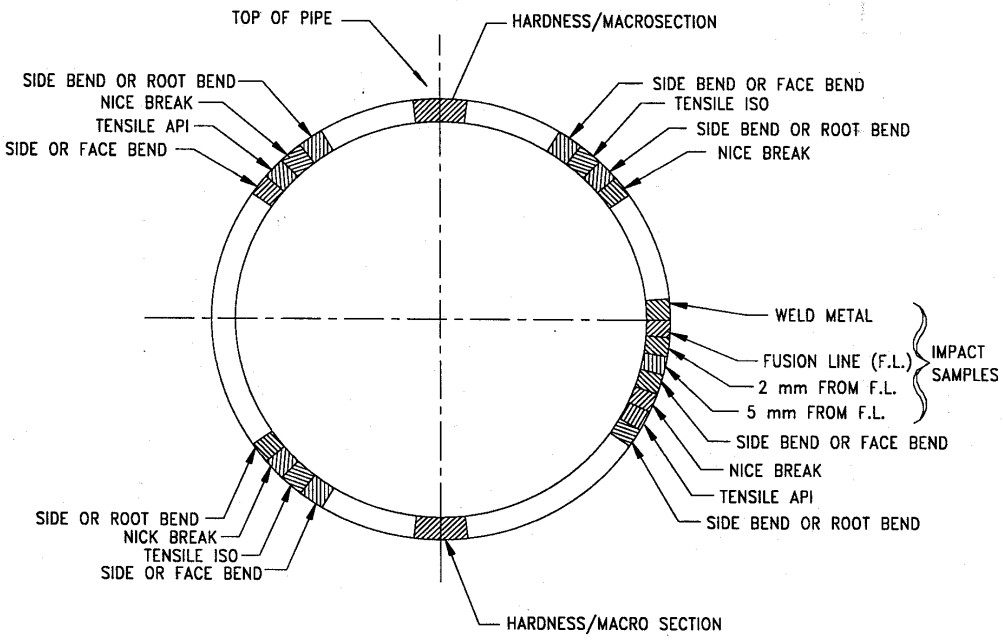


FIGURE 1A. LOCATION OF SPECIMENS FOR WELD PROCEDURE QUALIFICATION FOR PIPE DIA. $\geq 12^{3/4}$"

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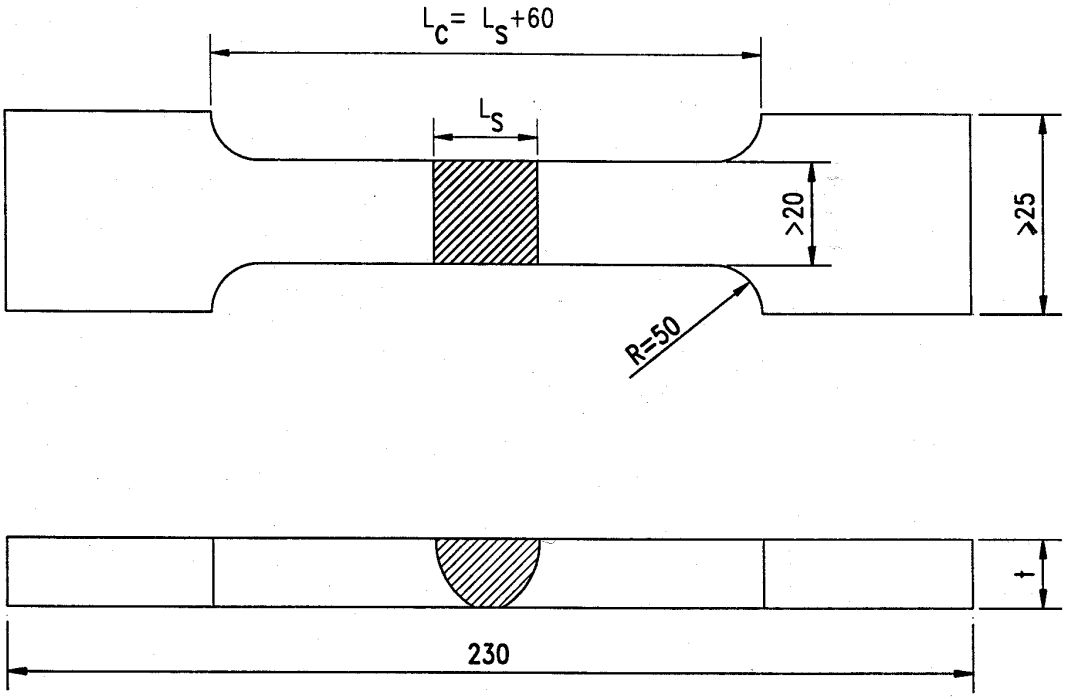


FIGURE 2. ISO TENSILE TEST SPECIMEN

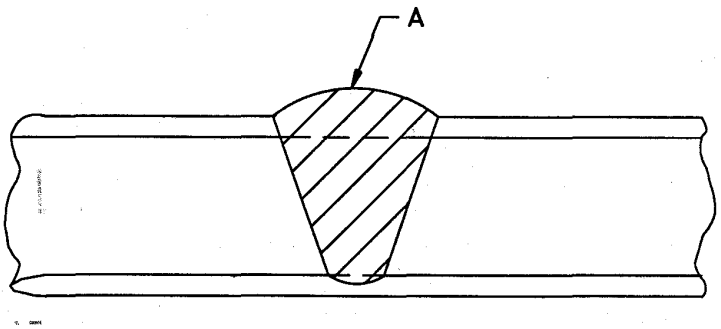
LEGEND

t = PIPE WALL THICKNESS

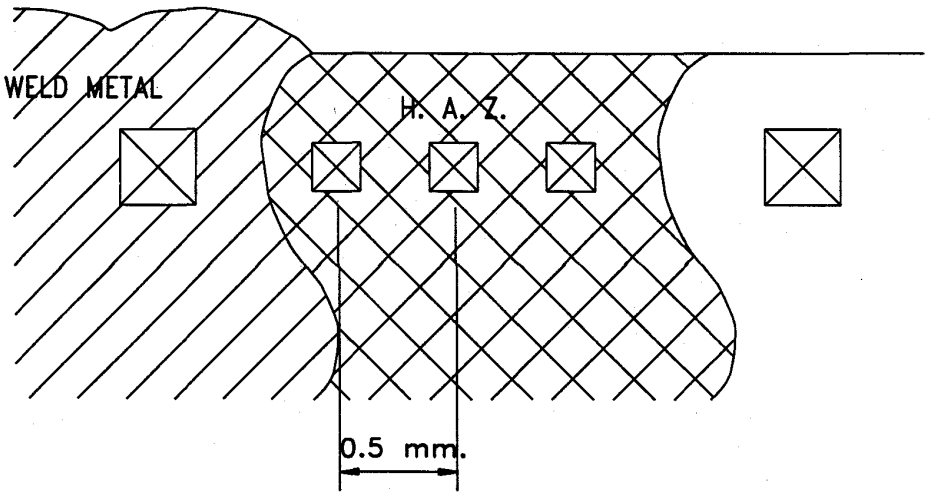
L_S = WELD WIDTH AFTER LEVELLING

L_C = LENGTH OF PARALLEL EDGES

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HARDNESS TESTING – BUTT WELDS



DETAIL – A

FIGURE 3. HARDNESS TESTING OF WELD JOINTS – SCHEMATIC

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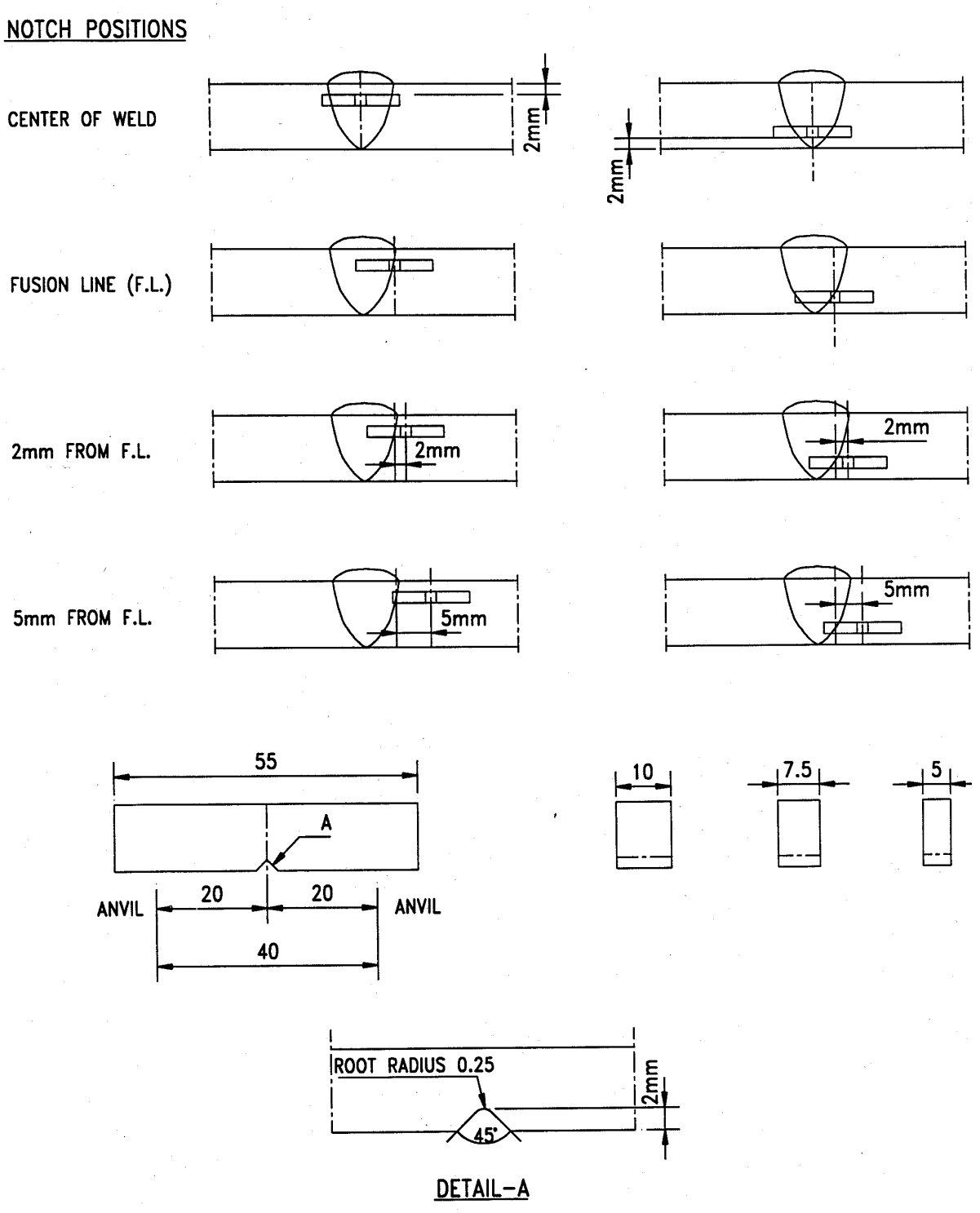
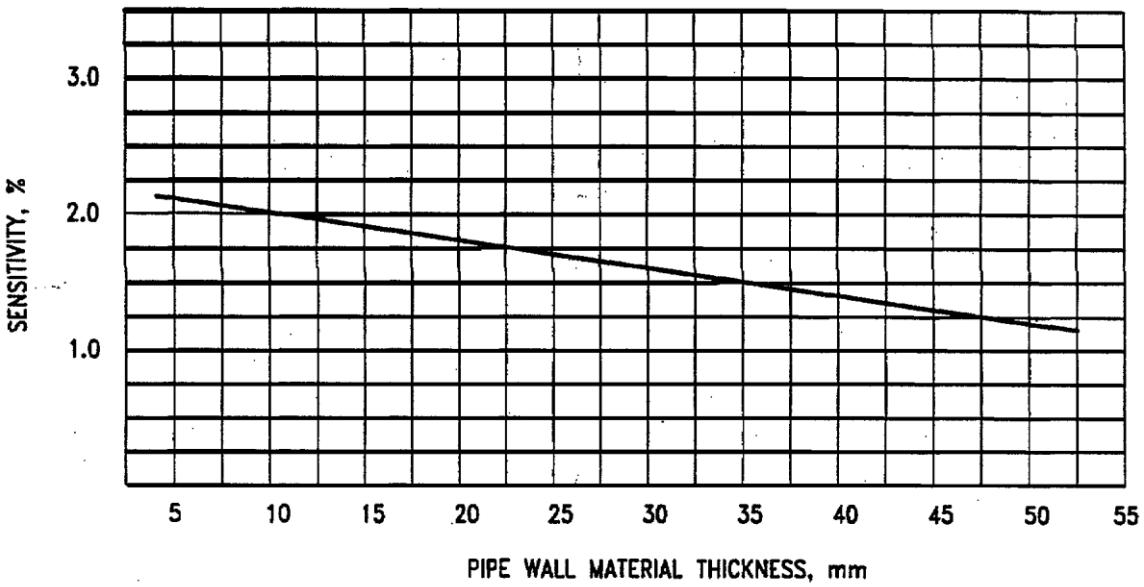


FIG.4. CHARPY V – NOTCH TEST SPECIMEN

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NOTE

FOR PRODUCTION RADIOGRAPHY, SENSITIVITY READINGS BASED ON FILM SIDE PENETRAMETERS ARE TO BE JUDGED AS PER RESULTS FROM THE PROCEDURE QUALIFICATION WITH PENETRAMETER PLACED ON THE SOURCE SIDE.

Figure 5

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WELDING SPECIFICATION CHARTS FOR PIPING CLASSES

PROJECT : GANDHAR COMPRESSOR PROJECT

CLIENT : GAIL (INDIA) LIMITED

JOB NO. : B240

0	8.04.2019	Issued for Tender	S S Pandey	P Chowdhary	H K Parmar
Rev. No	**Date**	**Purpose**	**Prepared by**	**Checked by**	**Approved by**

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WSC FOR PIPING CLASSES: DA1A 5

WSC FOR PIPING CLASSES: AA3A 6

WSC FOR PIPING CLASSES: AA4A, BA4A, DA4A, EA4A 7

WSC FOR PIPING CLASSES: AA1K, BA1K 8

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GENERAL NOTES

1.1 Scope:

This document covers the Welding Specification for the piping classes covered in the Piping Material Specification (B240-000-83-41-SP-0001-0) WPS and PQR for the field fabrication and erection of piping system shall be made in conformity with this document. No deviations are acceptable unless specifically approved through prescribed deviation permit.

1.2 Reference Standards:

This document shall be read in conjunction with the latest revisions/editions of the following documents:

a. Job Specification for Non Destructive Examination Requirements of Piping, EIL Spec. No. 6-44-0016

b. ASME Boiler & Pressure Vessel Code – Sections V, VIII(Div.-1), IX & II-C

c. ASME B31.3

d. ASTM E10

e. Standard Specification for Fabrication & Erection of Piping, EIL Spec.No. 6-44-0012

f. Welding Specification for Fabrication of Piping, B240-000-02-42-WSP-0001.

1.3 GTAW process can be applied in place of SMAW process with a corresponding suitable filler metal for the application.

1.4 Abbreviations:

GTAW	:	Gas Tungsten Arc Welding
OD	:	Outer Diameter
PQR	:	Procedure Qualification Record
SMAW	:	Shielded Metal Arc Welding
WSC	:	Welding Specification Chart
WPS	:	Welding Procedure Specification

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WSC FOR PIPING CLASSES: AA1A, BA1A, DA1A, EA1A					
MATERIAL SPECIFICATIONS	PIPES	**ASTM A 333 GR.6, ASTM A106 GR.B, API 5L GR.B PSL2, API 5L GR.X-52 PSL2**			
	FITTINGS	**ASTM A234 GR.WPB , MSS SP-75 GR.WPHY-52, ASTM A 234 GR.WPB-W**			
	FLANGES	**ASTM 105, ASTM A694 GR.F-52**			
	OTHERS	-			
BASE METAL `P' NO	1				
WELDING PROCESS	GROOVE JOINTS				
	BUTT		OTHER THAN BUTT		
	ROOT PASS: **SMAW/ GTAW (NOTE-1)**	FILLERPASS: **SMAW/GTAW (NOTE-2)**	ROOTPASS: SMAW/ **GTAW**	FILLER PASS: **SMAW/ GTAW**	
	FILLET JOINTS/ SOCKET JOINTS: **SMAW**				
WELDING MATERIALS	GROOVE JOINTS				
	BUTT		OTHER THAN BUTT		
	ROOT PASS: **E6010/ ER70S-2**	FILLER PASS: **E7016/ E7018 / ER70S-2**	ROOT PASS: **E6010/ ER70S-2**	FILLER PASS: **E7016/ E7018/ ER70S-2**	
	FILLET JOINT/SOCKET JOINT: **E7016/E7018**				
	BACKING RING: NA		CONSUMABLE INSERT: NA		
JOINT PREPARATION	**ASME B31.8**				
GASES	PURGING: -		SHIELDING: **ARGON**		
GAS COMPOSITION	PURGING: -		SHIELDING: **99.995 %**		
PREHEATING	PREHEAT TEMP: +**10°C MIN./ 100°C MIN. FOR THK.>25.4 MM (NOTE-3)**		INTERPASS TEMP.: ---		
POST HEATING: -					
POST WELD HEAT TREATMENT	HOLDING TEMP: -		HOLDING TIME: -		
	RATE OF HEATING: -		MIN. HOLDING TIME: -		
	METHOD OF COOLING: -		RATE OF COOLING: -		
MECHANICAL PROPERTY REQUIREMENTS	CHARPY `V' NOTCH VALUE: **(NOTE -4)**		MIN: **27 J**	AVERAGE: ---	
	AT TEMPERATURE:		**MINUS (-) 29°C**		
	HARDNESS: **248 HV 10 MAXIMUM**				
CODE OF FABRICATION	**ASME B31.8/API 1104/ASME SECTION IX & OISD 226**				

TECHNICAL NOTES:

1. **THE ROOT PASS FOR SINGLE SIDE WELDING SHALL BE DONE BY GTAW PROCESS.**
2. **FOR PIPING SIZES 2" OD AND BELOW SHALL BE ENTIRELY WELDED BY GTAW PROCESS.**
3. **PRE-HEAT TEMPERATURE OF ATLEAST 50°C SHALL BE PROVIDED FOR THE FIRST TWO PASSES FOR THK>=12.5 mm & ≤ 25 mm.**
4. **DURING WELDING PROCEDURE QUALIFICATION, WELD METAL AND HAZ SHALL SHOW MINIMUM IMAPCT VALUE OF 27 J AT MINUS TWENTY NINE DEGREE CELSIUS AND CROSS SECTIONAL HARDNESS OF 248 HV10.**

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WSC FOR PIPING CLASSES: DA1A					
MATERIAL SPECIFICATIONS	PIPES	**API 5L GR.X70 PSL-2, API 5L GR.X60 PSL-2**			
	FITTINGS	**---**			
	FLANGES	**ASTM A694 GR.F-70, ASTM A694 GR.F-60**			
	OTHERS	-			
BASE METAL `P' NO	1				
WELDING PROCESS	GROOVE JOINTS				
	BUTT		OTHER THAN BUTT		
	ROOT PASS: **SMAW/ GTAW**	FILLERPASS: **SMAW**	ROOTPASS: **SMAW/ GTAW**	FILLER PASS: **SMAW**	
	FILLET JOINTS/ SOCKET JOINTS: **SMAW**				
WELDING MATERIALS	GROOVE JOINTS				
	BUTT		OTHER THAN BUTT		
	ROOT PASS: **E6010/ ER70S-2**	FILLER PASS: **E8018-G/ E8010-P1 (NOTE-1)**	ROOT PASS: **E6010/ ER70S-2**	FILLER PASS: **E8018-G/ E8010-P1 (NOTE-1)**	
	FILLET JOINT/SOCKET JOINT: **E8018-G (NOTE-1)**				
	BACKING RING: NA		CONSUMABLE INSERT: NA		
JOINT PREPARATION	**ASME B31.8**				
GASES	PURGING: -		SHIELDING: **ARGON**		
GAS COMPOSITION	PURGING: -		SHIELDING: **99.995 %**		
PREHEATING	PREHEAT TEMP: +**10°C MIN./ 100°C MIN. FOR THK.>25.4 MM (NOTE-2)**		INTERPASS TEMP.: ---		
POST HEATING: -					
POST WELD HEAT TREATMENT	HOLDING TEMP: -		HOLDING TIME: -		
	RATE OF HEATING: -		MIN. HOLDING TIME: -		
	METHOD OF COOLING: -		RATE OF COOLING: -		
MECHANICAL PROPERTY REQUIREMENTS	CHARPY `V' NOTCH VALUE: **(NOTE-3)**		MIN: **27 J**	AVERAGE: ---	
	AT TEMPERATURE:		**MINUS (-) 29°C**		
	HARDNESS: **248 HV 10 MAXIMUM**				
CODE OF FABRICATION	**ASME B31.8/API 1104/ASME SECTION IX & OISD 226**				

TECHNICAL NOTES:

1. **EACH BATCH OF ELECTRODES SHALL MEET THE MINIMUM TENSILE AND YIELD STREGTH OF API 5L GR.X70 PSL2 MATERIAL.**

2. **PRE-HEAT TEMPERATURE OF ATLEAST 50°C SHALL BE PROVIDED FOR THE FIRST TWO PASSES FOR THK>=12.5 mm & ≤ 25 mm.**

3. **DURING WELDING PROCEDURE QUALIFICATION, WELD METAL AND HAZ SHALL SHOW MINIMUM IMAPCT VALUE OF 27 J AT MINUS TWENTY NINE DEGREE CELSIUS AND CROSS SECTIONAL HARDNESS OF 248 HV10.**

4. **DURING WELDING OF API 5L GR.X-70/60 PSL2/EQUIVALENT MATERIAL TO ANY OTHER MATERIAL GRADE GIVEN IN AA1A/BA1A/DA1A/EA1A PIPING CLASS, WELDING CONSUMABLES SPECIFEID IN THIS CHART SHALL BE USED.**

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WSC FOR PIPING CLASSES: AA3A				
MATERIAL SPECIFICATIONS	PIPES	**ASTM A106 GR.B**		
	FITTINGS	**ASTM A234 GR.WPB**		
	FLANGES	**ASTM 105**		
	OTHERS	-		
BASE METAL `P' NO	1			
WELDING PROCESS	GROOVE JOINTS			
	BUTT		OTHER THAN BUTT	
	ROOT PASS: **SMAW**	FILLERPASS: **SMAW**	ROOTPASS: **SMAW**	FILLER PASS: **SMAW**
	FILLET JOINTS/ SOCKET JOINTS: **SMAW**			
WELDING MATERIALS	GROOVE JOINTS			
	BUTT		OTHER THAN BUTT	
	ROOT PASS: **E6010**	FILLER PASS: **E6013/ E7018/E7016**	ROOT PASS: **E6010**	FILLER PASS: **E6013/ E7018/E7016**
	FILLET JOINT/SOCKET JOINT: **E6013/E7018/E7016**			
	BACKING RING: NA		CONSUMABLE INSERT: NA	
JOINT PREPARATION	**ASME B31.8**			
GASES	PURGING: -		SHIELDING: **---**	
GAS COMPOSITION	PURGING: -		SHIELDING: **---**	
PREHEATING	PREHEAT TEMP: +**10°C MIN./ 100°C MIN. FOR THK.>25.4 MM (NOTE-1)**		INTERPASS TEMP.: ---	
POST HEATING: -				
POST WELD HEAT TREATMENT	HOLDING TEMP: -		HOLDING TIME: -	
	RATE OF HEATING: -		MIN. HOLDING TIME: -	
	METHOD OF COOLING: -		RATE OF COOLING: -	
MECHANICAL PROPERTY REQUIREMENTS	CHARPY `V' NOTCH VALUE:		MIN: ---	AVERAGE: ---
	AT TEMPERATURE:		**----**	
	HARDNESS: ---			
CODE OF FABRICATION	**ASME B31.8/API 1104/ASME SECTION IX & OISD 226**			

TECHNICAL NOTES:

1. **PRE-HEAT TEMPERATURE OF ATLEAST 50°C SHALL BE PROVIDED FOR THE FIRST TWO PASSES FOR THK>=12.5 mm & ≤ 25 mm.**

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WSC FOR PIPING CLASSES: AA4A, BA4A, DA4A, EA4A					
MATERIAL SPECIFICATIONS	PIPES	**ASTM A 333 GR.6**			
	FITTINGS	**ASTM A 420 GR.WPL6, ASTM A 420 GR.WPL6-W**			
	FLANGES	**ASTM A 350 GR.LF2 CL.1**			
	OTHERS	**-**			
BASE METAL `P' NO	1				
WELDING PROCESS	GROOVE JOINTS				
	BUTT		OTHER THAN BUTT		
	ROOT PASS: **GTAW**	FILLERPASS: **SMAW/GTAW (NOTE-1)**	ROOTPASS: **GTAW**	FILLER PASS: **SMAW/ GTAW**	
	FILLET JOINTS/ SOCKET JOINTS: **SMAW**				
WELDING MATERIALS	GROOVE JOINTS				
	BUTT		OTHER THAN BUTT		
	ROOT PASS: **ER80S-Ni1 (NOTE-2)**	FILLER PASS: **E7016-1/ E7018-1 / ER80S-Ni1 (NOTE-2)**	ROOT PASS: **ER80S-Ni1 (NOTE-2)**	FILLER PASS: **E7016-1/ E7018-1 / ER80S-Ni1 (NOTE-2)**	
	FILLER JOINT/SOCKET JOINT: **E7016-1/E7018-1 (NOTE-2)**				
	BACKING RING: NA		CONSUMABLE INSERT: NA		
JOINT PREPARATION	**ASME B31.8**				
GASES	PURGING: -		SHIELDING: **ARGON**		
GAS COMPOSITION	PURGING: -		SHIELDING: **99.995 %**		
PREHEATING	PREHEAT TEMP: +**10°C MIN./ 100°C MIN. FOR THK.>25.4 MM (NOTE-3)**		INTERPASS TEMP.: **315°C MAX.**		
POST HEATING: -					
POST WELD HEAT TREATMENT	HOLDING TEMP: -		HOLDING TIME: -		
	RATE OF HEATING: -		MIN. HOLDING TIME: -		
	METHOD OF COOLING: -		RATE OF COOLING: -		
MECHANICAL PROPERTY REQUIREMENTS	CHARPY `V' NOTCH VALUE: **(NOTE-4)**		MIN: **27 J**	AVERAGE: ---	
	AT TEMPERATURE:		**-45°C**		
	HARDNESS: **200 BHN MAX.**				
CODE OF FABRICATION	**ASME B31.8/API 1104/ASME SECTION IX & OISD 226**				

TECHNICAL NOTES:

1. **FOR PIPING SIZES 2" OD AND BELOW SHALL BE ENTIRELY WELDED BY GTAW PROCESS.**
2. **EACH BATCH SHALL BE IMPACT TESTED AT SITE AS PER ASME SECTION II PART C. IMACT TESTING SHALL BE CARRIED OUT AT -45°C.**
3. **PRE-HEAT TEMPERATURE OF ATLEAST 50°C SHALL BE PROVIDED FOR THE FIRST TWO PASSES FOR THK>=12.5 mm & ≤ 25 mm.**
4. **DURING PROCEDURE QUALLIFICATION, STANDARD-SIZE CHARPY TEST PIECES SHALL DEMONSTRATE MINIMUM IMPACT VALUE OF 27 J. THE TEST TEMPERATURE SHALL BE MINUS (-) FORTY FIVE DEGREE CELSIUS.**

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WSC FOR PIPING CLASSES: AA1K, BA1K					
MATERIAL SPECIFICATIONS	PIPES	**ASTM A312 TP304**			
	FITTINGS	**ASTM 182 GR. F304, ASTM A403 GR. WP304-S**			
	FLANGES	**ASTM A182 GR.F304**			
	OTHERS	**-**			
BASE METAL `P' NO	**8**				
WELDING PROCESS	GROOVE JOINTS				
	BUTT		OTHER THAN BUTT		
	ROOT PASS: **GTAW**	FILLER PASS: **GTAW/ SMAW (NOTE-1)**	ROOTPASS: **GTAW /SMAW**	FILLER PASS: **GTAW / SMAW**	
	FILLET JOINTS/ SOCKET JOINTS: **SMAW**				
WELDING MATERIALS	GROOVE JOINTS				
	BUTT		OTHER THAN BUTT		
	ROOT PASS: **ER 308 / ER 308L**	FILLER PASS: **ER308/ ER 308L / E308-15/16/ E308L-15/16**	ROOT PASS: **ER 308/ ER 308L / E308-15/16/ E308L-15/16**	FILLER PASS: **ER 308/ ER 308L / E308-15/16/ E308L-15/16**	
	FILLET JOINT/SOCKET JOINT: **E308-15/16/ E308L-15/16**				
	BACKING RING: NA		CONSUMABLE INSERT: NA		
JOINT PREPARATION	**ASME B31.8**				
GASES	PURGING: - **ARGON**		SHIELDING: **ARGON**		
GAS COMPOSITION	PURGING: - **99.995%**		SHIELDING: **99.995 %**		
PREHEATING	PREHEAT TEMP: **10°C MIN.**		INTERPASS TEMP.: **175°C MAX**		
POST HEATING: -					
POST WELD HEAT TREATMENT	HOLDING TEMP: -		HOLDING TIME: -		
	RATE OF HEATING: -		MIN. HOLDING TIME: -		
	METHOD OF COOLING: -		RATE OF COOLING: -		
MECHANICAL PROPERTY REQUIREMENTS	CHARPY `V' NOTCH VALUE:		MIN: **---**	AVERAGE: ---	
	AT TEMPERATURE:		**---**		
	HARDNESS:				
CODE OF FABRICATION	**ASME B31.8/API 1104/ASME SECTION IX & OISD 226**				

TECHNICAL NOTES:

1. **FOR PIPING SIZES 2" OD AND BELOW SHALL BE ENTIRELY WELDED BY GTAW PROCESS.**

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SPECIFICATION FOR SURFACE PREPARATION AND PROTECTIVE COATING SYSTEM - NEW CONSTRUCTION

PROJECT : GANDHAR COMPRESSOR PROJECT

OWNER : GAIL (INDIA) LIMITED

JOB NO. : B240

Rev. No.	Date	Purpose	Prepared by	Reviewed by	Approved by
0	08.04.2019	Issued For Tender	S S Pandey	P Chowdhary	H K Parmar

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1.0 GENERAL

1.1 This technical specifications shall be applicable for the work covered by the contract, and without prejudice to the provisions of various international codes of practice, standard specifications etc. It is understood that contractor shall carry out the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of Engineer-In-Charge.

1.2 Wherever it is stated in the specification that a specific material is to be supplied or a specific work is to be done, it shall be deemed that the same shall be supplied or carried out by the contractor. Any deviation from this standard without written deviation permit from appropriate authority will result in rejection of job.

1.3 This specification covers the requirement for protective coating for new construction.

2.0 SCOPE

2.1 Scope of work covered in the specification shall include, without being limited to the following.

2.1.1 This specification defines the requirements for surface preparation, selection and application of primers and paints on external surfaces of equipment, vessels, machinery, piping, ducts, steel structures, external & internal protection of storage tanks for all services and chimneys if any. The items listed in the heading of tables of paint systems is indicative only, however, the contractor is fully responsible for carrying out all the necessary painting, coating and lining on external and internal surfaces as per the tender requirement.

2.2 Extent of Work

2.2.1 The following surfaces and materials shall require shop, pre-erection and field painting:

- All uninsulated Carbon Steel & Alloy Steel equipments like vessels, Columns, storage Tanks, Exchangers if any, parts of boilers etc.
- All uninsulated carbon steel and low alloy plant and related piping, fittings and valves (including painting of identification marks), furnace ducts and stacks.
- All insulated parts of vessels, boilers, chimneys, stacks, piping and steam piping and if any other insulated items present.
- All items contained in a package unit as necessary.
- All structural steel work, pipe, structural steel supports, walkways, handrails, ladders, platforms etc.
- Flare lines, external surfaces of MS chimney with or without refractory lining and internal surfaces of MS chimney without refractory lining. (If present)
- Identification of colour bands on all piping as required including insulated aluminium clad, galvanized, SS and nonferrous piping.
- Identification lettering/ numbering on all painted surfaces of equipment/piping insulated aluminium clad, galvanized, SS and non-ferrous piping.

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- Marking / identification signs on painted surfaces of equipment/piping including hazardous service.
- Supply of all primers, paints and all other materials required for painting (other than Owner supplied materials)
- Over insulation surface of equipments and pipes wherever required.
- Painting under insulation for carbon steel, alloy steel and stainless steel as specified.
- Painting of pre-erection/fabrication and Shop primer.
- Repair work of damaged pre-erection/ fabrication and shop primer and weld joints in the field/site before and after erection as required.
- All CS Piping, equipments, storage tanks and internal surfaces of RCC tanks in ETP plant.
- Quality control, testing and inspection during all stages of work (surface preparation, application of coating and testing of furnished coating).

2.2.2 The following surfaces and materials shall not require painting in general. However, if there is any specific requirement by the Owner, the same shall be painted as per the relevant specifications:

a. Uninsulated austenitic stainless steel.
b. Plastic and/or plastic coated materials
c. Non-ferrous materials like aluminum, Cu-Ni alloy.

2.3 Documents

2.3.1 The contractor shall perform the work in accordance with the following documents issued to him for execution of work.

a. Bill of quantities for piping, equipment, machinery and structures etc.
b. Piping Line List.
c. Painting specifications including special civil defence requirements.

2.4 Unless otherwise instructed, final paint coating (i.e., application of field primer, wherever required, intermediate and top coats) on pre-erection/ shop primed equipments shall be applied at site, only after all welding, testing on systems are completed as well as after completion of steam purging wherever required.

2.5 Changes and deviations required for any specific job due to clients requirement or otherwise shall be referred to EIL for deviation permit.

3.0 REFERENCE CODES & STANDARDS

3.1 Without prejudice to the provision of Clause 1.1 above and the detailed specifications of the contract, latest editions of the following codes and standards are applicable for the work covered under this specification.

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ISO-12944	:	Corrosion Protection of steel Structures by Protective Paint System
NACE 0198	:	Control of Corrosion under Thermal Insulation and Fireproofing Materials
ISO 14713-2	:	Zinc Coatings – Guidelines and Recommendations for the Protections against Corrosion of Iron and Steel in Structures, Part-2: Hot Dip Galvanizing
ASTM Vol. 6.01&6.03	:	American standard test methods for Paints and Coatings
IS-101	:	Methods of test for ready mixed paints and enamels
IS-5	:	Colours for ready mixed paints and enamels.
IS-2379	:	Indian Standard for Pipe line identification-colour code
RAL DUTCH	:	International Standard for colour shade (Dutch Standard)
ANSI A 13.1	:	Scheme for identification of piping systems: American National Standards Institution
SSPC	:	Steel Structures Painting Council

3.2 Surface Preparation Standards

The latest editions of any of the following standards shall be followed for surface preparation:

3.2.1 ISO 8501-1 **/** SIS-05 59 00: ISO standard for Preparation of steel substrates before application of paints and related products. This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-In-Charge.

3.2.2 Steel Structures Painting Council, U.S.A. (Surface Preparation Specifications (SSPC-SP).

3.2.3 National Association of Corrosion Engineers, U.S.A., (NACE).

3.2.4 Various International Standards equivalent to Swedish Standard for surface preparations are given in Table-I.

3.3 The contractor shall arrange, at his own cost, to keep a set of latest edition of above standards and codes at site.

3.4 The paint manufacturer's instructions shall be followed as far as practicable at all times for best results. Particular attention shall be paid to the following:

a. Instructions for storage to avoid exposure as well as extremes of temperature.

b. Surface preparation prior to painting shall carried out as per this standard

c. Mixing and thinning.

d. Application of paints and recommended limit on time intervals in between coats.

4.0 EQUIPMENT

4.1 All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipments, scaffolding materials, shot & grit blasting equipments & air compressors etc. required to be used shall be suitable for the work and all in good order and shall be arranged by the contractor at site and in sufficient quantity. The

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manufacturer's test certificates **/** data sheets for all the above items shall be reviewed by Engineer-in-charge at site before start of work.

4.2 Mechanical mixer shall be used for paint mixing operations in case of two pack systems except that the Engineer-In-Charge may allow the hand mixing of small quantities at his discretion in case of specific requirement for touch up work only.

5.0 SURFACE PREPARATION, SHOP PRIMER COATING APPLICATION & REPAIR

5.1 General

5.1.1 In order to achieve the maximum durability, one or more of following methods of surface preparation shall be followed, depending on condition of surface to be painted and as instructed by Engineer-In-Charge. Adhesion of the paint film to surface depends largely on the degree of cleanliness of the metal surface. Proper surface preparation contributes more to the success of the paint protective system.

a. Abrasive blast cleaning

b. Mechanical or power tool cleaning

5.1.2 Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. Unless otherwise specified, surface preparation shall be done as per provisions of relevant tables given elsewhere in this specification. The minimum acceptable standard, in case of thermally sprayed metal coatings, in case of mechanical or power tool cleaning it shall be St. 3 or equivalent. In case of blast cleaning it shall be Sa 2-1/2 as per Swedish Standard SIS-055900 (latest edition) or SSPC-SP or ISO 8501-01.Blast cleaning shall be Sa 3 as per Swedish Standard in case thermally sprayed metal coatings.

Before surface preparation by blast cleaning, the surface shall be degreased by aromatic solvent to remove all grease, oil etc.

5.1.3 Irrespective of whether external or internal surface to be coated, blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceed 85%. In case of internal coating of storage tanks, dehumidifier shall be used, to control humidity level below 60%. Dehumidifier should depress the dew point of air in the enclosed space, sufficient enough so as to maintain it 3^0C below the metal substrate temperature during centre period of blasting and coating application. During the interval time between application of primer coat and subsequent intermediate and top coats or between blast cleaning completion and start of application of primer coat, dehumidifier unit should be in continuous operation to ensure that no condensation occurs on substrate.

Dehumidifier should be able to maintain grain drop (moisture removal) at the rate of 25 grains per pound of air per hour. Dehumidifier should have capacity of at least 2 air changes per hour of the enclosed space. All necessary psychometric data should be collected by contractor for the given site conditions before starting operation of dehumidifier to ensure that desired values of dew point, moisture content in enclosed scope is achieved.

Dehumidification to be maintained round the clock for surface preparation and painting till the total coating application is over.

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Dehumidifier shall not be stopped under any condition till the entire blasted surface is primed to the satisfaction of the technical representative of the paint manufacturer interested with quality assurance for the work. In case the dehumidifier breaks down in middle of the job, the same shall be replaced at the risk and the cost of the contractor and the entire unfinished work shall be repeated.

5.1.4 The Engineer in-charge shall have the right to disallow usage of dehumidifier if the performance is not meeting the specified requirements. Under such circumstances the contractor shall remove the equipment and replace the same with another equipment to provide satisfactory results without any additional cost to the owner.

5.1.5 Irrespective of the method of surface preparation, the first coat of primer must be applied by airless spray/ air assisted conventional spray if recommended by the paint manufacturer on dry surface. This should be done immediately and in any case within 4 hours of cleaning of surface. However, at times of unfavorable weather conditions, the Engineer-In-Charge shall have the liberty to control the time period, at his sole discretion and/or to insist on re-cleaning, as may be required, before primer application is taken up. In general, during unfavorable weather conditions, blasting and painting shall be avoided as far as practicable.

5.1.6 The external surface of R.C.C. chimney to be painted shall be dry and clean. Any loose particle of sand, cement, aggregate etc. shall be removed by scrubbing with soft wire brush. Acid etching with 10-15% HCL solution for about 15 minutes shall be carried and surface must be thoroughly washed with water to remove acid & loose particles and then dried completely before application of paint.

5.2 Procedure for Surface Preparation

5.2.1 Air Blast Cleaning with abrasives

The surfaces shall be blast cleaned using one of the abrasives like angular chilled cast iron or steel grit, copper slag or Nickel slag, $A1_2O_3$ particles at pressure of 7kg/cm^2 at an appropriate distance and angle depending of nozzle size maintaining constant velocity and pressure. Chilled cast iron or steel shall be in the form of shot or grit of size in the range of G16 – G42 conforming to SSPC AB1 and S250 grade size of steel shots (maximum) to obtain a desired surface profile of 35-50 microns trough to peak. For all other abrasives, size shall be in the range of G16 – G24. The combination of steel grits and shots shall be normally in the ratio of 3:1. The quality of abrasives shall be free from contaminants and impurities and shall meet the requirements of SSPC AB1. Compressed air shall be free from moisture and oil. The blasting nozzles should be venturi style with tungsten carbide or boron carbide as the materials for liners. Nozzles orifice may vary from 3/16" to ¾". On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey white metallic luster. Primer/first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall not be done outdoors in bad weather without adequate protection or when there is dew on the metal, which is to be cleaned. Surface profile shall be uniform to provide good key to the paint adhesion (i.e. 35 to 50 microns). If possible vacuum collector shall be installed for collecting the abrasives and recycling.

5.2.2 Mechanical or Power Tool Cleaning

Power tool cleaning shall be done by mechanical striking tools, chipping hammers, grinding wheels or rotating steel wire- brushes. Excessive burnish of surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached

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rust mill scale etc. shall be removed by clean rags and /or washed by water or steam and thoroughly dried with compressed air jet before application of paint.

5.3 Non-Compatible Shop Coat Primer

For equipments on which application of total protective coating (Primer + Intermediate + top coat) is carried out at shop, compatibility of finish coat with primer should be checked with paint manufacturer. If the shop coat is in satisfactory condition showing no major defect upon arrival at site, the shop coat shall not be removed.

5.4 Shop coated equipments (coated with Primer & finishing coat) should not be repainted unless paint is damaged. Repair shall be carried out as per this specification depending upon compatibility of paint.

5.5 Shop primed equipment and surfaces will only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer should be completely removed before application of selected paint system for particular environment.

5.6 For Package units/equipment, shop primer should be as per the paint system given in this specification. However, manufacturer's standard can be followed after review.

As mentioned in section 2.4, all coating application at field (field primer, intermediate and top coat) on equipments, structures, piping, etc., shall be carried out only after its erection and all welding, testing, steam purging (wherever carried out) have been completed.

5.7 Coating Procedure and Application

All paint coatings shall be applied by airless spray excepting at the following special cases where application can be carried out by brush subject to suitability of the application of the paint product by brush.

- Spot repair
- Stripe coating on edges
- Small bore parts not suitable for spray application.

Irregular surfaces such as sharp edges, welds, small brackets, and interstices may stripe coated to ensure specified DFT is achieved. Paint manufacturer recommendation should be followed before deciding for brush application.

5.7.1 Surface shall not be coated in rain, wind or in environment where injurious airborne elements exists, when the steel surface temperature is less than 5°F above dew point when the relative humidity is greater than 85% or when the temperature is below 40°F and when the ambient/substrate temp is below the paint manufacturer's recommended temperature of application and curing. De-humidifier equipment shall be used to control RH and Dew point. The paint application shall not be done when the wind speed exceeds 20 km per hour.

5.7.2 Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hrs. of the same day.

5.7.3 To the maximum extent practicable, each coat of material shall be applied as a continuous film uniform thickness free of probes. Any spots or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

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5.7.4 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without the development of any detrimental film irregularities, such as lifting or loss of adhesion of the under coat. Manufacturer instruction shall be followed for inter-coat interval.

5.7.5 When the successive coat of the same colour have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life and shall be recommended by the original paint manufacturer.

5.7.6 Airless spray application shall be in accordance with the following procedure: as per steel structure paint Manual Vol.1 & Vol.2 by SSPC, USA, Air less spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor is sued to operate a pump to produce pressures of 1000 to 6000 psi. Paint is delivered to the spray gun at this pressure through a single hose within the gun, a single paint stream is divided into separate streams, which are forced through a small orifice resulting in atomization of paint without the use of air. This results in more rapid coverage with less over spray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional air spray.

Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have in built agitator that keep the paint uniformly mixed during the spraying. The unit shall consist of in built strainer. Usually very small quantity of thinning is required before spray. In case of high build epoxy coating (two pack). 30:1 pump ratio and 0.020-0.023” tip size will provide a good spray pattern. Ideally fluid hoses should not be less than 3/8” ID and not longer than 50 feet to obtain optimum results.

In case of gun choking, de-choking steps shall be followed immediately.

5.7.7 Brush application of paint shall be in accordance with the following:

a. Brushes shall be of a style and quality that will enable proper application of paint.

b. Round or oval brushes are most suitable for rivets, bolts, irregular surface, and rough or pitted steel. Wide flat brushes are suitable for large flat areas, but they shall not have width over five inches.

c. Paint shall be applied into all corners.

d. Any runs or sags shall be brushed out.

e. There shall be a minimum of brush marks left in the applied paint.

f. Surfaces not accessible to brushes shall be painted by spray, doubers, or sheepkin.

5.7.8 For each coat the painter should know the WFT corresponding to the specified DFT and standardize the paint application technique to achieve the desired WFT. This has to be ensured in the qualification trial.

5.8 Drying of Coated Surfaces

5.8.1 No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats.

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Drying time of the applied coat should not exceed maximum specified for it as a first coat; if it exceeds the paint material has possibly deteriorated or maxing is faulty.

5.8.2 No paint shall be force dried under conditions which will cause chalking, wrinkling, blistering formation of pores, or detrimentally affect the conditions of the paint.

5.8.3 No drier shall be added to paint on the job unless specifically called for in the manufacturer's specification for the paint.

5.8.4 Paint shall be protected from rain, condensation, contamination, snow and freezing until dry to the fullest extent practicable.

5.9 Spot Repair of Damaged Primer

5.9.1 Where pre erection shop primer has been damaged at isolated localized spots during handling and transportation, or after erection / welding, the repair of damaged coating of pre-erection / pre-fabrication or shop primer shall be done as given below and as per the Table given at Clause no. 9.1 of this specification.

5.9.2 Repair of damaged inorganic zinc silicate pre-erection / pre-fabrication or shop primer (F9) after erection / welding in the design temperature of -90°C to 400°C and damaged silicone aluminium (F-12) pre-erection / pre-fabrication or shop primer after erection / welding for design temperature range of 401 – 550 °C.

Surface Preparation: Quickly remove the primer from damaged area by mechanical scraping and emery paper conforming to SSPC-SP-3 to expose the white metal. Blast clean the surface, if possible. Feather the primed surface over the intact adjacent surface surrounding the damaged area by emery paper.

Primer coating: One coat of F-9 shall be applied wherever damage was observed on pre-erection / pre fabrication or shop primer of inorganic zinc silicate coating (F-9). Similarly one coat of F-12 shall be applied wherever damage observed on pre-erection ***/*** pre-fabrication shop primer of silicone aluminium (F-12).

5.9.3 Wherever if damaged areas are found extensive and spread over large areas, then entire pre-erection / pre-fabrication or shop primer shall be removed by blasting to achieve SSPC-SP-10 then entire blasted surface shall be primed again with F-9 or F-12 as applicable for the intended design temp.

5.10 Paint Application

5.10.1 Shop priming/pre-erection priming with F9 or F12 shall be done only on blasted surface (SSPC-SP-10)

5.10.2 Shop priming / pre-erection priming with F9 or F12 shall be done only with airless spray.

5.10.3 Assessment of Painting Requirement:

The paint system to be applied for a specific job shall be arrived at sequentially as given below:

- Identify the environment from area classification details and chose the appropriate table.

- Identify the design temperature from the technical documents

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- Identify the specific field paint system and surface preparation requirement from the above identified table and temperature range.

- Identify the shop priming requirement from clause 9.1 based on compatibility of the above paint system.

- Identify the need of repair of shop primer and execute as per clause 9.1.

6.0 DOCUMENTATION/ RECORDS

6.1 A written quality plan with procedure for qualification trials and for the actual work including test and inspection plan & procedure for approval before start of work.

6.2 Daily progress report with details of weather conditions, particular of applications, no of coats and type of materials applied, anomalies, progress of work versus program.

6.3 Results of measurement of temperatures relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.

6.4 Particulars of surface preparation and paint application during trials and during the work.

6.5 Details of non-compliance, rejects and repairs.

6.6 Type of testing equipments and calibration.

6.7 Code and batch numbers of paint materials used.

The coating applicator must maintain a job record consisting of all the information as per 6.2 - 6.7 above as well as the approved procedure of work (6.1 above). The job record consisting of information as required in accordance to 6.2 - 6.7 shall be entered on daily basis and should be daily signed by Engineer-in-charge.

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7.0 SURFACE PREPARATION STANDARDS

Sr. No.	Description	Various International Standards (Equivalent)			Remarks
		ISO 8501-1/ SIS-05 59 00	SSPC-SP, USA	NACE, USA	
1	Manual or hand tool cleaning Removal of loose rust, loose mill scale and loose paint, chipping, scrapping, standing and wire brushing. Surface should have a faint metallic sheen	St 2	SSPC-SP-2	-	This method is applied when the surface is exposed to normal atmospheric conditions when other methods cannot be adopted and also for spot cleaning during maintenance painting.
2	Mechanical or power tool cleaning Removal of loose rust loose mill scale and loose paint to degree specified by power tool chipping, de-scaling, sanding, wire brushing and grinding, after removal of dust, surface should have a pronounced metallic sheen.	St 3	SSPC-SP-3	-	
3	Dry abrasive blast cleaning There are four common grades of blast cleaning				
3.1	White metal Blast cleaning to white metal cleanliness. Removal of all visible rust. Mill scale, paint & foreign matter 100% cleanliness with desired surface profile.	Sa 3	SSPC-SP-5	NACE No. 1	Where extremely clean surface can be expected for prolong life of paint system.
3.2	Near white metal Blast cleaning to near white metal cleanliness, until at least 95% of each element of surface area is free of all visible residues with desired surface profile.	Sa 2½	SSPC-SP-10	NACE No. 2	The minimum requirement for chemically resistant paint systems such as epoxy, vinyl, polyurethane based and inorganic zinc silicate paints, also for conventional paint systems used under fairly corrosive conditions to obtain desired life of paint system.
3.3	Commercial Blast Blast cleaning until at least two-third of each element of surface area is free of all visible residues with desired surface profile.	Sa 2	SSPC-SP-6	NACE No. 3	For steel required to be painted with conventional paints for exposure to mildly corrosive atmosphere for longer life of the paint systems.

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Sr. No.	Description	Various International Standards (Equivalent)			Remarks
		ISO 8501-1/ SIS-05 59 00	SSPC-SP, USA	NACE, USA	
3.4	Brush-off Blast Blast cleaning to white metal cleanliness, removal of all visible rust, mill scale, paint & foreign matter. Surface profile is not so important	Sa 1	SSPC-SP-7	NACE No. 4	

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8.0 PAINT MATERIALS

Typical characteristics and codes of various paint materials used in this specification are as follows:

Table: Paint Materials Characteristics

Description	P-2	P-4	P-6	P-7
Technical name	Chlorinated rubber Zinc Phosphate primer.	Etch primer/wash primer	Epoxy zinc phosphate primer	Cold Galvanizing
Type and composition	Single pack, air drying chlorinated rubber based medium plasticized with unsaponifiable plasticizer, pigmented with zinc phosphate.	Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate.	Two component polyamine cured epoxy resin medium, pigmented with zinc phosphate.	One pack Synthetic Resin based zinc galvanizing containing min 92% of electrolytic zinc dust of 99.95% purity.
Volume Solids %, Minimum	37	9	49	37
DFT per coat, µ	40-45	8-10	40-50	40-50
Theoritical covering capacity in m^2/coat/ litre	8-10	8-10	8-10	4m^2/kg
Weight per litre in Kg/litre	1.3±0.05	1.2±0.05	1.4±0.05	2.67 kg at 15°C
Touch dry at 30°C (max.)	30 min.	2 hrs.	30 min.	10 min.
Hard dry at 30 °C (max.)	8 hrs.	24 hrs.	8 hrs.	24 hrs.
Over-coating interval	Min.: 8 hrs	Min: 4-6 hrs.	Min.:8hrs.	Min.:4 hrs
Pot life at 30 °C for two component paints	NA	NA	6 - 8 hrs.	NA
Adhesion (ASTM D4541)	NA	NA	>7 MPa	NA
Temperature Resistance (min.), °C (ASTM D 2485) *Note 8	60 (Method A)	NA	80 (Method A)	50 (Method A)

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Table: Paint Materials Characteristics (Contd.)

Description	F-2	F-3	F-6A/B	F-6C	F-7
Technical name	Acrylic Polyurethane finish paint	Chlorinated rubber based finish paint	Epoxy-High Build coating	Solvent less epoxy coating	High build coal tar epoxy coating.
Type and composition	Two-pack aliphatic isocynate cured acrylic finish paint.	Single pack plasticized chlorinated rubber based medium with chemical and weather resistant pigments.	F-6A Two-pack Aromatic amine cured epoxy resin medium suitably pigmented. F-6B: polyamide cured epoxy resin medium suitably pigmented	Two pack, cured with Amine Adduct; catalyzed epoxy resin suitably pigmented	Two pack polyamide cured epoxy resin blended with coaltar medium, suitably pigmented
Volume Solids %, (Min.)	40	36	57	98	62
DFT per coat, µ	30-4	30-40	100-125	250-500	100-125
Theoritical covering capacity in M^2/coat/litre	10-15	11-15	5-6	2-3	5.2-6.5
Weight per liter in kgs/litre	1.15±0.03	1.15±0.03	1.42±0.03	1.40±0.03	1.40±0.03
Touch dry at 30 °C, (Max.)	30 min.	30 min.	3 hrs.	3 hrs.	4 hrs.
Hard dry at 30 °C, (Max.)	8 hrs.	8 hrs.	16 hrs.	16 hrs.	48 hrs.
Full cure at 30 °C (for immersion/ high temperature service)	NA	NA	5 days	5 days	5 days
Over-coating interval	Min.12 hrs.	Min. Overnight	Min. Overnight, Max. 5 days	Min. 8 hrs., Max. 48 hrs.	Min. 24 hrs., Max. 5 days
Pot life (approx.) at 30 °C for two component paints	5-8 hrs.	NA	3-6 hrs.	30 min.	4-6 hrs.
Adhesion (ASTM D4541)	>5 MPa	>4 MPa	>7 MPa	>8 MPa	>5 MPa
Abrasion Resistance (ASTM D4060) For 1000 g load	<300 mg /1000 cycles/CS17 or <100 mg /1000 cycles/CS10	NA	NA	NA	NA
Temperature Resistance (min.), °C (ASTM D 2485) *Note 8	80 (Method A)	60 (Method A)	80 (Method A)	120 (Method A)	125 (Method A)

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Table: Paint Materials Characteristics (Contd.)

Description	F-8	F-9	F-11	F-12
Technical name	Self-priming type surface tolerant high build epoxy coating (complete rust control coating)	Inorganic zinc silicate coating	Heat resistant synthetic medium based two pack Aluminium paint suitable upto 250°C dry temp.	Heat resistant silicone Aluminium paint suitable upto 540°C dry temp.
Type & composition	Two pack epoxy resin based suitable pigmented and capable of adhering to manually prepared surface and old coating.	A two pack air drying self-curing solvent based inorganic zinc silicate coating with minimum 80% zinc content on dry film. The final cure of the dry film shall pass the MEK rub test ASTM D4752.	Heat resistant synthetic medium based two pack Aluminium paint suitable upto 250°C.	Single pack silicone resin based medium with Aluminium flakes.
Volume Solids %, Min.	75	57	35	18
DFT per coat, µ	100-125	65-75	15-20	15-20
Theoretical covering capacity in m^2/coat/litre	6.0-7.2	8-9	10-12	8-10
Weight per liter in kgs/litre	1.41±0.03	2.3±0.03	0.95±0.03	1.00±0.03
Touch dry at 30 °C (max.)	3 hrs.	30 min.	3 hrs.	30 min.
Hard dry at 30 °C (max.)	24 hrs.	12 hrs.	12 hrs.	24 hrs.
Full cure 30°C (for immersion /high temperature service)	5days	NA	NA	NA
Over-coating interval	Min. 10 hrs.	Min. 12 hrs. at 20 °C & 50% Relative Humidity	Min. 24 hrs.	Min. 24 hrs.
Pot life at 30 °C for two component paints	90 min.	4-6 hrs.	NA	NA
Adhesion (ASTM D4541)	>5 MPa	>5 MPa	NA	NA
Temperature Resistance (min.), °C (ASTM D 2485) *Note 8	80 (Method A)	400 (Method B)	250 (Method A)	540 (Method B)

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Table: Paint Materials Characteristics (Contd.)

Description	F-14	F-15	F-16	F-17	F-20
Technical name	Polyamine cured coal tar epoxy	Two-component Epoxy phenolic coating cured with Polyamine adduct hardener	Ambient temperature curing Poly Siloxane coating/ High build cold applied inorganic copolymer based aluminium coating suitable for under insulation of CS and SS	Novolac epoxy phenolic coating cured with Polyamine adduct hardener	Glass flake reinforced vinyl ester coating
Type & composition	Specially formulated polyamine cured coal tar epoxy suitable for application under insulation	Two pack ambient temperature curing epoxy phenolic coating system suitable for application under insulation	Suitable for high temperature service and under insulation coating for CS, alloy steel and SS	Novolac epoxy phenolic coating cured with Polyamine adduct hardener	Two component glass flake filled vinyl ester lining for under immersion services upto 90 °C.
Volume Solids %, Min.	67	67	58	98	98
DFT per coat, µ	100-125	75-100	75-100	300-450	500-600
Theoritical covering capacity in m^2/coat/ litre	5-8	4-5	7- 9	6.5- 8	1.6 minimum
Weight per liter in kgs/litre (mix paint)	1.45±0.03	1.65±0.03	1.3	1.7	>1.2
Touch dry at 30 °C (max.)	4 hrs.	3 hrs.	1 hr.	2 hrs.	2 hrs.
Hard dry at 30 °C (max.)	24 hrs	24 hrs	16 hrs	24 hrs	4 hrs.
Full cure 30 °C (for immersion /high temp. service)	7 days	7 days	NA	7 days	4 days
Over-coating interval	Min. 6 hrs., Max.5 days	Min. 36 hrs., Max. 21 days	Min.16 hrs., Max. NA	Min. 16 hrs., Max. 21 days	Min. 4 hrs., Max.3 days
Pot life at 30 °C (for two component paints)	4 hrs.	4-6 hrs.	1 hr.	1 hr.	50 min-1 hr.
Adhesion (ASTM D4541)	>6 MPa	>7 MPa	>8 MPa for Polysiloxane	>8 MPa	>7, Tensile strength >20N/mm2 (ASTM D 638)
Temperature Resistance (min.), °C (ASTM D 2485) *Note 8	125 (Method A)	150 (Method A)	550 (Method B)	150 (Method A)	90 (Method A)

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Notes:

1. Covering capacity and DFT achieved per coat depends on method of application. Covering capacity specified above is theoretical. For estimation of actual quantity of paints required, include the losses during application. Minimum specified DFT should be maintained in any case.
2. All primers and finish coats should be ambient temperature curing and air drying unless otherwise specified.
3. All paints shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured. Wherever a deviation is noticed from the specification in manufacturer data sheet, more stringent one between the data sheet and the specification shall prevail e.g. if this specification recommends Sa2½ and the manufacturer data sheet requires Sa3, the surface preparation shall be done as per Sa 3. However in another case if this specification requires the surface preparation of Sa 2½ and the manufacturer data sheet recommends only Sa 2 as minimum, the surface preparation shall be done as per Sa 2½.
4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.
5. Higher specific gravity of F-9 is also acceptable.
6. Internationally recognized & acceptable testing method shall be used for lab testing wherever testing standards are not mentioned.
7. Theoretical covering capacity, hard dry, pot life, full cure period, & over coating interval shall be as per manufacturer's data sheets and no testing is required. Slight variation in the values of these parameters along with *weight per liter* may be permissible with the discretion of engineer-in-charge only.
8. Temperature resistance tests (ASTM D2485) shall be carried out for minimum required temperature resistance indicated.
9. Wherever *ASTM D 2485 method B* is applicable, test results of the panels *subjected to salt spray (ASTM B 117) after muffle furnace exposure* shall be submitted for pre-qualification purpose.
10. F-6A shall be suitable for immersion services.
11. F-6C shall be suitable for immersion services of hydrocarbons and DM water.
12. F-7 shall be suitable for immersion service of hydrocarbons & underground service up to 80 °C minimum.
13. F-14 shall be suitable for under insulation service up to 125 deg C.
14. F-15 shall be suitable for high temperature immersion & under insulation services.
15. F-17 shall be suitable for high temperature immersion service and underground services

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9.0 COATING SYSTEMS

Corrosivity category C5-I (very high – industrial) in accordance with ISO 12944-2 and other International Standards/Practices are considered for selecting the Coating Systems for bare steel surfaces exposed to atmosphere. Atmospheric zone coating systems are designed for a high durability (approx. 15 years). For insulated surfaces, coating selection is based on NACE 0198 guidelines and other successful international practices.

9.1 Repair of pre-erection/pre-fabrication or shop primer after erection/welding for all un-insulated CS, LTCS & low alloy steel items

Sr. No.	Design Temp. in °C	Surface Preparation	Coating System	Total DFT in Microns (min.)	Remarks
1	-90 to 400	SSPC-SP-3	1 coat of F-9	65-75	See Note below and Clause 5.9.1
2	401 to 550	SSPC-SP-3	1 coat of F-12	20	

Note: The application and repair of pre-erection/pre-fabrication or Shop Primer given in above tables shall be done for all the items to be painted. In case the damages of primer are severe and spread over large area, entire primer shall be removed by blasting to achieve SSPC-SP-10 and surfaces to be primed again with F-9 or F-12 as applicable.

9.2 Coating system for Gratings (Note 5), Rolling & Stationery Ladders, Spiral Stairways, Hand Rails

Sr. No.	Design Temp., °C	Coating System	Total DFT in Microns (min.)
1	Up to 60	Hot Dip Galvanizing to 80-85 microns as per ISO 14713-2/ ISO 1461 + 1 coat of P-6 @ 40µ DFT/coat + 1 coat of F-2 @ 40 microns DFT/coat	80 microns of finish coat (excluding the thickness of galvanizing)

Notes:

1. No galvanized specimen shall have thickness less than 80 microns.

2. Repair of the damaged areas of galvanized coatings due to welding during erection shall be carried out as per recommended practice ASTM A 780, using cold galvanizing spray process. Organic paint systems are not acceptable for the repair.

3. After repair of damaged galvanized coating by cold galvanization (P-7), the repaired area shall be top coated with paint system as given in table above (i.e. 1 coat of P-6 @ 40µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat).

4. Suggested cold galvanizing manufacturers are ZINGA, LOCTITE, ZRC etc.

5. Galvanized gratings don't require painting in general except for safety reason such as escape routes, walkways. Hence. Galvanized gratings shall be painted for indication escape routes or walkways only as per table above (i.e. 1 coat of P-6 @ 40µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat).

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9.3 Coating System for uninsulated and above ground (atmospheric zone) CS, LTCS & low allow steel surfaces

(Structural steel, piping, vessels, columns, reactors, pumps, compressors, exchangers, valves & other equipment etc.)

Sr. No.	Design Temp., °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total DFT, µ (min.)	Remarks
			Primer	Finish Coat		
1	-90 to -15	SSPC-SP-10; 1 coat of F-9 @ 65-75µ DFT/Coat	None	None	65-75	**a)** No over-coating to be done on F-9 as it will lead to mud cracking. **b)** F-12 shall be ambient temperature curing type
2	(-)14 to 80	SSPC-SP-10; 1 coat of F-9 @ 65-75µ DFT/Coat	1 coat of P-6 @ 40 µ DFT/coat (Tie/ Mist Coat)	2 coats of F-6A @ 100 µ DFT/coat + 1 coat of F-2 @ 40µ DFT/Coat	345-355	
3	81 to 400	SSPC-SP-10; 1 coat of F-9 @ 65-75µ DFT/Coat	None	2 coats of F-12 @ 20µ DFT/Coat	105-115	
4	401 to 540	SSPC-SP-10; 1 coat of F-12 @ 20µ DFT/Coat	None	2 coats of F-12 @ 20µ DFT/Coat	60	

NOTES:

1. The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The Contractor is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated through his scope of work as per tender document.

2. If the Pre-erection/Pre-fabrication & Shop Primer has already been completed, the same shall not be repeated again in the field. In case the damages of primer are severe and spread over large areas, the engineer-in-charge may decide & advise re-blasting and priming again. Repair of pre-fabrication/pre-erection primer, if required, shall be done as per this specification.

3. Flare line within unit or offsite areas shall be coated as per Sr. No. 3 of above table

4. For external surface of MS chimney with or without refractory lining and for internal surface without refractory lining, paint system as per Sr. No. 3 of above table shall be followed.

5. For external surface of RCC Chimney, 2 coats of F-6B @ 100µ DFT/coat to obtain total DFT of 200 µ shall be applied after proper surface preparation as per clause no. 5.1.6.

6. In case of paint systems where finish (top) coat is F-12, the colour bands shall be applied over the Aluminum paint as per the Color coding requirement for specific service of piping.

7. For piping, equipment, vessels, columns & valves etc., scope of surface preparation, application of primers to finish coat including repair shall be as per applicable contractual documents like SOR, MR, and PR etc.

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9.4 Coating system for effluent treatment plant (ETP)

Sr. No.	Design Temp., °C	Surface Preparation	Coating System		Total DFT, µ (min.)	Remarks
			Primer	Finish Coat		
1	For External Surfaces of C.S./M.S. items: Screens, Walk way bridges, Baffles, Dual media filters, Vertical pumps, piping in treated effluent sump, bio sludge pump, Screw pump and pump house, CS tanks, sumps and vessels.					
	-14 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75µ DFT/coat	2 coats of F-6A @100µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat; (2x100+40= 240)	305-315	-
2	For Internal Surfaces of CS/MS Items: Bio-sludge sump, Filter feed sump, Process sump, Sanitary sump, Transfer sump, Sludge, Slop oil tank, scrapping mechanism in Clarifier					
	-14 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75µ DFT/coat.	3 coats of F-6A @100µ DFT/coat (3x100=300)	365-375	Note:1
3	All R.C.C./concrete surfaces exposed to effluent water / liquid such as tanks, structures, drains etc. in Process sump, TPI separator (Process and Oil), Aeration Tank and Transfer sump etc.					
	-14 to 80	Blast cleaning to SSPC-SP guide lines and Acid etching with 10-15% HCl acid followed by thorough water washing.	Epoxy Screed lining		3mm	Epoxy screed lining shall be applied as per specific manufacturer and Engineer-in-Charge instructions
4	C.S/M.S Dual media filters (Internal), Chemical dosing tanks (internal) such as Di-Ammonium Phosphate (DAP) and Urea					
	Up to 60	SSPC-SP-10	Natural Rubber Lining (As per IS 4682, Part 1)		4.5mm	Natural Rubber lining shall be applied as per specific manufacturer and Engineer-in-Charge instructions

Notes:

1. Coating manufacturers shall provide their Quality control test certificate of coating materials (F-6A) for immersion service of the exposed effluent.

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9.5 External coating systems for uninsulated carbon steel and low alloy steel Storage Tanks

Sr. No.	Design Temp., °C	Surface Preparation (Field)	Coating system		Total DFT, µ (min.)	Remarks
			Primer	Finish Coat		
a	All external surfaces of shell, wind girders, appurtenances, roof tops of all above ground tank including top side of external and internal floating roof and associated external structural works.					
1	-14 to 80	SSPC-SP-10	1coat of F-9 @ 65-75µ DFT/coat + 1coat of P-6 @ 40µ DFT/ coat ;	2 coats of F-6A @ 100µ DFT /coat + 1 coat of F-2 @ 40µ DFT/ coat;	345-355	F-6 should be suitable for occasional water immersion
2	81 to 150	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat + 1 coat of F-15 intermediate coat @ 80µ DFT/coat ;	1 coat of F-15 finish coat @80µ DFT/ coat + 1 coat of F-2 @ 40µ DFT/ coat;	280	-
3	151 to 400	SSPC-SP-10	1coat of F-9 @ 65-75µ DFT/coat	2 coats of F-12 @20 µ DFT/ coat Or 1 coat of F-16 @ 125 µ DFT / coat	105-115 Or 190-200	For higher design temperatures, system as per Sr. No. c (1) of this table is applicable
b	External surfaces of bottom plate (soil side) for all storage tanks					
1	-14 to 80	SSPC-SP-10	1 coat of F-7 @ 125µ DFT/ coat	2 coats of F-7@ 125µ DFT/coat	375	F-7 should be suitable for immersion service of the products given
2	81 to 150	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat + 1 coat of F-15 intermediate coat @ 80µ DFT/coat	1 coat of F-15 finish coat @ 80µ DFT/ coat	240	-

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3	151 to 550	SSPC-SP-10	1 coat of F-16 @ 125 µ DFT /coat	1 coat of F-16 @ 125 µ DFT /coat	250	-
c	For underside of the bottom plate (in case tank is not lifted during PWHT) (see Note 2c)					
1	-180 to 650	For CS, SSPC SP 10	1 coat of inert polymeric matrix coating @ 125 µ	1 coats of inert polymeric matrix coating @ 125 µ	250	.
		For SS SSPC-SP-7 (15-25µ surface profile)				

Notes

1. All paint coating application including primer for tankage shall be carried out at field after erection and completion of all welding.

2. For underside of bottom plate :

   a) Painting shall be carried out before laying of bottom plate for tanks with Non-Post Weld Heat Treatment (PWHT).

   b) For tanks with PWHT, painting shall be carried out after PWHT.

   c) In case tank is not lifted during PWHT then painting shall be applied before laying of bottom plate, clause no. 12.3.1 shall be followed.

Caution: PWHT temperature shall not exceed 650 °C.

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9.6 Internal coating systems for carbon steel and low alloy Storage Tanks

Sr. No.	Design Temp., °C	Surface Preparation	Coating system		Total DFT, µ (min.)	Remarks
			Primer	Finish Coat		
a	**Crude Oil, ATF, Turpentine Oil, Lubricating Oil & Vegetable Oil** Underside of floating roof, internal surface of cone roof, inside of bottom plate, Internal surfaces of Shell - including wetted and free board height, oil side surfaces of deck plates, oil side surfaces of pontoons, roof structures, structural steel, ladders and other CS internals					
1	-14 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat;	240	-
b	**Petroleum Products & Intermediates like LDO, HSD , Gas Oil, Feeds of FCC-PC, FCC-LCO, VGO-HDT, ISOM, DHDT, Reformate, DCU, NHT & Gasoline, Naphtha, Isomerate & Kerosene** Underside of Floating roofs, internal surface of cone roof, inside of bottom plate, internal surfaces of Bare shell for full height, underside of floating roof, oil side surfaces of deck plates, oil side surfaces of pontoons, support structures and ladders etc.					
1	-14 to 45	SSPC-SP-10	1 coat of F-9 @ 75 µ DFT/coat	-	65-75	
2	46 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat;	240	-
c	**Potable, Raw & Fire Water** All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
1	-14 to 60	SSPC-SP-10	1 Coats of F-6A @ 100 µ DFT/coat;	2 Coats of F-6A @ 100µ DFT/ Coat	300	Note-1
d	**De-Mineralized (DM) Water** All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
1	-14 to 60	SSPC-SP-10	1 Coats of F-6A @ 100µ DFT/coat;	2 coats of F-6C @ 200µ DFT/ coat;	500	-
2	61 to150	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat; (80+80=160)	240	-

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e	**Hydrochloric Acid (HCl) 10 %** All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
1	-14 to 60	SSPC-SP-10	1 Coat of clear two component solvent free vinyl ester primer @ 100µ DFT/ Coat	2 Coats of F-20 @ 500µ DFT/ Coat	1100	-
f	**Aggressive Solvents like Hexane, Hexene, Benzene, Xylene & Toluene** All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
1	-14 to 65	SSPC-SP-10	1 coat of F-9 @ 65-75µ DFT/ coat	---	65-75	-
g	**Ethylene Glycol (EG) Tanks** Internal shell-full height, bottom plate, underside of roof and all accessories					
1	All	SSPC-SP-10	None	3 coats of vinyl chloride co-polymer @ 75µ /Coat; (3x75=225)	225	-
h	**Inside Pontoon and Inside of Double Deck of all Floating Roofs**					
1	-14 to 80	SSPC-SP-3	1 coat of F-8 @ 100µ DFT/coat	1 coat of F-8 @ 100µ DFT/coat	200	-
i	**Wet Slops, Amine Solutions, Sour Water , Water Draw Off** All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
1	-14 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat;	240	-
j	**Vacuum Residue, Fuel Oil , Dry Slop, Bitumen & Other High Temperature Hydrocarbon Liquids** Underside of floating roof, internal surface of cone roof, bottom plate, inside of bare shell – including wetted and non-wetted surfaces, oil side surfaces of deck plates, oil side surfaces of pontoons, roof structures, structural steel and ladders					
1	Up to 150°C	SSPC-SP-10	-	1 coat of F-17 @ 375µ DFT/ coat;	375-475	-
k	**Alkalis upto 50 % Concentration** All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
1	Up to 60°C	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	2 Coats of F-6 A @ 100µ DFT/coat;	280-100	-

Notes

1. F-6 A shall be suitable for drinking water service and should have competent authority certification.

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9.7 Coating systems for external side of underground carbon steel plant piping and underground Vessels

Sr. No.	Design Temp., °C	Surface Preparation & Shop Primer	Coating system		Total Final DFT, µ (min.)	Remarks
			Surface Preparation & Primer	Finish Coat		
a	**Underground carbon steel plant piping**					
1	25 to 65		SSPC-SP-10; 1 coat of synthetic fast drying primer 25 @µ DFT/ coat	1 layer of coal tar tape coating @ 2mm +1 coat of synthetic fast drying primer 25 @µ DFT/ coat + 1 layer of coal tar tape coating @ 2mm /layer as per ANNEXURE-II (EIL Std. Spec. 6-79-0011)	-	-
2	65 to 150	---	SSPC-SP-10; 1 coat of F-17 primer @ 400µ DFT/ coat	1 coat of F-17 intermediate coat @ 400µ DFT/coat	800	-
3	151 to 450	---	SSPC-SP-10; 1 coat of F-16 primer @ 125µ DFT/ coat	1 coat of F-16 finish coat @125µ DFT/ coat	250	This system is suitable up to 550 °C
b	**External side of uninsulated underground storage vessels**					
1	-40 to 80	SSPC-SP-10; 1 coat of F-7 @ 125µ DFT/ coat	---	2 coats of F-7 @ 125µ DFT/coat	375	-
2	81 to 150	SSPC-SP-10; 1 coat of F-17 primer @ 400µ DFT/ coat	---	1 coat of F-17 @ 400µ DFT/coat	800	-
3	151 to 400	SSPC-SP-10; 1 coat of F-16 primer @ 125µ DFT/ coat	---	1 coat of F-16 finish coat @125µ DFT/ coat	250	This system is suitable up to 550 °C

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9.8 Coating System for Insulated CS, LTCS, Low Alloy Steel & Stainless Steels Surfaces

(Insulated Piping, Equipments, Storage vessels, tanks, Columns etc.)

Sr. No.	Design Temp., °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total Final DFT, µ (min.)	Remarks
			Primer/ Intermediate	Finish Coat		
a	**Carbon steel, LTCS and Low Alloy Steel Piping, Storage tanks, Vessels, Equipments etc.**					
1	-45 to 125	SSPC-SP-10; 1coat of F-15 @ 75µ DFT/coat	-	2 coats of F-15 @ 75µ DFT/coat;	225	-
2	126 to 540	SSPC-SP-10; 1coat of F-12 @ 20µ DFT/coat	-	2coat of F-12 @ 20µ DFT/coat;	60	Note-3
b	**Stainless Steel, Alloy-20 Piping, Vessels & Equipments (Note:2)**					
1	-45 to 125	SSPC-SP-7 (15-25µ surface profile); 1 coat of F-15@ 75 µ DFT/coat	-	2 coat of F-15 @ 75 µ DFT/coat;	225	
2	126 to 550	SSPC-SP-7 (15-25µ surface profile); 1 coat of F-16 @ 125 µ DFT/coat	-	1 coat of F-16 @ 125 µ DFT/coat	250	
c	**Cyclic Service of Carbon Steel, LTCS, Alloy Steels & Stainless Steel**					
1	- 45 to 150	SSPC-SP-10 For CS, LTCS & Low Alloy Steel, SSPC-SP-7 for SS (15-25µ surface profile); 1 coat of F-15 @ 75 µ DFT/coat	-	2 coat of F-15 @ 75 µ DFT/coat;	225	Note-4

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2	-180 to -45 and 150 to 650	SSPC-SP-10 For CS, LTCS & low Alloy Steel; SSPC-SP-7 for SS (15-25µ surface profile) ; 1 coats of inert polymeric matrix coating @ 125 µ	-	1 coats of inert polymeric matrix coating @ 125 µ	250	

Notes

1. "Cyclic Service" is characterized by rapid temperature fluctuation.
2. The blast cleaning abrasives for SS and Alloy steel surfaces shall be Aluminium oxide grits/shots or garnet.
3. Alternatively, for Tanks, Vessels & Equipments, thermally sprayed aluminium coating (TSAC) @ 300µ as per ANNEXURE-I is also acceptable.
4. Alternatively, for this temperature range, 1 coat of F-17 @ 300 µ is also acceptable.
5. For insulated vessels & equipment scope of surface preparation, application of primers to finish coat including repair shall be as per applicable contractual documents like SOR, MR, PR etc.

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9.9 Internal Coating System for carbon steel components of coolers/ condensers for fresh water service

(Water boxes, channels, partition plates, end covers and tube sheets etc.)

Sr. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total Final DFT, µ (min.)	Remarks
			Primer	Finish paint		
1	Up to 80 °C	SSPC-SP-10	1 coat of F-15 @ 80 microns	2 coats of F-15 @ 80µ DFT/coat;	240	-
2	80 to 140	SSPC-SP-10	---	1 coat of Glass Fibre Reinforced Novolac Epoxy	1500	-

Note: Above table is applicable in line with the data sheets of the respective exchangers.

9.10 Internal Coating System for galvanized or non-ferrous or stainless steel/ duplex stainless steel components of coolers/ condensers for fresh water service

Sl. No.	Design Temp., °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total DFT (min.), µ	Remarks
			Primer	Finish paint		
1	Up to 80	Sweep Blasting	1 coat of F-15 @ 80µ DFT/coat;	1 coat of F-15 @ 80µ DFT/coat;	160	-
2	80 to 140	Sweep Blasting	-	1 coat of Glass Fibre Reinforced Novolac Epoxy	1500	-

Note: Above table is applicable in line with the data sheets of the respective exchangers.

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10.0 STORAGE

All paints and painting materials shall be stored only in rooms to be arranged by contractor and approved by Engineer-in-charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the word "PAINT STORAGE – NO NAKED LIGHT – HIGHLY INFLAMABLE" shall be clearly displayed outside. Manufacturer's recommendation shall be followed for storage of paint materials.

11.0 COLOUR CODE

The colour coding of OWNER is applicable. It is in the applicators/contractors scope to obtain confirmation for applicable colour coding from the OWNER/ EIL.

Alternatively, contractor shall prepare color code scheme of structures, equipment, pipings etc. in line with international practices and get the same approved from the Owner.

Note for color coding

- All LPG service PSVs shall be painted in Deep Blue.
- All drains & Vents shall be painted in Main line colour.
- The colour code scheme is for identification of piping service group. It consists of a ground colour and 1 or more colour bands.

11.1 Identification

The system of colour coding consists of a ground colour and secondary colour bands superimposed over the ground colour. The ground colour identifies the basic nature of the service and secondary colour band over the ground colour distinguishes the particular service. The ground colour shall be applied over the entire length of the un-insulated pipes. For insulated lines ground colour shall be provided as per specified length and interval to identify the basic nature of service and secondary colour bands to be painted on these specified length to identify the particular service. Above colour code is applicable for both unit and offsite pipelines.

11.2 Ground Colour

On uninsulated pipes, the entire pipe has to be painted in ground colour., and on metal cladded insulated lines, minimum 2M long portion should be painted.

11.3 Colour Bands

Location of colour bands:

- At Battery Limits
- Intersection points & change of direction points in piping
- Midway of piping section, near valves, across culverts
- At 50 M interval on long stretch pipes
- At starting and termination points.

Minimum width:

NB	Width
3" and below	75 mm
Above 3" to 6"	NB X 25 MM
Above 6" to 12"	NB X 18 MM
Above 12"	NB X 15 MM

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For insulated pipes, NB indicates OD of the insulation.

Sequence:

Colour bands shall be arranged in sequence showing Table above and the sequence follows the direction of flow. The width of the 1st Band to 2nd band is 4:1,

Wherever deemed required by Process Department or Safety, pipes handling hazardous substances will be given hazard marking of 30 mm wide diagonal stripes of Black and Golden Yellow as per IS : 2379.

11.4 Special Camouflage Painting for Uninsulated Crude and Product Storage Tanks.

Coating System shall be as per this specification.

Camouflage painting scheme for Defense requirement in irregular patches will be applied with 3-colours:

Dark Green	:	Light green	:	Medium Brown
5	:	3	:	2

- The patches shall be irregular and asymmetrical and inclined at 30 to 60 Degrees.
- Patches should be continuous at surface meeting lines / points.
- Slits / holes shall be painted in dark green shade.
- Width of patches shall be 1 to 2 meters.

11.5 Identification Markings on Equipment / Piping

Equipment tag Numbers shall be Stenciled / neatly painted using normal 'Arial' Lettering Style on all equipment and piping (Both insulated & uninsulated) after completion of all paint works. Lettering colour shall be either BLACK or WHITE, depending upon the background, so as to obtain good contrast.

Operations Group shall specify location.

Sizes shall be:

Columns, Vessels, Heaters:	150 mm
Pumps and other M/c	50 mm
Piping	OD/2 with Maximum 100 mm
Storage Tanks	(As per Drawings)

11.6 Colour Coding for Control Valve

a) Carbon steel body - Light grey

Alloy steel body - Canary yellow

Stainless steel body - Natural

b) The actuator of the Control valve shall be painted as:

Direct action (open on air failure) valves - Green

Reverse acting (close on air failure) valves - Red

The painting Status shall be comprehensively updated every 6 months for compliance

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12.0 IDENTIFICATION OF VESSELS, PIPINGS etc.

12.1 Equipment number shall be stencilled in black or white on each vessel, column, equipment & machinery (insulated or uninsulated) after painting. Line number in black or white shall be stencilled on all the pipe lines of more than one location as directed by Engineer-In-Charge; Size of letter printed shall be as below:

Column & Vessels	-	150mm (high)
Pump, compressor & other machinery	-	50mm (high)
Piping	-	40-150 mm

12.2 Identification of Storage Tanks

The storage tanks shall be marked as detailed in the drawing.

13.0 PAINTING FOR CIVIL DEFENCE REQUIREMENTS

13.1 Following items shall be painted for camouflaging if required by the client.

a. All Columns
b. All tanks in Offsites
c. Large Vessels
d. Spheres

13.2 Two coats of selected finishing paint as per defense requirement shall be applied in a particular pattern as per 13.3 and as per the instructions of Engineer-In-Charge.

13.3 Method of Camouflaging

13.3.1 Disruptive painting for camouflaging shall be done in three colours in the ratio of 5:3:2 (all matte finish).

Dark Green		Light Green		Dark Medium Brown
5	:	3	:	2

13.3.2 The patches should be asymmetrical and irregular.

13.3.3 The patches should be inclined at 30º to 60º to the horizontal.

13.3.4 The patches should be continuous where two surfaces meet at an angle.

13.3.5 The patches should not coincide with corners.

13.3.6 Slits and holes shall be painted in dark shades.

13.3.7 Width of patches should be 1 to 2 meters.

14.0 QUALITY CONTROL, INSPECTION AND TESTING

14.1 All painting materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable (see section 24.0).

14.2 The contractor must produce Test Certificate from Pre-Qualified Paint Manufacturer for various tests as detailed out in section 25.1 of this document. The Engineer-in-Charge shall have the right to test wet samples of paint from each batch at random for verifying quality of paint supplied. Contractor shall arrange to have such tests,

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when called for by Engineer-in-Charge, performed at his cost at any one of the NABL accredited laboratories under witness of NACE CIP Level-2 (min.) / Qwner/ Owner's representative.

Samples for the test will be drawn at random in presence Engineer-in-Charge or his representations. Following tests to be carried out if called for by Engineer-in-Charge:

- Specific Gravity
- % solids by weight (% zinc content in case of inorganic or organic zinc primer)
- Drying time (touch dry & full curing)
- Adhesion
- Flexibility
- Hardness
- Storage stability (pot life)

Test methods for above tests shall be as per relevant ASTM or ISO Standard.

14.3 The painting work shall be subject to inspection by Engineer-In-Charge at all times. In particular, following stage-wise inspection will be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

(a) Surface preparation
(b) Primer application
(c) Each coat of paint

14.4 **Surface preparation:** Following tests are to be carried out during surface preparation**.**

i) Test for presence of oil/ grease and contamination

The steel substrate after degreasing as per SSPC-SP 1 shall be tested as per following procedure to validate absence of oil and grease contamination:

- Visual inspection: Continue degreasing until all visible signs of contamination are removed.
- Conduct a solvent evaporation test by applying several drops or a small splash of residue-free tri-chloromethane on the suspect area especially pitting, crevice corrosion areas or depressed areas. An evaporation ring formation is indicative of oil and grease contamination.
- Continue degreasing and inspection till test is passed.

ii) Tests for surface finish of blasted surface shall be done by visual inspection using SSPC-VIS1. Clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on blasted surface. Checks shall be done on each component atleast once per 200 m^2 of blasted surface and minimum of 3 checks per shift.

iii) Test for presence of soluble salt as per method ISO 8502-9. Maximum allowable salt content shall be considered 20 mg/m^2. Checks shall be done on each component atleast once per 200 m^2 of blasted surface and minimum of 3 checks per shift. In case salt exceeds specified limit, the contaminated surface shall be cleaned by method as per Annexure-C of IS 12944-4 (water cleaning). After cleaning surface shall be retested for salt after drying.

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iv) Blast Profile Measurement

The angular profile depth measurement shall be done by profile tape as per method NACE Standard RP 0287 or ASTM D 4417 method B (Profile depth gauge micrometer). Spot measurement shall be carried out every 15m^2 of blasted surface. At each spot three measurements shall be taken over an area of 10 cm^2 and average of measurements to be recorded and reported. If desired profile (35-50 µ or as recommended by paint manufacturer) is not achieved, blasting shall continue to get the required profile.

v) Test for Blasting Media (for every fresh batch of media and one random test during blasting):

- Blasting Media shall be visually inspected for absence of contamination and debris using 10X magnification.
- Inspection for the absence of oil contamination shall be conducted using following procedure:
  - Fill a small clean 200 ml bottle half full of abrasive.
  - Fill the bottle with potable water, cap and shake the bottle.
  - Inspect water for oil film/slick. If present, the blasting media is not to be used.
- Soluble salt contamination if suspected shall be verified by method ASTM D 4940. If present, media to be replaced.
- Clean blasting equipment, especially pot and hoses, and then replace blasting media and retest.

vi) Test for Blasting Air (once daily before start of blasting and once at random during blasting):

The air for blasting shall be free from moisture and oil. The compressor air shall be checked for oil and water contamination per ASTM D 4285.

In addition to above, record should include type of shop primer already applied on equipment e.g. zinc silicate, zinc rich epoxy or zinc phosphate etc. Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer-In-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good any defects found during final inspection/guarantee period/ defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra cost to owner, the extra coat should have prior approval of Engineer-in-charge.

14.5 Primer Application

After surface preparation, the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-In-Charge. The shades of successive coats should be slightly different in colour in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer-In-Charge before application of successive coats.

The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring dry film thickness of each coat, surface profile

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gauge for checking of surface profile, holiday detectors and pinhole detector and protector whenever required for checking in case of immersion conditions.

Prior to application of paints on surfaces of chimneys, the thickness of the individual coat shall be checked by application of each coat of same paint on MS test panel. The thickness of paint on test panels shall be determined by using gauge such as 'Elkometer'. The thickness of each coat shall be checked as per provision of this specification. This shall be approved by Engineer-In-Charge before application of paints on surface of chimney.

At the discretion of Engineer-In-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations. The contractor is responsible to arrange the same.

14.6 **Inspection of finished coating:** Inspection of applied coatings shall consist of measurement of the following:

i) Coating Dry Film Thickness Check: DFT measurement shall be as per ISO 2808. Type II electromagnetic gauges should be used for ferrous substrates. DFT gauge calibration, number of measurement shall be as per SSPC-DA 2. Measured DFT shall be within + 10% of the dry film thickness, specified in the specifications.

ii) Adhesion Testing: Adhesion of the primer to the steel substrate and inter-coat adhesion of the subsequent coat(s) after curing for at least a week after application of the topcoat shall be examined by a knife test in accordance with ASTM D 6677. For the knife test, if the rating is better than 8, the adhesion is considered acceptable. The adhesion is destructive and tested areas shall be repaired afterward using the spot repair procedure. Alternatively, the applicator may perform the adhesion test on a steel coupon coated using the same surface preparation and coating application procedure as the work piece. Adhesion testing shall be carried out for each component at least once per 200 m^2 of coated surface.

iii) Holiday Testing: Holiday testing shall be conducted in accordance with NACE SP 0188. For immersion services, 100% of coated area shall be inspected for holidays. For atmospheric exposure, 10% of coated area which must include weld seams, corners and edges to be holiday tested. Voltage at which test is to be carried out will depend upon DFT of coating being tested and shall be as per NACE SP 0188. Any holiday is unacceptable and should be marked and repaired immediately.

14.7 The contractor shall arrange for spot checking of paint materials for Specific gravity, glow time (ford cup) and spreading rate.

14.8 **Final Inspection of coating system**

A final inspection shall be conducted prior to the acceptance of the work. The coating contractor and the facility owner shall both be present and they shall sign an agreed inspection report. Such reports shall include:

General
- Names of the coating contractor and the responsible personnel
- Dates when work was performed

Coating Materials
- Information on coating materials being applied

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- Condition of coating materials received

Environmental Conditions
- Weather and ambient conditions
- Coating periods

Surface Preparation
- Condition of surface before preparation
- Tools and methods used to prepare surface
- Condition of surface after preparation

Coating Application
- Equipment used
- Mixing procedure prior to application
- Coating application techniques used

Testing
- Type and calibration of inspection instruments used
- Type of quality control tests performed, and results

15.0 GUARANTEE

The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work.

16.0 QUALIFICATION CRITERIA OF PAINTING CONTRACTOR/ SUB-CONTRACTOR

Painting contractor who is awarded any job for EIL, Projects under this standard must have necessary equipments, machinery, tools and tackles for surface preparation, paint application and inspection. The contractor mush have qualified, trained and experienced surface preparator, paint applicator, inspector and supervisors. The contractor supervisor, inspector, surface preparator and paint applicator must be conversant with the standards referred in this specification.

17.0 QUALIFICATION/ ACCEPTANCE CRITERIA FOR COATING SYSTEM

17.1 Pre-Qualification of Paint Coating Manufacturer and his Products

Paint Coating manufacture meeting the following requirements shall be considered for supply of their products:

- Manufacturer should have been in continuous business of paint coating formulation and manufacturer for at least past 5 years.
- Manufacturer should posses past experience of supplying his products to hydrocarbon, petrochemical, fertilizer. Chemical processing industry or offshore platforms in the past 5 years.
- Coating manufacturer should have supplied at least 10000 litre of an individual product to hydrocarbon, petrochemical, fertilizer, chemical processing industry or offshore platforms.

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- The manufacturer's manufacturing procedure & QA/QC system shall meet ISO 9001 requirements and preferably should posses ISO 14000 certificate.
- The Quality control set up should be manned by qualified paint technologists whose bio data should be sent along with quality control organization chart.

CONTRACTOR shall procure the paint materials from the qualified manufacturer meeting above requirements and after obtaining prequalification testing approval as per requirements mentioned in clause 17.2 below.

17.2 Pre-Qualification Testing Procedure:

The paint manufacturer engaged by the mechanical contractor shall carry out the tests in reputed Government Laboratories (like National Test House Mumbai, National Test House Kolkata, Institute of Chemical Technology Mumbai, HBTI Kanpur, IICT Hyderabad) as a part of qualification. Paint manufacturer shall provide the paint samples to laboratory for testing of the parameters for each category of paint as mentioned in Clause 8.0 (Paint Materials Characteristics) and testing of Coating System properties as per Table given below. The testing laboratory will confirm the compliance of the paint material with respect to the acceptance criteria mentioned in this specification. Contractor shall furnish these test certificates along with all necessary supporting documents/information to EIL site for approval/ acceptance. The paint manufacturer will be qualified and approved by EIL site for supply of paints after review/assessment of the submissions made by the contractor. Test certificates which are more than 3 years old will not be considered. Paint manufacturers are advised to carryout pre-qualification testing accordingly for paints supply to EIL projects.

TABLE: PRE-QUALIFICATION TESTING

System No.	Coating System	Reference Clause	Total DFT, µ (Min.)
1.	F-9+P6+F6B+F2	Clause 9.3, Sr. No. 2 of table	345
2.	F12+F12+F12	Clause 9.3, Sr. No. 3 of table	60
3.	F15+F15+F15	Clause 9.5, Sr. No. b (2) of table	240
4.	F16+F16	Clause 9.5, Sr. No. b (3) of table	250
5.	F17	Clause 9.6, Sr. No. j (1) of table	375
6.	F8+F8	Clause 9.6, Sr. No. h (1) of table	200
7.	F7+F7+F7	Clause 9.5, Sr. No. b (1) of table	375
8.	F-20	Clause 9.6, Sr. No. e (1) of table	1100
9.	F6A+F6C+F6C	Clause 9.6, Sr. No. d (1) of table	500
10.	Inert Polymeric Matrix	Clause 9.5,	250

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		Sr. No. c (1) of table	
11.	F6A+F6A+F6A	Clause 9.6, Sr. No. c (1) of table	300

Sr. No.	Test	For System Number	Duration	Acceptance Criteria
1.	Cyclic Test Salt Spray: 72 hrs. Drying in air: 16 hrs. UV-A340 nm weather meter: 80 hrs. One cycle: 168 hrs. (25 cycles at 168 hrs. each cycle) (ASTM D5894)	1	4200 hrs.	Shall pass. No chalking, cracking, flaking, blistering or peeling shall be observed.
2.	Chemical Resistance Test **(**ASTM D543)			
2a.	10% & 40% NaOH	3,5,8 & 11* *H_2SO_4 solution pH = 5.0 to 5.5 for system 11	1000 hrs.	Shall pass.
2b.	5% H_2SO_4		168 hrs.	No cracking, discoloration, blistering, peeling or softening of film shall be observed.
2c.	Xylene		4 weeks	
2d.	Acetone		4 weeks	
2e.	Ethanol		4 weeks	
2f.	Kerosene		4 weeks	
2g.	Sea water		2000 hrs.	
3.	Immersion in DM/DI water @ 90° (ASTM C868)	3,5 & 8	30 days	No softening, blistering or film damage.
4.	Resistance to DM water using water immersion. (ASTM D870)	9	2000 hrs.	Shall pass. No chalking, cracking, flaking, blistering or peeling.
5.	100% Humidity Test (ASTM D2247)	1 to 11 (except system-2)	1440 hrs.	Shall pass

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6.	Dry Heat Resistance Test (ASTM D2485 method B at 540^0 C for system 2 and 550^0 C for system 4)	2 & 4	-	Shall pass the test. No peeling, cracking, blistering, abnormal discoloration or loss of adhesion.
7.	Thermal Shock Resistance Test; 5 cycles @ 30 minutes in furnace at 120 ^{0} C and 15 minutes in water after quenching in water for each cycle. (ASTM D2485 method A)	2,3,4 & 10 (For system-2, testing to be done after heating the panels at 175°C for 2 hrs.)	-	Shall pass
8.	Cathodic Disbondment Test (ASTM G8 @ 60°C)	3 & 5	-	Shall pass

Each coating product to be qualified shall be identified by the following:

1) Specific gravity of Base and curing agent (Ref. ISO 2811)
2) Ash content (ASTM D1650), volatile and non-volatile matters (ISO 3251) of each component

These identification tests of coating materials shall be carried out on the batch, which is used for the Pre-qualification testing and in the same reputed government laboratory.

17.3 Information to be furnished during delivery of paint materials:

CONTRACTOR along with delivery of paint material has to furnish following information from paint manufacturer to EIL for acceptance/approval of products:

a) Batch test certificates

Along with paint products delivery to site from the pre-qualified coating manufacturer, CONTRACTOR has to produce test certificate (from paint manufacturer) for each category of product for the following test items. All test results must mention clearly the batch no. and category of product tested. Tests shall be witnessed by NACE CIP Leve-2 (minimum) inspector. Tests to be conducted for following properties:

- Specific Gravity
- % solids by weight (% zinc content in case of inorganic or organic zinc primer)

b) Product information sheet/ technical data sheet for each category of product

The contractor shall be fully responsible for the quality of the paints products as per prequalification testing. After the paint materials are supplied to site, the supplier shall

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organize random sampling and testing in a NABL accredited laboratory as per discretion of the Engineer-in-charge (refer clause 14.2). Failing to meet the specified quality requirements may cause rejection of the paint products.

18.0 METHOD OF SAMPLING & DISPATCH FOR LABORATORY TESTING

(Pre-Qualification tests (sec. 17.2), Batch testing (sec. 17.3) and Inspection testing (sec. 14.0))

18.1 Samples of coating materials should be submitted to the laboratory in sealed containers with batch no. and test certificate on regular format of manufacturer's testing laboratory.

18.2 All test panels should be prepared by testing laboratory. Surface preparation for a system shall be done in accordance with this specification. For individual products testing, minimum surface preparation shall be Sa 2.5. Colour photographs of test panels should be taken before and after the test and should be enclosed along with test report.

Sample batch no. and manufacturer's test certificate should be enclosed along with the report. Test report must contain details of observation and rusting if any, as per the testing code.

18.3 Manufacturers should intimate EIL, details of sample submitted for testing, name of testing agency, date, and contact personnel of the testing agency.

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ANNEXURE-I

SPECIFICATION FOR THERMALLY SPRAYED ALUMINIUM COATING (TSAC)

1.0 SCOPE

The following sections outlines the requirement of supply, application and testing of thermally sprayed aluminum coatings (TSAC) for corrosion protection of carbon steel piping and equipments with design temperature not exceeding 540 ^{0} C.

2.0 ITEMS TO BE THERMALLY SPRAYED

Steel Structures/equipments to be protected by TSAC shall be as specified in this specification. Structures, components thermally sprayed shall not have any uncoated area or shall not be in mechanically connected by flanges etc to any uncoated bare steel work. Such adjacent areas to TSA coated areas, if not coated by TSA shall have suitable paint coating system as per the standard specification.

3.0 TSAC REQUIREMENTS

3.1 Surface Preparation

All the parts to be sprayed shall be degreased according to SSPC-SP-1. The absence of oil and grease after degreasing shall be tested by method given elsewhere in the specification (Refer Sec. 6.7). Thereafter the surface to be abrasive blasted to white metal finish as per NACE 1/SSPC-SP-5 for marine and immersion service. Using SSPC VIS 1, it is to be visually assessed that the blast cleaned surface meets requirement of SSPC-SP-5. Thereafter clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on the blasted surface. Finally blasted surface shall be tested for presence of soluble salts as per method ISO 8502-9. Maximum allowable salt content shall be considered 50mg/m^2. (5 micrograms/cm^2) .In case salt content exceeds specified limit. The contaminated surface shall be cleaned by method as per Annex C of IS 12944-4 (Water Cleaning). After cleaning the surface shall be retested for salt content after drying. Testing shall be carried out at least on each component, once per 200 m^2 and a min of 3 times per shift during progress of work.

The blasting media shall be either chilled iron or angular steel grit as per SSPC-AB-3 of mesh size G-16 to G-40. Copper, Nickel slag, Garnet or Aluminum Oxide as abrasives will also be suitable having mesh size in the range of G16 to G24 (10-30 mesh), conforming to SSPC-AB-1. Mesh size shall be required as appropriate to the anchor tooth depth profile requirement and blasting equipment used. The blasted surface should be having angular profile depth not less than 65 microns with sharp angular shape but shall not exceed 85 microns. The profile depth shall be measured according to NACE standard RP 0287 (Replica Tape) or ASTM D 4417 method B (Profile depth gauge).

For manual blasting one profile depth measurement shall be taken every 10-20 m^2 of blasted surface. Surface preparation shall be completed in one abrasive blast cleaning operation wherever possible. If rust bloom (visual appearance of rust) appears on the blast cleaned surface before thermal spraying, the affected area shall be re-blasted to achieve specified degree of cleanliness after which only thermal spraying shall commence.

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Air blasting pressure at nozzle shall be normally maintained at 100 psi. Air pressure and media size should be reduced and adjusted to preclude damage/distortion to thin gauge materials. Blasting time on work piece should be adjusted to only clean the surface and cut required anchor tooth with minimum loss of metal. Blast angle should be as close to perpendicular as possible but in no case greater than $\pm 30^{0}$ from perpendicular to work surface. Blasting media must be free of debris, excessive fines, and contaminants such as NaCl and sulfur salts (Ref. SEC 6.0 of this Spec). Blast cleaning shall not be performed when the surfaces to be blasted are wet or less than 5°C above dew point temperature or when the relative humidity in the vicinity of the work is greater than 90%.

3.1.1 Blasting Equipment

The TSAC applicator shall use mechanical (centrifugal wheel) or pressure pot blast cleaning equipment and procedures. Suction blasting equipment shall not be used. Sec 6.6.2 shall be used to validate clean and dry air.

3.1.2 Feed Stock

The feed stock shall be in the form of wire. The feed stock shall be 99.5% aluminum of commercial purity grade, its composition shall be in accordance with requirement of BS 1475 or ASTM B833 or ISO 209-1 type A1 (wrought aluminum and aluminum alloys, wire). Wire shall be supplied in protective wrapping indicating batch number and other details.

3.1.3 Thickness Requirement

The nominal thickness of finished TSAC shall be 250 microns having minimum value of 225 microns at low thickness areas (valleys) and not more than 275 microns at peak areas.

The finished thickness shall be measured using SSPC-PA 2 type 2 fixed probe gauge (Magnetic Gauge).

3.1.4 Coating Bond Strength Requirement

The TSAC coating shall have a minimum individual tensile-bond strength value of 1000 psi for flame sprayed and 1500 psi for arc sprayed coating with an average of 2000 psi for arc sprayed coatings. Minimum tensile bond strength should be achieved by proper anchor tooth profile of blasted surface, laying down the TSA thickness in multiple passes and carrying out TSA application under controlled environment

3.1.5 Porosity

All thermally sprayed metallic coatings will have porosity. For thermally sprayed aluminum coatings porosity shall not exceed 15% of total surface area for flame sprayed coating and 8% for arc spray coating.

4.0 THERMAL SPRAY APPLICATION PROCEDURE

Items in the atmospheric zone to be coated by TSA shall be applied by either Flame spray or Arc spray method only. For coating under insulation, application shall be by arc wire method.

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4.1 Equipment Set Up

4.1.1 Thermal spray equipment shall be set up calibrated, operated (1) according to manufacturer instructions/technical manuals and also TSAC applicators refinement thereto and (2) as validated by Procedure Qualification (Sec 7.0 of this specification).

4.1.2 **Spray Parameters**

Spray parameters (see 4.1.3 below) and thickness of each crossing pass shall be set and shall be validated with bend test (See 6.5 of this Spec).

4.1.3 Spray Parameters

Spray Parameters	Method of Application	
Arc voltage	Arc wire Spray	Flame Wire Spray
	27 V	-
Air pressure	80 psi	80 psi
Steel surface cleanliness	NACE-1 white metal	NACE-1 white metal / or Near white metal
Steel surface profile	75 microns (minimum)	75 microns (min.)
Arc current	250-280A	-
Coating thickness	225 microns (nominal)	225 microns(Nominal)
Coating adhesion	> 1500 psi (Total coating),see 3.1.4	>1000 psi
Coating porosity	Less than 8%	Less than 15%.
Spray distance (spray Gun work piece)	6-8”	5-7”
Spray Pass width	40mm	20 mm

The above parameters to be validated with a bend test by the contractor before start of work (for details of bend test see Sec 6.5 of this Spec).

4.2 Post Blasting Substrate Condition and Thermal Spraying Period.

4.2.1 The steel surface temperature shall be at least 5°C above dew point of ambient air temperature.

Steel substrate surface temperature shall be recorded by with a contact pyrometer. Thermal spraying should commence within 15 minutes from the time of completion of blasting

4.2.2 **Holding Period**

Time between the completion of final anchor tooth blasting and completion of thermal spraying of blasted surface should be no more than four hours. If within this period rust bloom appears Sec 4.4.1 of this specification will apply.

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4.3 Pre-Heating

For flame spraying, the initial starting area of 1-2 square feet to be preheated to approx.120^{0}C to prevent condensation of moisture in the flame on the substrate. For arc spraying the preheating is not required.

4.4 Thermal Spraying

Spraying should commence only after validation of equipment set up by procedure qualification test and spray parameter validation tests described in Sec 7.0 and 6.5 respectively. Thermal spraying must commence within 15 minutes from the time of completion of blast cleaning

The specified coating thickness shall be applied in several crossing passes. The coating bond strength is greater when the spray passes are kept thin. Laying down an excessively thick spray pass increases the internal stresses in TSAC and decreases the bond strength of total TSAC. The suitable thickness for crossing passes shall be determined by procedure qualification test described in Sec 7.0 of this specification.

For manual spraying, spraying to be done in perpendicular crossing passes to minimize thin spots in coating. Approx. 75-100 microns of TSAC shall be laid down in each pass.

The surface geometry of the item or area to be sprayed should be inspected before application. The spraying pass and sequence shall be planned according to following.

- Maintain Gun as close to perpendicular as possible and within ± 30° from perpendicular to the substrate.
- Maintain nominal standoff distance and spray pass width as given below:

Spray method	Standoff (Inches)	Spray pass width (Inches)
Arc Wire	6-8	1 ½(40mm)
Flame wire	5-7	¾(20mm)

4.4.1 **Rust Bloom** (Visual appearance of rust or Discoloration):

If Rust bloom appears on the blasted surface before thermal spraying, the affected area shall be re-blasted to achieve the specified level of cleanliness.

If Rust bloom in form of discoloration, or any blistering or a degraded coating appears at any time during application of TSAC, then spraying shall be stopped and acceptable sprayed area shall be marked off. The unsatisfactory areas shall be repaired to the required degree of surface cleanliness and profile.

Blast the edges of the TSAC to provide for 2-3” feathered area overlap of the new work into existing TSAC.

Then apply TSAC to the newly prepared surfaces and overlap the existing TSAC to the extent of feathered edge so that overlap is a consistent thickness.

4.4.2 **Masking**

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Masking all those parts and surfaces which are not required to be thermally sprayed as instructed by purchaser should be inspected by applicator to ensure that they are properly marked and covered by purchaser.

Complex geometries (flanges, valve manifolds, intersections) shall be masked by applicator to minimize overspray i.e. TSAC applied outside spray parameters (primarily gun to substrate distance and spray angle).

4.4.3 **TSAC Finish**

The deposited TSAC shall be uniform without blisters, cracks, loose particles, or exposed steel as examined with 10 X magnification.

5.0 SEALER

Sealant shall be applied after satisfactory application of TSAC and completion of all testing and measurements of the finished TSAC as per Sec 6.0 of this specification.

For shop work Sealer shall be applied immediately after thermal spraying and for field work sealer shall be applied within 8 hours. The sealcoat shall be thin enough to penetrate into the body of TSAC.

The sealant shall be Silicone Alkyd Aluminium paint having DFT not more than 35-40 micron. Typically seal coat shall be applied at a spreading rate resulting in theoretical 38 microns DFT. The seal coat shall be applied in accordance with SSPC-PA 1 and the paint manufacturer instruction for sealing.

6.0 TESTING AND MEASUREMENT SCHEDULE

6.1 Surface Finish

That the blasted cleaned surface meets the required criteria (NACE 1/SSPC-SP 5) shall be visually inspected using SSPC-VIS 1. The clear cellophane-tape test as per ISO 8502-3 shall be used to confirm absence of dust or foreign debris on the cleaned surface. Checks shall be done on each component at least once per 200 m^2 of blasted surface and minimum of 3 checks per shift.

6.2 Blast Profile Measurement: (In-Process testing during actual production before application of TSA coating)

The angular profile depth measurement shall be done by profile tape as per method NACE Standard RP 0287 or ASTM D 4417 method B (Profile depth gauge micrometer). Spot measurement shall be carried out every 15m^2 of blasted surface. At each spot three measurements shall be taken over an area of 10 cm^2 and average of measurements to be recorded and reported.

If profile is <65 microns blasting shall continue till greater than 65 microns depth profile is achieved.

6.3 TSAC Thickness (In-Process Testing For finished coating during regular production)

6.3.1 TSAC finished thickness shall be measured using SSPC-PA 2 type 2 fixed probe gauge.

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6.3.2 For flat surfaces, measurements shall be taken along a straight measurement line, one measurement line for every 15 m^2 of applied TSAC shall be selected along which 5 measurements to be taken at 25 mm internal and average to be reported.

6.3.3 For curved surface or complex geometry, 5 measurements shall be taken at a spot measuring 10 cm^2 in area. One spot to be taken for every 15 m^2 of applied TSAC area.

6.3.4 The TSAC thickness in surface changes or contour changes, welds and attachments shall be also measured and reported.

6.3.5 If TSAC is less than specified minimum thickness, apply additional TSAC until specified thickness range is achieved.

6.3.6 All locations and values of TSAC thickness measurements shall be recorded in Job Record (JR).

6.4 Tensile Bond Testing (In-Process testing for finished coating during regular production)

- Tensile Bond strength of the TSAC finish coat shall be determined according to ASTM D 4541 using a self-aligning adhesion tester.

- One measurement shall be made every 50 m^2. If tensile bond at any individual spot is less than 1000 psi for flame sprayed coating and 1500 psi for arc sprayed coating the degraded TSAC shall be completely removed and reapplied.

- The tensile bond portable test instrument to be calibrated according to ASTM C 633

6.5 Bend Tests

Bend test shall be carried out at beginning of each work shift. Bend tests shall also be conducted on sample coupons before start of thermal spraying work to qualify the following as mentioned earlier in this specification.

- To qualify spray parameters and thickness of each crossing pass.

6.5.1 **Test Procedure**

a) Five corrosion control steel coupons each of dimension 50 mm x 150 mm x 1.3 mm thick to be prepared.

b) Surface shall be prepared by dry abrasive blast cleaning as per this specification.

c) TSAC shall be applied as per specified thickness range. TSAC should be sprayed in crossing passes laying down approx. 75-100 microns in each pass.

d) TSAC applied coupons shall be bent 180° around a 13 mm diameter mandrel.

e) Bend test shall be considered passed if on bend radius there is

- No cracking or spalling or lifting by a knife blade from the substrate
- Only minor cracking that cannot be lifted from substrate with a knife blade.

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f) Bend test fails if coating cracks with lifting from substrate.

6.6 Tests for blasting media, blasting air

6.6.1 Blasting Media (For every fresh batch of media and one random test during blasting)

Blasting Media shall be visually inspected for absence of contamination and debris using 10 X magnification.

a) Inspection for the absence of oil contamination shall be conducted using following procedure :

- Fill a small clean 200 ml bottle half full of abrasive.
- Fill the bottle with potable water, cap and shake the bottle.
- Inspect water for oil film/slick. If present, the blasting media is not to be used.

b) Soluble salt contamination if suspected shall be verified by method ASTM D 4940. If present, media to be replaced.

c) Clean blasting equipment, especially pot and hoses, and then replace blasting media and retest.

6.6.2 Test for Blasting Air (Once Daily before start of blasting and once at random during blasting)

The air for blasting shall be free from moisture and oil. The compressor air shall be checked for oil and water contamination per ASTM D 4285.

6.7 Test for presence of oil/grease and contamination

The steel substrate after degreasing as per SSPC-SP 1 shall be tested as per following procedure to validate absence of oil and grease contamination.

a) Visual inspection - Continue degreasing until all visible signs of contamination are removed.

b) Conduct a solvent evaporation test by applying several drops or a small splash of residue-free tri-chloromethane on the suspect area especially pitting, crevice corrosion areas or depressed areas. An evaporation ring formation is indicative of oil and grease contamination.

Continue degreasing and inspection till test is passed.

7.0 TSAC APPLICATOR QUALIFICATION

Following tests to be carried out as part of procedure qualification test for the applicator.

- Thickness measurement
- Coating bond strength
- Porosity test
- Bend strength

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TSAC applicator's surface finishing and application process and equipment set up, calibration and operation shall be qualified by application of TSA on a reference sample which shall be used as a comparator to evaluate the suitability of application process. Only that applicator will be permitted to carry out the work when test specimens coated by the applicator meets the desired requirements as cited below.
The sample shall be made of a steel plate measuring approx. 18"x 18" x ¼" thick. If the actual work is less than ¼" thick then the sample to be made from material of representative thickness.

The surface preparation, TSAC application shall be made with actual field equipments and process/spray parameters and procedures as per the specification. The depth profile of blasted surface, TSAC coating thickness for each cross pass and total thickness range shall be as per specification.

The surface preparation and thermal spraying shall be carried out in representative environmental conditions spraying with makeshift enclosure.

7.1 After application of coating, thickness and tensile bond measurements shall be made in following manner.

- Divide the sample piece into four quadrants.
- Measure thickness along the diagonal line of each quadrant.
- Four each quadrant five in-line thickness measurements at 1" interval shall be done using SSPC-PA 2 type 2 fixed probe gauge. Thus a total of four "five in line" thickness measurements to be done for the whole sample.
- One tensile bond measurement using ASTM D 4541 type III or IV portable self-aligning test instrument to be done at centre of each quadrant. Total of 4 measurements for the sample.
- One porosity evaluation test by Metallographic examination shall be conducted to demonstrate the achievement of porosity within the limits specified. Sample shall be prepared for Metallographic examination as per ASTM E-3.
- The procedure shall be considered qualified if thickness and tensile-bond strength and porosity values meet the specification requirement.

7.2 Bend test: Bend test shall be carried out as detailed at sec. 6.5 of this specification.

Applicators thermal spray equipment set-up, operation and procedure of application including in-process QC checkpoints adopted during procedure qualification as described above should be always subsequently followed during entire duration of work.

8.0 DOCUMENTATION

The following information shall be provided by TSAC applicator before award of work.

- TSAC application process consisting of equipment capabilities and their technical parameters, feed stock material and source of procurement.
- Detailed application procedure and in-process quality control check points for (a) surface preparation (b) thermal spraying (c) seal coats.

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- Type and specification of instruments to be deployed for measurement of blast profile depth, TSAC thickness and tensile bond.

- Paint manufacturer data sheet for the selected sealing coat to be applied.

9.0 RECORDS

- The TSAC applicator shall maintain job record to record production and QC information. All the results of the tests and quality control checks shall be entered in the record for each component/part thermally sprayed. All the result of tests (thickness, tensile bond, bend tests) and other validation tests (e.g. procedure qualification test, test for surface cleanliness after abrasive blasting, test for cleanliness of abrasives and air) shall also be recorded and duly signed by the Owner/ Owner's Representative.

- All the information mentioned in Sec 8.0 above should also form part of the Job record.

- Any modification affected after procedure qualification in the procedure, QC, spray parameter, equipment spec to the original information (submitted before award of the work) must also form part of Job record.

10.0 WARRANTY

The TSAC applicator shall warrant the quality of material used by providing the purchaser with a certificate of materials used to include

- Spray feed stock: Alloy type/designation, Lot Number, wire diameter, chemical analysis, name of supplier, manufacturer.

- Sealant: Name of manufacturer, application data sheet.

11.0 SAFETY

The TSAC applicator shall follow all safety procedures required by the purchaser/owner. Owner shall also give compliance requirement to be followed by applicator. The applicator shall follow all appropriate regulatory requirements.

12.0 CODES AND STANDARDS

This specification shall apply in case of conflict between specification and following applicable standards:

AWS C. 2.17	Recommended Practice for Electric arc Spray.
ASTM C 633	Test Method for Adhesive/Cohesive Strength of Flame Sprayed Coatings.
ASTM D 4285	Method for indicating Oil or Water in Compressed Air.
ASTM D 4417	Test Method for Field Measurement of Surface Profile of Blasted Steel.
BS 2569	Specification for Sprayed Metal Coating.
NACE Standard RP 0287	Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape.
ASTM D 4541	Test method for Pull-Off Strength of Coating Using Portable Adhesion Testers.
ANSI/AWS C2.18	Guide for the Protection of Steel with Thermal Spray

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	Coatings of Aluminum, Zinc and Their Alloys and Composites.
NACE No. 12/AWS C2.23M/SSPC-CS 23.00	Specification for the application of thermal spray coatings (Metallizing) of aluminum, zinc, and their alloys and composites for the corrosion protection of steel.
SSPC Publication	The inspection of coatings and linings: A Handbook of Basic practice for Inspectors, Owners, and Specifiers.
SSPC-AB 1	Mineral and Slag Abrasives.
SSPC-AB 3	Ferrous Metallic Abrasives.
SSPC-PA 1	Shop, Field, and Maintenance Painting of Steel.
SSPC-PA 2	Measurement of Dry Coating Thickness with Magnetic Gages.
NACE No. 1/SSPC-SP 5	White Metal Blast Cleaning.
NACE No. 2/SSPC-SP 10	Near –White Metal Blast Cleaning.
SSPC-VIS 1	Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.

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ANNEXURE-II

EIL Standard Specification No. 6-79-0011

Standard Specification for Tape Coating for Underground Steel Pipelines

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भूमिगत स्टील पाइपलाइनों हेतु टेप कोटिंग के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR TAPE COATING FOR UNDERGROUND STEEL PIPELINES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
					Approved by	
2	09.08.18	REVISED & ISSUED AS STANDARD SPECIFICATION	SM	SS	SG	RKT
1	16.08.12	REVISED & ISSUED AS STANDARD SPECIFICATION	SS	RC	PPL	DM
0	09.06.03	ISSUED AS STANDARD SPEC.	GVS	GS	KKS	SKG

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Abbreviations:

ASTM	:	American Society for Testing and Materials
AWWA	:	American Water Works Association
DFT	:	Dry Film Thickness
ISO	:	International Organization for Standardization
SSPC	:	Steel Structure Painting Council

For the purpose of this specification, the following definitions shall apply:

OWNER	:	Owner is the party that initiates the project and ultimately pays for its design & construction.
PMC	:	Owner's authorized agent/consultant to act for the owner. PMC is the party, which carries out management of the project.
MANUFACTURER	:	The party which manufactures and/or supplies the tape coating materials and services to perform the duties specified by owner/PMC.

Materials & Coating Standards Committee

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Members : Mr. Deepak Gupta (Projects)
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ANNEXURE-I 12

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1.0 SCOPE

This specification covers the requirement for materials, surface preparation, application, inspection, repairs and handling for external corrosion protection of underground carbon steel pipelines, field joints and coating repair with service temperature upto 60°C using coal tar tape coating.

2.0 REFERENCE DOCUMENTS

The latest edition of the following standards and documents shall apply:

2.1 AWWA C-203: Coal tar protective coatings and linings for steel water pipelines

2.2 SIS 05-5900: Pictorial surface preparation standard for painting steel surface ISO 8501:1988

2.3 SSPC-SP: The Society for Protective Coatings surface preparation specifications :

SSPC-SP1: Solvent cleaning
SSPC-SP3: Power tool cleaning
SSPC-SP10: Near white metal blast cleaning

2.4 BS 4164: British Standard Specification for coal tar based hot applied coating materials for protecting iron and steel including a suitable primer

3.0 GENERAL REQUIREMENTS

3.1 Equipments and accessories required for tape coating shall be in good operating conditions. Adequacy of equipments and accessories shall be ensured by EPCC Contractor and Certified.

3.2 Necessary arrangements for power supply and other utilities shall be made for completion of the job.

3.3 Necessary testing and inspection facilities as required by this standard shall be developed at site and shall be approved by the PMC/OWNER.

3.4 Protective tapes and other materials brought to site shall be as per the specifications of this standard and should be approved by the PMC/OWNER.

Field and laboratory tests as given in this standard shall be carried out for each batch of primer and tape.

3.5 All work shall be carried out in accordance with this specification and shall be phase wise approved by PMC/OWNER. Any working procedure developed from this specification shall be approved in advance by the Engineer-In-Charge (EIC).

3.6 Manufacturers recommended/ Trained supervisor and skilled applicator shall be engaged by the contractor for application, inspection and quality assurance.

3.7 Applicator shall possess copy of reference documents and test procedure appearing in this standard, which are required for field application.

4.0 DOCUMENTATION

The following documentation is required:

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4.1 Before Starting-Up of the Work

A quality plan with procedures for qualification trials and for the actual work shall be made. The quality plan shall include a time table for the various activities, with a description of coating materials to be used, their application, qualification of personnel involved in the work, responsibilities and lines of communications, details of equipment and their calibration, proposed hold points for PMC/OWNER inspection and endorsement and the detailed procedures for the testing and inspection. Documented evidence that the requirements of this specification have been met during production shall be shown.

4.2 During Execution of Coating Job

- Daily progress reports on application of tape coating materials with details on weather conditions
- Results of comparison of surface cleanliness, surface profile on blast cleaned surface, tape coating thickness, holiday detection and adhesion tests
- Particulars of surface preparation, priming and tape application; no. of wraps
- Details of non-compliance, rejects and repairs
- Types of testing equipments and calibration
- Code and batch numbers of coating materials used
- Field tests on primers and tape coat
- Progress of work as per scheduled program.

5.0 MATERIALS

5.1 General Requirements

5.1.1 Manufacturer's test certificates shall be produced and examined by the PMC/OWNER for all materials, proposed to be used for tape coating as per this standard.

5.1.2 All materials brought to site for tape coating shall be suitably marked and identifiable with the following information:

- Manufacturer's name
- Type of material and code
- Batch number
- Date of manufacturing
- Technical datasheet for each type of material
- Shelf life
- Manufacturer's quality control test certificates with actual results of each batch.

5.1.3 Materials without manufacturer's test certificates and identification marks shall not be accepted and used.

5.1.4 Test certificate from competent/recognized Govt. laboratory/in the laboratory of internationally reputed certifying agencies like, Lloyds registrars, DNV (Det Norske Veritas), BV (Bureau Veritas) on the properties of materials quoted by the manufacturer in the technical data sheet shall also be submitted along with the technical data sheet of the products. Any recent past certificate can also be submitted

5.1.5 Each batch of primer and tape shall be tested in the field by the procedure as given in this standard. PMC/OWNER will review the field test data before use of the materials.

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5.2 Characteristics and Functional Requirements of Coating Materials

5.2.1 Coal tar tapes

Materials for coal tar tape coating shall conform to the following specifications. The following are the salient features of coal tar tape coating materials.

5.2.1.1 Primer

The primer shall be type B as specified in AWWA C-203. Following are the main characteristics:

Type	Fast drying, synthetic, chlorinated rubber-synthetic plasticizer-solvent based
Drying time (tack free)	15 minutes (approx.) (ASTM D1640)
Flash point	> 23^{0}C (ASTM D93/D3941)
Volatile matter (105-110^{0}C) percent by mass	75 (maximum) (ASTM D2369)
Viscosity, on FORD CUP NO. 4 (4mm nozzle) at 23^{0}C	35-60 seconds (ASTM D1200)
DFT	25 microns/coat (minimum)
Coverage (Theoretical)	10 M^2/Lit/Coat
Coverage (Practical) @ 25 microns DFT coat	6 M^2/Lit/Coat (minimum) (ASTM D344)
Application properties	By brush/ spray should produce an effective bond between metal and subsequent coaltar tape
Adhesion test (after 72 hours)	The primer shall be tested after applying tape coating as per AWWA C-203.

5.2.1.2 Coal tar tape

The tape shall be coal-tar component supported on fabric of inorganic fibres.

a) Raw coal tar pitch

The coal tar (hard pitch) which shall have the following salient properties:

Characterization	Values		Standard
Softening point ^{0}C	65	121	ASTM D36
Specific gravity	1.30±0.05		ASTM D71
Ash content, %	0.5 Max.		ASTM D2415
Physical state	Solid at ambient temperature		

b) Fabric

Type: The fabric shall be a thin, flexible, uniform mat or tissue composed of glass fibers in an open structure bonded with a suitable resinous inert material compatible with coal tar.

Weight (min) g/m^2 40
Thickness (min.) mm 0.3
Breaking load in the longitudinal direction: 2.28KN/m (min.)

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Porosity	When related to pressure difference across the sample, the glass fibre fabric shall have porosity of not less than 0.6mm and not more than 1.9mm of water at an average air velocity of 61m/minute (1m/sec.)
Temperature resistance	The fabric shall be unaffected under load in hot coal tar at 288°C for one minute. It shall not shrink length wise or width wise.
Pliability test	No cracking shall take place when bent over a mandrel of 3mm radius through 90° arc at a uniform speed of approximately 2 seconds after immersing in water for 10 to 15 minutes.

Note (1) : Manufacturer's test data in the laboratory are required for the above properties on the materials supplied.

c) Physical properties of coal tar tape

Property	Requirement		Test method
	Min.	Max.	
Service temperature (^{0}C)	-	60	
Tape thickness mm	2.0	2.5	AWWA C-203
Weight average (kg/sq.m/mm)	1.25	-	ASTM D146
Breaking strength in longitudinal direction kN/m	0.7		AWWA C-203
Adhesion	AWWA C-203.		
Insoluble content % by wt in petrol	93 minimum (procedure given in ANNEXURE-I)		

d) Physical properties of coal tar component in the finish tape

Property	Requirement		Test method
	Min.	Max.	
Softening point (^{0}C)	65	121	ASTM D36
Penetration at 25^{0}C/100g/ 10^{-1} mm/5 sec	1	9	ASTM D5/BS-4164
Filler %	20	35	ASTM D 2415 or AWWA C-203

e) Filler

Characteristics	Requirement	Test Method
Fineness: % w/w, minimum	Shall pass through mesh size of 75 microns	ASTM D1366
Loss on ignition at 800° C, w/w max.	10	ASTM D1208

f) Field Tests

Few test methods given in ANNEXURE-I are mainly applicable during field application.

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6.0 SURFACE PREPARATION

6.1 All oil, grease on the pipe metal surface shall be thoroughly removed by flushing with a suitable solvent (such as xylene or 1,1,1 trichloroethylene) and wiping with clean rags. The solvent cleaning shall be as per SSPC-SP-1. If required detergent cleaning shall be done before or after solvent cleaning.

6.2 The degreased pipe metal surface shall be blast cleaned to Sa2½ of SIS -05-5900 or SSPC-SP-10 with a surface profile of 30-50 microns trough to peak. Blasted surface that rusts before priming shall be cleaned by wire brushing or shall be re-blasted. Priming shall be done within 4 hours of completion of blast cleaning. Otherwise total re-blasting may be necessary.

7.0 APPLICATION OF PRIMER

One coat of primer shall be applied on blast cleaned surface by brush or spray to achieve complete wetting of the surface as recommended by the manufacturer. In case the surface is wet during application of primer, the surface should be made dry. The primer shall be allowed to become touch dry prior to tape application. Primer and tape shall be supplied by the same manufacturer.

8.0 TAPE COATING SYSTEM AND APPLICATION

8.1 Tape Coating System

(a) One coat of fast drying synthetic primer by brush or spray after surface preparation to provide complete wettability of the surface.
(b) One layer of coal tar tape coating with 2 mm thickness on the surface of primed pipe after touch dry.
(c) Second coat of fast drying synthetic primer by brush or spray on 1st layer of tape coating to provide complete wettability of the surface for application of 2nd layer of tape.
(d) 2nd layer of coal tar tape coating with 2 mm thickness on the surface of primed pipe after touch dry.

8.2 Application Method

Tape application should follow primer application as soon as the primed pipe surface is touch dry. The primer and tape application should not be done in case of dusty/windy weather or during rain. Primed surface should not be kept exposed to atmosphere for very long duration.

The tape shall be wrapped in accordance with the manufacturer's recommendations in a manner that shall meet the adhesion and holiday detection requirement of this standard. In any event, there shall be a minimum of 12.5 mm overlap per single wrap.

The applied coating system shall be as follows:

(a) In application, care shall be taken that there are no air pockets or bubbles beneath tape and the tape shall be in intimate contact with the primed steel.
(b) Manufacturer recommended/trained supervisor and skilled applicator shall be engaged for tape application.

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9.0 FIELD JOINT COATING AND REPAIR OF DAMAGED COATING

9.1 Field Joint Coating on Exterior Welds

The exterior joints shall be cleaned and surface preparation by blast cleaning to Sa2½ finish of SIS-05-5900/SSPC-SP-10 as given in clause 6.0. The coating materials shall be same as applied on as main pipeline. The tape coating material applied on field weld joints shall overlap at least 75 mm the main pipe coating on each side of the field joint to form a continuous external coating free of defects. The coating inspection for quality assurance shall be as given in clause 10.0.

9.2 Repair of Damaged Tape Coating

9.2.1 Damages, flawed areas and holidays: Areas that are damaged, flawed or contain holidays shall be repaired using the tape coating materials applied on main pipeline and made by the same manufacturer. In no case, shall damaged areas be repaired by applying additional tape over loose damaged tape where the damage goes down to the metal or where the bond of the tape has been destroyed.

9.2.2 Repair of tape: Repair shall be made by removing the applied tape coating from the area around the holiday. The surface preparation shall be done as per clause 6.0 of this specification and then repair the area by using the same system of primer and hot applied tape as was used for the original wrapping as given in clause 8.0. When completed, the area shall be re-tested following the method of electrical inspection described in clause 10.8.

10.0 INSPECTION AND TESTING FOR QUALITY ASSURANCE

The following stage wise inspection and testing shall be carried out at manufacturers end/at site by the OWNER or by OWNER's representative third party inspection agency. Petrol test as per Clause No. 5.2.1.2 c) and Section 2.3 of ANNEXURE-I shall be conducted at site under the supervision of EIC.

10.1 Fast Drying Synthetic Primer Materials

The physical properties of primer are given in clause 5.2.1.1.The test procedure given is in Annexure-1

10.2 Tape Coating

As per 5.2.1.2 (b), (c), & (d), the procedure is given in ANNEXURE-I.

10.3 Measurement of Pipe thickness (in case of coating refurbishment)

10.4 Surface Preparation

- Blast cleaning equipment for nozzle type, size, safety gauges, working condition, and pressure at the tip of the gun.
- Abrasive type, hardness to provide required profile size and cleanliness.
- Measurement of surface profile and comparing cleanliness with visual standards of ISO 8501.

10.5 Measurement of pitting depth area of pitted portion, inspection of weld filling and grinding and patch plate welding, welding of replaced pipe if any.

10.6 Checking of condition of concrete saddles, rubber padding and end seals wherever required.

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10.7 Inspection of Primer after Application

- Checking for drying time to be touch dry, tack free drying and hard drying of primer.
- Dry film thickness (DFT) shall be checked on metal panel separately.

10.8 Inspection of Tape Coating after Application

- Visual inspection for uniformity without any wrinkles and irregularities and overlapping width as per specifications
- Adhesion test as per AWWA C-203
- High voltage holiday detection test for pinholes as per AWWA C-203.

10.8.1 Visual

The coated pipes including field joint coating shall be visually inspected for cracks, trapped air, uniformity, damage etc. Any repair arising out of visual inspection will be decided by PMC/OWNER.

10.8.2 Thickness

Thickness has to be measured with a caliper with caliper surfaces of at least 20mm diameter, on 5 tape pieces with an edge length of at least 50mm taken from 5 different coils. The measuring pressure should be 0.5 N/m^2. The measuring accuracy should be within 0.1 mm.

10.8.3 Adhesion Test

a) Adhesion tests shall be made to determine the proper bond between the tape and the primed pipe. One test per section (of upto 10 meter length) shall be carried out initially afterwards adhesion test is to be done as per the advice of PMC/OWNER. Repair required due to adhesion testing shall be decided by the PMC/OWNER.

b) Temperature of the tape and pipe to be tested shall be between 10^0C and 27^0C. If required cold water shall be poured over the test area to bring down the temperature to with in the above range. The coating shall be allowed to set at ambient temperature for 72 hrs.

- A test area shall be selected where the tape is smooth for 150 mm in the longitudinal direction of the tape.
- Two knife cuts of 150 mm long and 50 mm apart shall be made through the tape.
  - A flat blade shall be used to pry up 50 mm of the fabric.
- The 50 mm flap of fabric shall be grasped firmly in one hand and shall be pulled with a quick motion in the direction of the remaining 100 mm of the 150 mm knife cut.
- The adhesion is satisfactory if (i) the tape tears at the point of stripping or (ii) the fabric strips from the underlying tape component, leaving no more than 10% or less of the primer or bare metal exposed.

c) Adhesion between tape to tape can be tested following similar procedure as in (b). This should preferably be done on a test panel.

10.8.4 High voltage holiday detection test

- All tape coated pipes and joints shall be tested with an approved high voltage holiday detector preferably equipped with an audio visual signaling device to indicate any faults, holes, breaks or conductive particles in the protective coating.

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- The applied output voltage of the holiday detector shall have a spark discharge of thickness equal to at least twice the thickness of the coating to assure adequate inspection voltage and compensate for any variation in coating thickness. The electrode shall be passed over the coated surface at approximately half the spark discharge distance from the coated surface only one time at the rate of approximately 10 to 20 meters per minutes. The edge effects shall be ignored. Excessive voltage shall be avoided as it tends to induce holidays in the coated surface thereby giving erroneous readings.
- While selecting test voltages, consideration shall be given to the tolerance on coating thickness and the voltage should be selected on the basis of maximum coating thickness likely to be encountered during testing of a particular pipe.

Thickness of Coating (mm)	Test Voltage (Max.) (kV)
2	10
3	12
4	15

- The electrical equipment used to test tape coating shall be a portable, low amperage, adjustable-voltage, pulse type holiday detector. It shall be furnished with a coil spring electrode or a suitable brush type electrode. The primary input wattage shall not be higher than 20 W, and the minimum pulse at crest voltage shall be 20 per second.

11.0 PROTECTION OF COATED PIPES AGAINST UV DEGRADATION

When the coated pipes are required to be left out exposed to sun light for more than a week before back filling the trench, the coated pipe shall be protected with white coloured water emulsion latex paint. The water emulsion latex paint to be used must be stabilized, pigmented dispersion of water-insoluble film forming, high molecular wt. Synthetic polymeric materials in water. After application and drying the paint must be able to produce a film that adheres to the coal tar tape coating is white in colour, water resistant and able to withstand exterior exposure without degradation for a minimum of 90 days.

12.0 COAL TAR TAPE WIDTH

The width of coal tar tape coating for various pipe sizes shall be as follows:

Pipe Size (Nominal Bore)	Tape Width (mm)
80	100/125
100	100/125/166
150	125/166/200
200	125/166/200/250
250	166/200/250/333
300	166/200/250/333
>300	333

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ANNEXURE-I

TEST METHODS

1.0 PRIMER (fast drying chlorinated rubber based synthetic primer)

1.1 Test method for volatile content (refer ASTM D2369 for full details)

Procedure:

A specimen sample of primer 0.50± 0.10 gms is weighed into a tared aluminum foil dish into which add 3 ml of solvent toluene technical grade and disperse completely. Heat the above sample in the forced draft oven for 60 mins. at $110^0C \pm 5^0C$. Remove the dishes from the oven place immediately in desicator, cool to room temperature and weigh. Calculate % volatile matter (V) by using the following formula:

$$V = \frac{(W_2 - W_1)}{S} \times 100$$

Where, W_2 - Weight of dish + Specimen
W_1 - Weight of dish + Specimen after heating
S - Specimen wt.

1.2 Test method for viscosity by ford cup no. 4 (refer ASTM D1200 for full details)

The efflux time of primer is determined by ford cup no.4. The cup is cleaned thoroughly by solvent toluene and a soft brush. Fill the cup with the primer to full level by holding the orifice with a rubber stopper or finger pull the stopper away and simultaneously start the timer and measure the time until the first break of primer in the orifice. Measure the temperature of the fluid in the efflux stream. It shall be reported the efflux time in seconds at a measured temperature.

1.3 Test method for drying time (refer ASTM D1640 for full details)

Apply the primer by brush on clean glass/clean mild steel panels of suitable sizes and measure the drying time at a normal room temperature and 50% relative humidity with the coated panels on horizontal position:

a) **Set-to-touch time:** Lightly touch the test film with the tip of clean finger and immediately place the finger tip against a piece of clean clear glass. Observe if any coating is transferred to the glass. The film is set- to- touch where it still shows a tacky condition, but none of it adheres to the finger.

b) **Dust free time:** The coating film is considered to have dried dust free when the cotton fibres can be removed by blowing lightly over the surface of film.

c) **Tack free time:** The film is considered free from after tack when the test paper drops of the test film within 10 seconds.

2.0 COAL TAR TAPE

2.1 Test Method for Relative Density of Tape (refer ASTM D71for full details)

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The test sample is suspended from a thin wire and weighed first in air, then in water at 25°C in a glass beaker. The relative density is calculated from these weights.

Relative density of tape sample at 25°C $= \frac{A}{(A-B)}$

Where, A = Weight of specimen in air in mg.
B = Weight of specimen in water at 25°C in mg.

2.2 Test Method for Adhesion of Tape Coating in Laboratory (AWWA C-203)

Clean a section of 2 inch dia steel pipe of 2 ft length or a flat steel panel of 2 inch x 6 inch prime the cleaned metal and apply a 2 inch width of tape as per manufacturer's recommendations. The coating shall be allowed to set at room temperature for 72 hrs. after the test sample has completely set, grasp one end of the tape and pull it off by hand. The coating is considered to have satisfactory adhesion if [1] the fabric tears at the point of stripping or (2) the fabric strips from the under lying coating material leaving no more than approximately 10% or less of the primer or bare metal exposed.

2.3 Test Method for % Wt Loss in 24 hrs Immersion of Tape in Petrol

Samples as described below for this test shall be drawn at random in presence of EIC at site from the lot delivered to site.

Test Method: Cut 2 tape samples from the same batch weighing accurately 100gms each with same dimensions (wt. A) and put this sample in a clean and dry 600 ml capacity glass beaker. Pour 550 ml of standard quality petrol (gasoline) into the glass beaker in v-shape form so that the tape sample gets totally immersed in petrol. The level of petrol shall be about 5 cm above the tape sample.

Cover the mouth of the beaker with two layers of thick polyethene sheets and tie these polyethene sheets with a rubber band around the mouth of the glass beaker. Allow the beaker to stand at room temperature for 24 hrs without any disturbance. No stirring is to be done. Take the tape sample out of the beaker after 24 hrs and spread it on blotting papers on a table. Allow it to dry in the air for 4 hrs weigh the tape accurately again (wt. B)

$$\% \text{ Loss in wt.} = \frac{(A-B) \times 100}{A}$$

$$\% \text{ Insoluble} = 100 - \% \text{ Loss in wt.}$$

The above test shall simultaneously be carried out with 3 more tape samples selected at random and the average result shall be taken.

The indicative loss for coal tar tape in petrol shall be 7% maximum.

2.4 Standard Test Method for Relative Density of Solid Hard Pitch of Coal (refer ASTM D71for full details).

This test is applicable for testing at manufacturer's end.

2.4.1 **Summary of Test Method**

The sample is suspended from a thin wire and weighed, first in air, then submerged in water at 25°C. The relative density is calculated from these weights.

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Relative density of sample at 25^0C = $\frac{A}{A - B}$

Where A = Weight of specimens in air in mg.
B = Weight of the specimen in water at 25^0C in mg.

2.4.2 **Procedure**

Tare the balance with a piece of 0.127, (5 ml) nichrome wire or mono-filament nylon line sufficiently long to reach from the hook on the pan. Support to the saddle when the latter is in position across the pan. Attach the test specimen to the wire or line so that it is suspended 20 to 30 mm above the straddle when the other end of the wire is attached to the hook.

Weigh the suspended specimen to the nearest 1 mg and record this weight as "A". Fill a 400 or 600ml beaker two thirds full with freshly boiled distilled water containing a small amount of detergent. About 100 mgs of Alconox detergent to 200 ml of water has been found satisfactory. Adjust the temperature of water to 25 ± 2^0C and maintain this temperature during the remainder of the test. Place the beaker with water on the saddle with the specimen, still suspended, and fully submerged. Weight the immersed specimen to the nearest 1 mg and record this weight as "B".

Repeat the determination with the second test specimen.

2.4.3 **Report**

Report the average of two determinations to the third place, unless the individual values differ by more than 0.005. In this case, repeat the determinations.

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TECHNICAL NOTES FOR PIPES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	25.09.14	REVISED AND ISSUED AS STANDARD SPECIFICATION	SH	AK	RN	ATD SC
5	31.12.13	REVISED AND ISSUED AS STANDARD SPECIFICATION	UK	SH	AK	RN SC
4	04.07.08	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	SC	DM	VC
3	15.03.00	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	BRB	NS	AS
2	04.04.94	HYDROTEST & I.G.C. TEST CLAUSES REVISED	AKG	BPV	GRR	AS

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Abbreviations:

ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing & Materials
BHN	:	Brinell Hardness Number
BIS	:	Bureau of Indian Standards
E.FS.W	:	Electric Fusion Weld
E.R.W	:	Electric Resistance Weld
HAZ	:	Heat Affected Zone
HIC	:	Hydrogen Induced Cracking
IBR	:	Indian Boiler Regulations
IGC	:	Inter Granular Corrosion
IS	:	Indian Standard
LT	:	Low Temperature
MR	:	Material Requisition
NACE MR	:	National Association of Corrosion Engineers : Material Requirement
NB	:	Nominal Bore
NPT	:	Nominal Pipe Thread
PMI	:	Positive Material Identification
PR	:	Purchase Requisition
SMYS	:	Specified Minimum Yield Strength
SS	:	Stainless Steel

Piping Standards Committee

Convenor : Mr. R. Nanda

Members :
Mr. M. Ismaeel
Mr. Amrendra Kumar
Mr. G. Balaji
Mr. K.J. Harinarayanan (HMTD)
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1.0 GENERAL

1.1 All pipes and their dimensions, tolerances, chemical composition, physical properties, heat treatment, hydrostatic test and other testing and marking requirements shall conform to the latest codes and standards specified in the material requisition (MR). Supplier shall strictly comply with MR/PR stipulations and no deviations shall be permitted. Post Order Concession/Deviation Permit 5-0000-0180-F1 as mentioned in Cl. 5.18 of Specification for Quality Management System Requirements from Bidders (6-78-0001) is not applicable.

1.2 Testing

1.2.1 Test reports shall be supplied for all mandatory tests as per the applicable material specifications. Test reports shall also be furnished for any supplementary tests as specified in the MR & Clauses 1.10 & 1.11.

1.2.2 Material test certificates (physical property, chemical composition & heat treatment report) shall also be furnished for the pipes supplied.

1.2.3 PMI shall be performed as per the scope and procedures as defined in the spec for PMI at Supplier's Works (6-81-0001).

1.2.4 Refer to specification nos. 6-81-0002 and 6-81-0003 for Inspection & Test plans for welded pipes and seamless pipes respectively.

1.3 Manufacturing Processes

1.3.1 Steel made by acid Bessemer process shall not be acceptable.

1.3.2 All longitudinally welded pipes should employ only automatic welding.

1.4 Pipe shall be supplied in single or double random length of 4 to 7 and 7 to 14 meters respectively.

1.5 a. Seamless and E.R.W. pipes shall not have any circumferential seam joint in a random length. However, in case of E.FS.W pipe, in one random length one welded circumferential seam of same quality as longitudinal weld is permitted. This weld shall be at least 2.5 m from either end. The longitudinal seams of the two portions shall be staggered by 90°. Single random length in such cases shall be 5 to 7 m.

b. Unless otherwise mentioned in the respective material code, E.FS.W pipes < 36" shall not have more than one longitudinal seam joint and E.FS.W pipes ≥ 36" shall not have more than two longitudinal seam joints.

1.6 Pipe with screwed ends shall have NPT external taper pipe threads conforming to ASME/ANSI B1.20.1 up to 1.5" NB & IS 554 for 2" to 6" NB.

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1.7 Pipe with beveled ends shall be in accordance with ASME B16.25. Weld contours shall be as follows:

Material	Wall Thickness	Weld Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Up to 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Up to 10 mm	Figure 4
	> 10 mm & Up to 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

1.8 Galvanized pipes shall be coated with zinc by hot dip process conforming to IS 4736 / ASTM A 153.

1.9 All austenitic stainless steel pipes shall be supplied in solution annealed condition. All types of 321 or 347 stainless steel pipes shall be in a stabilized heat treated condition. Stabilizing heat treatment shall be carried out subsequent to the normal solution annealing. Soaking time & holding temp. for stabilizing heat treatment shall be 4 hrs & 900°C respectively.

1.10 I.G.C. Test for Stainless Steels

1.10.1 For all austenitic stainless steel pipes inter-granular corrosion test shall have to be conducted as per following:

ASTM A262 Practice "B" with acceptance criteria of "60 mils/year (max.)".

OR

ASTM A262 Practice E with acceptance criteria of no cracks at 20X magnification and microstructure to be observed at 250X magnification shall ensure the absence of any cracks/ fissures. When testing is conducted as per practice 'E' photograph of microstructure shall be submitted for record.

1.10.2 When specifically asked for in MR for high temperature application of some grades of austenitic stainless steel (eg.SS 309, 310, 316, 316H etc.) ASTM A262 Practice "C" with acceptance criteria of "15 mils/year (max.)" shall have to be conducted.

1.10.3 For the IGC test as described in 1.10.1 & 1.10.2, two sets of samples shall be drawn from each solution annealing lot; one set corresponding to highest carbon content and the other set corresponding to the highest pipe thickness.

1.11 All welded pipes indicated as 'CRYO' & 'LT' in MR shall be impact tested per requirement & acceptance criteria of ASME B31.3. The impact test temperature shall be -196°C & -45°C for stainless steel and carbon steel respectively unless specifically mentioned otherwise in MR.

1.12 NACE/HIC Requirements

1.12.1 Pipes under "NACE" category and those designated as "HIC1" shall meet the requirements given in NACE MR-0103 unless mentioned otherwise.

1.12.2 Pipes made from plates and designated as "HIC1" shall meet the HIC requirements of EIL specification 6-79-0013 unless mentioned otherwise.

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1.13 Specified heat treatment for carbon steel and alloy steel and solution annealing for stainless steel pipes shall be carried out after weld repairs. Number of weld repairs at the same spot shall be restricted to maximum two by approved repair procedure.

1.14 For black or galvanized pipes to IS 1239, the minimum percentage of elongation shall be 20%.

1.15 All 1Cr-½Mo and 1¼Cr-½Mo seamless pipes shall be normalised and tempered.

1.16 For all welded alloy steel pipes with mandatory requirement of heat treatment and radiography, radiography shall be performed after heat treatment.

1.17 For Hydrogen service pipes following special requirements shall also be met:

1.17.1 All carbon steel pipes having wall thickness 9.53 mm (0.375") and above shall be normalised. Cold drawn pipes shall be normalised after the final cold draw pass for all thicknesses.

1.17.2 All alloy steel (Cr-Mo) pipes shall be normalised and tempered. The normalising and tempering shall be a separate heating operation and not a part of the hot forming operation. The maximum room temperature tensile strength shall be 100,000 psig.

1.17.3 For carbon steel Pipes, hardness of weld and HAZ shall be 200 BHN (max.). For alloy steel Pipes, hardness of weld and HAZ shall be 225 BHN (max.).

1.17.4 For all austenitic stainless steels, the weld deposit shall be checked for ferrite content. A Ferrite No.(FN) not less than 3% and not more than 10% is required to avoid sigma phase embrittlement during heat treatment. FN shall be determined by Ferritescope prior to post weld heat treatment.

1.17.5 For all Carbon steel and Alloy steel pipes with wall thickness over 20mm, Charpy-V Notch impact testing shall be carried out in accordance with paragraph UG-84 of ASME Section VIII, Div-1 for weld metal and base metal from the thickest item per heat of material and per heat treating batch. Impact test specimen shall be in complete heat treated condition and accordance with ASTM A370. Impact energies at 0°Celsius shall average greater than 27J (20 ft-lb) per set of three specimens, with a minimum of 19J (15 ft-lb).

1.18 For dual grades of SS where specified, chemical composition and mechanical properties of both grades specified shall be ensured.

2.0 IBR PIPES

2.1 IBR Documentation

2.1.1 Pipes under purview of IBR shall be accompanied with IBR certificate original in Form III-A duly approved and countersigned by IBR authority/local authority empowered by the Central Boiler Board of India(Photocopy of the original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance) or Form III-D [for well known pipe manufacturers as per IBR] signed by Manufacturer's authorized representative. Well known pipe manufacturers, as recognized by IBR, shall submit a duly attested copy of Form XVI-G along with Form III-D.

2.1.2 For materials 1¼Cr - ½Mo (ASTM A335 Gr.P11 / A691 Gr.1¼Cr), 2¼Cr - 1Mo (ASTM A335 Gr.P22 / A691 Gr.2¼Cr) & 9Cr -1Mo-V (A335 Gr.P91/A691 Gr.91), Form III-A approved by IBR shall include the tabulation of Et, Sc & Sr values for the entire temperature range given below. Et, Sc & Sr values shall be such that throughout the temperature range

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$$\left.\begin{array}{ll} E_t / 1.5 & \geq \\ S_r / 1.5 & \geq \\ S_c & \geq \end{array}\right| S_A$$

where ,

S_A : Allowable stress at the working metal temperature.
E_t : Yield point (0.2% proof stress at the working metal temperature)
S_c : The average stress to produce elongation of 1%(creep) in 100000 hrs at the working metal temperature.
S_r : The average stress to produce rupture in 100000 hrs at the working metal temperature and in no case more than 1.33 times the lowest stress to produce rupture at this temperature.

S_A (psi)												
Temp(°F) Material	500	600	650	700	750	800	850	900	950	1000	1050	1100
A335 Gr.P11	17200	16700	16200	15600	15200	15000	14500	12800	9300	6300	4200	2800
A691 Gr.1¼Cr	18900	18300	18000	17600	17300	16800	16300	15000	9900	6300	4200	2800
A335 Gr.P22 / A691 Gr.2¼Cr	17900	17900	17900	17900	17900	17800	14500	12800	10800	7800	5100	3200
A335 Gr.P91/ A691 Gr.91	28100	27700	27300	26700	25900	24900	23700	22300	20700	18000	14000	10300

Note : S_A values shall be as per the latest edition prevailing.

2.2 For carbon steel pipes under IBR the chemical composition shall conform to the following:

Carbon (max) : 0.25%
Others (S, P, Mn) : As prescribed in IBR.

The chemical composition as indicated in this clause is not applicable for pipes other than IBR services.

3.0 ACCEPTABLE DEVIATIONS

3.1 Pipes to IS 3589 Gr.410 are acceptable in place of IS 3589 Gr.330.

3.2 Pipes of Grades SS317 of corresponding material are acceptable in place of Grades SS316 or SS316(2.5 Mo min.).

3.3 Pipes of Grades SS317L of corresponding material are acceptable in place of Grades SS316L or SS316L(2.5Mo min.).

3.4 Seamless pipes are acceptable in place of welded pipes except in the case of welded SS321/SS321H pipes with nominal thickness greater than 9.53mm.

4.0 HYDROSTATIC TEST

4.1 All pipes shall be hydrostatically tested.

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4.2 The mill test pressure shall be as follows:

4.2.1 Seamless, E.R.W. & Spiral Welded

a) Carbon Steel

Material Std.	Test Pressure Std.
ASTM A106 Gr.B	ASTM A530
API 5L Gr.B, Seamless	API 5L
API 5L, E.R.W.	API 5L
API 5L, Spiral	API 5L
ASTM A333 Gr.3 & 6, Seamless	ASTM A530
ASTM A333 Gr.3 & 6, E.R.W.	ASTM A530

b) Seamless Alloy Steel

Material Std.	Test Pressure Std.
ASTM A335 Gr.P1, P12, P11, P22, P5, P9	ASTM A530
ASTM A268 TP 405, TP410	ASTM A530

c) Seamless Stainless Steel

Material Std.	Test Pressure Std.
ASTM A312 Gr.TP 304, 304L, 304H, 316, 316L, 316H, 321, 347	ASTM A999

d) Seamless Nickel Alloy

Material Std.	Test Pressure Std.
ASTM B161 UNS No. 2200	ASTM B161
ASTM B165 UNS No. 4400	ASTM B165
ASTM B167 UNS No. 6600	ASTM B167
ASTM B407 UNS No. 8800	ASTM B407

e) Welded Nickel Alloy

Material Std.	Test Pressure Std.
ASTM B725 UNS No. 2200,4400	ASTM B725
ASTM B517 UNS No. 6600	ASTM B517
ASTM B514 UNS No. 8800	ASTM B514

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4.2.2 Electric Fusion Welded

a) Carbon Steel & Alloy Steel E.FS.W (16" & above)

Material Std.	Test Pressure Std.
API 5L Gr.B ASTM A671 Gr.CC65, 70 (Cl.32) ASTM A672 Gr.C60, 65, 70 (Cl.12,22) ASTM A671 Gr.CF60, 65, 66, 70 (Cl.32) ASTM A691 Gr.½Cr, 1Cr, 1¼Cr, 2¼Cr, 5Cr, 9Cr (Cl.42)	P = 2ST/D S = 90% of SMYS Except for API 5L Gr.B S = 85% of SMYS For API 5L Gr.B T = Nominal Wall Thickness D = O.D of Pipe

b) Stainless Steel E.FS.W (2" to 6")

The hydrostatic test pressure in kg/cm^2 for the following materials shall be as given below :

Material Gr.1 :ASTM A312 TP 304 / 304H / 316 / 316H / 321 / 347 welded.
Material Gr.2 :ASTM A312 TP 304L / 316L welded.

Size	Pipe Schedule : 10S		Pipe Schedule : 40S		Pipe Schedule : 80S	
	Material Gr. 1	Material Gr.2	Material Gr.1	Material Gr.2	Material Gr.1	Material Gr.2
2"	100	80	155	130	230	190
3"	80	60	155	130	230	190
4"	80	50	155	130	230	190
6"	65	35	90	75	155	130

c) Stainless Steel E.FS.W (8" and above).

Material Std.	Test Pressure Std.
ASTM A358 TP 304L, 304, 304H, 316L, 316, 316H, 321, 347 (Classes 1, 3 & 4)	P = 2ST/D S = 85% of SMYS T = Nominal Wall Thickness D = O.D of Pipe
ASTM A358 TP 304L, 304, 304H, 316L, 316, 316H, 321, 347 (Classes 2 & 5)	P = 2ST/D S = 72% of SMYS T = Nominal Wall Thickness D = O.D of Pipe

4.2.3 Carbon Steel Pipes to BIS Standards

Material Std.	Test Pressure Std.
IS 1239	IS 1239
IS 3589	IS 3589

4.3 Hydrostatic pressure testing shall be performed using iron free water, which is clean and free of silt. Maximum chloride content in water for hydrostatic testing for SS piping shall be 50 ppm.

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5.0 MARKING AND DESPATCH

5.1 All pipes shall be marked in accordance with the applicable codes, standards and specifications. In addition the purchase order number, the item code & special conditions like "IBR", "CRYO", "NACE", "H2" etc. shall also be marked.

5.2 Pipes under "IBR","CRYO", "NACE" & "H2" shall be painted with one circumferential stripe of colour red, light purple brown, canary yellow & white respectively for easy identification. Width of stripe shall be 12mm for pipe sizes less than 3" and 25mm for pipes 3" and above.

5.3 Paint or ink for marking shall not contain any harmful metal or metallic salts such as zinc, lead or copper which cause corrosive attack on heating.

5.4 Pipes shall be dry, clean and free from moisture, dirt and loose foreign materials of any kind.

5.5 Pipes shall be protected from rust & corrosion.

5.6 Rust preventive used on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.

5.7 Both ends of the pipe shall be protected with the following material:

Plain end	:	Plastic cap
Bevel end	:	Wood, Metal or plastic cover
Threaded end	:	Metal or plastic threaded cap

5.8 Pipes may be provided with plastic push-fit type end caps/ steel caps without belt wire.

5.9 Steel end protectors to be used on galvanized pipes shall be galvanized. Plastic caps can also be used as end protectors for galvanised pipe ends.

6.0 REFERENCES

6.1 6-81-0001: Specification for Positive Material Identification (PMI) at Supplier's Works.

6.2 6-81-0002: Inspection & test plan for welded pipes.

6.3 6-81-0003: Inspection & test plan for seamless pipes.

6.4 6-79-0013: Material requirements for carbon steel components used in sour service for petroleum refinery environments

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TECHNICAL NOTES FOR VALVES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	13.07.17	REVISED AND ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RN
6	04.08.10	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	ATD	SC	DM ND
5	04.07.08	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	SC	DM	VC
4	15.11.00	REVISED AND ISSUED AS STANDARD SPECIFICATION	RN	BRB	NS	MI
3	04.04.94	ISSUED IN LINE WITH GENERAL REVISION	AKG	NS	GRR	AS

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Abbreviations:

AARH	:	Arithmetic Average Roughness Height
ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing & Materials
BGO	:	Bevel Gear Operator
BHN	:	Brinnel Hardness Number
BIS	:	Bureau of Indian Standards
BS	:	British Standard
BVIS	:	Bureau Veritas Industrial Services
BW	:	Butt Weld
CAT	:	Category
CEIL	:	Certification Engineers International Limited
CS	:	Carbon Steel
DFT	:	Dry Film Thickness
DNV	:	Det Norske Veritas
DP	:	Dye-Penetrant
eDMS	:	Electronic Document Management System
IBR	:	Indian Boiler Regulations
IGC	:	Inter Granular Corrosion
IS	:	Indian Standard
LT	:	Low Temperature
LTCS	:	Low Temperature Carbon Steel
MOV	:	Motor Operated Valve
MP	:	Magnetic Particle
MR	:	Material Requisition
NDT	:	Non Destructive Testing
PMI	:	Positive Material Identification
PO	:	Purchase Order
PR	:	Purchase Requisition
RFQ	:	Request for Quotation
SCRD	:	Screwed
SS	:	Stainless Steel
SW	:	Socket Weld

Piping Standards Committee

Convenor : Mr M. Ismaeel

Members :
Mr. Amrendra Kumar
Mr. G. Balaji
Mr. Udayan Chakravarty
Mr. K.J. Harinarayanan (S&ME)
Mr. S. Ghoshal (Process-2)
Mr. G.K. Iyer (Projects)
Mr. Pankaj Kumar Rai (Construction)

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1.0 GENERAL

1.1 Vendor shall supply valves in accordance with the valve specification sheets along with auxiliaries, if any, such as gear operator, bypasses, drains, locking arrangements etc. wherever specified in the specification sheets, subject notes and other enclosures to the material requisition (MR).

1.2 Vendor shall quote in strict accordance with the valve data / specification sheets, subject technical notes and all other enclosures to the MR. For 'Cat-I valves', no deviations whatsoever shall be accepted. Post Order Waiver/ Deviation format 5-0000-0180-F1 as mentioned in Cl. 5.17 of specification for Quality Management System Requirements from Bidder (6-78-0001) is not applicable for Cat-I valves. For Cat-II Valves, if exceptions/ deviations become absolutely must, the same shall be requested as explained in clause 2.3.6 giving reasons for seeking such exceptions/ deviations.

1.3 All codes and standards for manufacture, testing, inspection etc. shall be of latest editions as on issue date of RFQ.

2.0 DOCUMENTATION

2.1 All document submissions to EIL shall be through EIL eDMS.

2.2 For 'Cat-I' valves, no documents shall be submitted with the offer.

2.3 For 'Cat-II' valves, vendor shall submit the following documents with the offer:

2.3.1 Manufacturer's complete descriptive and illustrative catalogue / literature.

2.3.2 Detailed dimensioned cross section drawing with parts / material lists, weight etc.

2.3.3 Drawings for valves with accessories like gear operator, hydraulic / pneumatic operator, motor, extension bonnet, extended stems with stands, bypass etc. giving major salient dimensions.

2.3.4 One copy of the valve specification sheets signed as "Accepted" by the manufacturer. Deviations, if any shall be marked as applicable on the valve specification sheet.

2.3.5 If the valve is regretted or has no deviation, the manufacturer shall write clearly on valve specification sheets as "Regret" or "No Deviation".

2.3.6 For 'CAT-II' valves, if there is any deviation, the same shall be listed clausewise.

2.3.7 On failure to submit documents as specified in clauses 2.1.1 to 2.1.6 above, the offer is likely to be rejected.

2.4 The following documents shall be submitted through eDMS of EIL after placement of the order:

2.4.1 For Cat-I valves to manufacturers' standard specified in MR/valve specification sheet, detailed dimensioned cross section drawing with parts, materials, weight, etc. shall be submitted for records/information.

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2.4.2 For 'Cat-II' valves, Vendor shall submit for review drawings mentioned in clauses 2.1.2 & 2.1.3 before start of manufacture. No other drawings shall be submitted for review.

2.4.3 Test report shall be supplied for all mandatory tests as per the applicable code. Test reports shall also be furnished for any supplementary tests as specified in clauses 3.13, 3.14 & 3.15.

2.4.4 Material test certificates (physical properties, chemical composition & heat treatment report) of the pressure containing parts shall be furnished for the valves supplied. Material test certificates for the other parts shall also be furnished for verification during inspection.

2.5 In addition to submissions through EIL eDMS, Catalogues/Drawings shall be in submitted in hard copies (6 sets) and soft copies (2 CDs/DVDs) along with delivery for Purchaser's record for all categories/types of valves.

3.0 DESIGN AND CONSTRUCTION

3.1 Valve shall be designed, manufactured, tested, inspected and marked as per the manufacturing standards, design codes and standards indicated in the respective valve specification sheets. Any conflict between the requisition, enclosures, specification sheets and referred standards/ codes shall be brought to the notice of the purchaser for clarifications and resolution, before proceeding with the manufacture. The purchaser's decision shall be final and binding to the vendor. The drawings submitted for review shall not include any deviations except as communicated in writing in Deviation permits. The Drawings shall be reviewed only for design and construction features.

3.2 All flanged valves shall have flanges integral (except forged valves) with the valve body. Flange face finish shall be normally specified in the valve specification sheet as 125 AARH etc. The interpretation for range of face finish shall be as follows:

Stock Finish	:	1000 µ in AARH max.
125 AARH	:	Serrations with 125 to 250 µ in AARH
63 AARH	:	32 to 63 µ in AARH

3.3 For all weld end valves with bevel end as per ASME B16.25, the contour of bevel shall be as follows:

Material	Wall Thickness	Weld Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Upto 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Upto 10 mm	Figure 4
	> 10 mm & Upto 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

Valve ends shall match thickness of the connecting pipe. Sloping of inside contour of valves shall be done wherever necessary to achieve this.

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3.4 For flanged valves with ring joint flanges the hardness shall be as follows:

Flange Material	Min. Hardness of Groove (BHN)
Carbon Steel	140
1% Cr to 5% Cr, 9% Cr	150
Type 304, 316, 321, 347	160
Type 304L, 316L	140

3.5 Following requirements for check valves shall be met over and above the valve specification sheet requirements:

3.5.1 Unless specified otherwise in the data sheet all check valves 3" & above (except in 900#, 1500# & 2500# rating) shall have a drain boss at location "G" (Refer Fig.No.1 of ASME B16.34) where pocket is formed in valve body. A tapped drain hole with plug shall be provided as per ASME B16.34. Threads shall be as per ASME B1.20.1 (Taper) NPT.

3.5.2 For heavy check valves, provisions shall be available for lifting by way of lugs, eye bolts and other such standard devices.

3.6 If an overlay weld-deposit is used for the body seat ring seating surface, the corrosion resistance of the seat ring base material shall be at least equal to the corrosion resistance of the material of the shell.

3.7 Following valve bypass requirements shall be met:

3.7.1 By-pass requirement for Gate valves shall be as follows unless otherwise mentioned.

ASME 150 Class	On sizes 26" and above
ASME 300 Class	On sizes 16" and above
ASME 600 Class	On sizes 6" and above
ASME 900 Class	On sizes 4" and above
ASME 1500 Class	On sizes 4" and above
ASME 2500 Class	On sizes 3" and above

3.7.2 The by-pass piping arrangement shall be such that clearance between main valve body and by-pass assembly shall be the minimum possible for layout reasons. Vendor shall follow the sketch enclosed in Specification No. 6-44-0052-A1.

3.7.3 By-pass valve shall be a globe valve. The sizes shall be as under:

On main valve ≤ 4"	:	1/2"
On main valve 6" to 8"	:	3/4"
On main valve 10" & above	:	1"

By-pass piping shall be of same metallurgy as main valve. The by-pass piping, fittings and valve tag numbers shall be as specified in Specification No. 6-44-0052-A2. In case details of by-pass arrangement for any Valve tag number is missing, Vendor shall bring the same to notice of EIL and provide by-pass as per details specified.

3.7.4 Vendor shall supply the by-pass valve duly tested and fitted to the main valve. Valves with by-pass shall have the direction of flow marked on the main valve. By-pass attachment to the

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main valve body shall not be screwed. All fillet welds for by-pass installation shall be 100% examined by DP/MP test and Butt-weld joints shall be 100% examined by radiography.

3.8 Valve body / bonnet shall be forged / cast as specified. Forgings are acceptable in place of casting but not vice-versa.

3.9 Stem shall be forged or machined from forged / rolled bar. No casting is permitted. However, integral stem of cast material is acceptable for Plug valves.

3.10 Stelliting / hardfacing by deposition, shall be minimum 1.6 mm.

3.11 Renewable seat rings shall be seal welded for valves of size 3" and above to prevent loosening in service.

3.12 For Low Temperature & Cryogenic valve requirements, refer Specification.No.6-44-0052-A3 unless otherwise specified.

3.13 For Hydrogen service valve requirements, refer Specification.No.6-44-0052-A4 unless otherwise specified.

3.14 Valves under 'NACE' category shall meet the requirements specified in MR-0103 unless otherwise specified.

3.15 For all austenitic stainless steel valves Inter Granular Corrosion (IGC) test shall be conducted as per the following:

3.15.1 ASTM A262 Practice 'B' with acceptance criteria of '60 mils/year (max.)' for all materials - forged, rolled, wrought and casting.

Or

ASTM A262 Practice 'E' with acceptance criteria of 'No cracks as observed from 20X magnification' for all materials other than castings. 'Microscopic structure to be observed from 250X magnification' in addition.

3.15.2 When specifically asked for in MR for high temperature application of some grades of austenitic stainless steel (eg. SS309, 310, 316, 316H etc.) ASTM A262 Practice 'C' with acceptance criteria of '15 mils/year (max.)' shall be conducted.

3.15.3 For the IGC test as described in Clauses 3.15.1 & 3.15.2, two sets of samples shall be drawn from each solution annealing lot. One set shall correspond to the highest Carbon content and the other to the highest pressure rating. When testing is conducted as per practice 'E', photograph of the microscopic structure shall be submitted for record.

3.16 All types of 321 or 347 stainless steel valves shall be in a stabilised heat treated condition. Stabilising heat treatment shall be carried out subsequent to the normal solution annealing. Soaking temperature and holding time for stabilising heat treatment shall be 900°C and 4 hours respectively.

3.17 Spiral wound bonnet gaskets are to be provided with inner/outer ring except when encapsulated gaskets type body-bonnet joints are employed. Outer ring may be avoided in case of non-circular spiral wound gasket used in 150# valve provided the outermost layer of spiral touches the bolts ascertaining the centering.

3.18 All Stainless Steel Castings shall be solution heat treated.

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3.19 Only normalized and tempered material shall be used in the following specifications :

Castings : A217 Gr.WC1, A217 Gr.WC4, A217 Gr.WC5, A217 Gr.WC6, A217 Gr.WC9, A217 Gr.C5, A217 Gr.C12

Forgings : A182 Gr.F11 Cl.2, A182 Gr.F12 Cl.2

3.20 Ball / Plug / Butterfly Valves

3.20.1 As a prequalification, fire safe test as per API 607 / API 6FA / BS EN ISO 10497 (Supersedes BS 6755 Part II) shall be carried out on soft seated ball, plug & butterfly valves and also on lubricated plug valves The test shall be witnessed and certified by a third party inspection agency like Lloyds, BVIS, DNV or EIL/ CEIL unless otherwise specified. The vendor has to submit test certificate for the particular design of the valve offered, if fire safe design is required as per the Valve Material Specification sheet..

3.20.2 Each valve shall be supplied with a lever / wrench except for gear operated / motor operated valves.

3.20.3 Soft-seated ball, plug & butterfly valves shall be supplied with antistatic devices.

3.20.4 BW / SW end ball valves shall have a 100 mm long seamless pipe nipple welded to each end of the valve. Nipples are to be welded prior to assembling Teflon seats / seals. Specifications of the nipples shall be as indicated in the MR.

3.20.5 The face-to-face dimensions of all ball valves shall be same as those of gate valves of the corresponding ANSI class (except 10" onwards in Class 150 where the face-to-face dimensions shall be as per API 6D long pattern).

3.20.6 The ball of ball valve shall not protrude outside the end flanges of valve.

3.20.7 Ball valves shall be of floating ball/trunnion mounted type as per following:

150#	8" & below	Floating ball
	10" & above	Trunnion mounted
300#	4" & below	Floating ball
	6" & above	Trunnion mounted
600# & above	1.5" & below	Floating ball
	2" & above	Trunnion mounted

3.20.8 Unless otherwise specified in the data sheets, bore of all reduced bore ball valves shall be limited to one size lower than the nominal bore.

3.21 The MOVs are to be installed in an open area and the actuators shall be suitable for all weather conditions. The testing of complete assemblies of MOVs along with the actuators shall be done by the supplier at his works.

3.22 Ends of flanged valves of 22" size shall match corresponding flanges to MSS-SP44 unless otherwise specified.

3.23 Yoke material shall be same as bonnet material where maximum temperature specified is more than 427°C.

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4.0 OPERATION

4.1 Gear operation shall be provided as under:

Valve Type	Class	Size Requiring Gear-Operator
Gate Valve, Globe Valve & Diaphragm Valve	150 Class	12" and larger
	300 Class	12" and larger
	600 Class	10" and larger
	900 Class	6" and larger
	1500 Class	3" and larger
	2500 Class	3" and larger
Ball Valve / Plug Valve (Other than pressure balance plug valves)	150 Class	6" and larger
	300 Class	6" and larger
	600 Class	4" and larger
	900 Class	3" and larger
	1500 Class	3" and larger
Butterfly Valve	150, 300 Class	6" and larger

For sizes lower than these ranges, hand wheel / lever / wrench shall be provided. For pressure balance plug valves manufacturer's recommendation shall be acceptable provided the requirements specified in clause 4.6 are met.

4.2 Gear operator shall be provided, with position indicators for open / close positions and with limit stops. (Limit stops are not applicable for gate and globe valves).

4.3 Where gear operator is not called for as per Clause 4.1 but vendor recommends a gear operator, the same shall be highlighted.

4.4 Gear operator shall be so designed as to operate effectively with the differential pressure across the closed valve equal to the cold non-shock pressure rating.

4.5 Ball, plug and butterfly valves, shall have "Open" position indicators with limit stops.

4.6 Hand wheel diameter shall not exceed 750mm and lever length shall not exceed 500mm on either side. Effort to operate shall not exceed 35 Kg at handwheel periphery. However, failing to meet the above requirements, vendor shall offer gear operated valve and quote as per clause 4.3.

5.0 INSPECTION AND TESTING

5.1 Every valve shall be subjected to all the mandatory tests and checks called in the respective codes / data sheet by EIL inspection or any third party as approved by the purchaser. For IBR valves refer clause 7.0.

5.2 Every valve, its components and auxiliaries must be subjected to all the mandatory tests and checks called for in the respective codes, data sheets etc. by the manufacturer.

5.3 Though the extent of inspection shall be as under, exact extent with hold points shall be decided by EIL regional inspection office and recorded in the form of inspection plan. In case of third party inspection, the inspection plan shall be approved by the purchaser.

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Forged Valves:

1. Visual and dimensional inspection.
2. Review of material test certificates.
3. Any mandatory or supplementary test.
4. Hydrostatic test on 10% valves selected on random basis.
5. Strip check is required for 1% of total ordered quantity of Gate & Globe valves (min. 1 No.) for each Valve sheet no., however, strip check is not required for CS/ Brass/ Bronze material valves with 13% Cr/ Brass/ Bronze trims.

Cast Steel Valves:

1. Visual and dimensional inspection.
2. Review of material test certificates.
3. Review of radiographs/radiographic reports or any other NDT tests wherever applicable as per data sheet.
4. Any mandatory or supplementary test.
5. Hydrostatic test 100% for body, 10% other test.
6. Strip check is required for 1% of total ordered quantity of Gate & Globe valves (min. 1 No.) for each Valve sheet no., however, strip check is not required for CS/ Brass/ Bronze material valves with 13% Cr/ Brass/ Bronze trims.

   Samples for strip check shall be selected at random and shall generally be in the highest size in the lot.

5.4 In case of motor operated or actuator operated valves, functional / operational checks as per the requirements of the specifications shall be made on each valve.

6.0 RADIOGRAPHY OF CAST VALVES

6.1 Valve castings shall undergo radiographic examination as specified below.

Material	Rating	Size Range	Radiography
All	150#	24" and below	NIL**
		26" and above*	100%
	300#	16" and below	NIL**
		18" and above	100%
	600# & above	All sizes	100%

* No radiography is required for valves of size 26" and above in cooling water service.

**For sizes 24" & below in 150# and 16" & below in 300#, radiography percentage if specifically mentioned in individual valve material spec sheet shall govern.

Radiography specified as random 10% or 20% etc. in the respective valve data sheet implies 10% or 20% etc. of number of valves ordered against each item number with a minimum of one valve against each item.

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6.2 Radiography procedure, areas of casting to be radiographed shall be as per ASME B16.34 and acceptance criteria shall be as per ASME B16.34 Annexure-B. However for areas of casting to be radiographed for types of valves not covered in ASME B16.34, vendor shall radiograph castings in line with ASME B16.34.

6.3 For random radiography wherever specified in individual data sheets, the sampling shall be per size of the quantity ordered for each foundry.

6.4 Radiography wherever specified in the data sheets or as per clause 6.1 shall be done by X-ray / γ-ray to get the required sensitivity.

7.0 IBR CERTIFICATION

7.1 For valves described "IBR", valves shall be in accordance with the latest IBR (Indian Boiler Regulation) including the requirements specified in the specification.

7.2 For SW / BW end carbon steel valves under IBR, the chemical composition shall conform to the following:

Carbon (Max)	:	0.25%
Others (S, P, Mn)	:	As per IBR

7.3 Valves coming under the purview of "IBR"(Indian Boiler Regulations) shall each be individually accompanied by IBR certificate original in Form III-C duly approved by IBR authority / local authority empowered by the Central Boiler Board of India. Photocopy of original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance.

7.4 All "IBR" valves shall be painted red in body-bonnet / body-cover joint.

8.0 MARKING

8.1 Valve markings, symbols, abbreviations etc. shall be in accordance with MSS-SP-25 or the standard referred in specification sheet as applicable. Vendor's name, valve rating, material designation, nominal size, direction of flow (if any) etc. shall be integral on the body.

8.2 Each valve shall have a corrosion resistant tag giving size, valve tag / code no., securely attached to the valve body.

8.3 Paint or ink for marking shall not contain any harmful metal or metal salts such as zinc, lead or copper which cause corrosive attack on heating.

8.4 Carbon Steel / Alloy Steel valves shall be painted with one coat of inorganic zinc silicate (minimum DFT 65 to 75 microns).

9.0 DESPATCH

9.1 Valve shall be dry, clean and free from moisture, dirt and loose foreign materials of any kind.

9.2 Valves shall be protected from rust, corrosion and any mechanical damage during transportation, shipment and storage.

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9.3 Rust preventive on machined surfaces to be welded shall be easily removable with a petroleum solvent or shall not be harmful to welding.

9.4 Each end of valve shall be protected with the following materials:

Flange Face	:	Wood or Plastic Cover
Bevelled End	:	Wood or Plastic Cover
SW & SCRD. End	:	Plastic Cap

9.5 End protectors of wood / plastic to be used on flange faces shall be attached by at least three bolts and shall not be smaller than the outside diameter of the flange. However, plastic caps for SW & SCRD end valves shall be press fit type.

9.6 End protectors to be used on bevelled end shall be securely and tightly attached.

9.7 For special service valves additional requirement for despatch shall be as prescribed in data sheet.

10.0 ATTACHMENTS

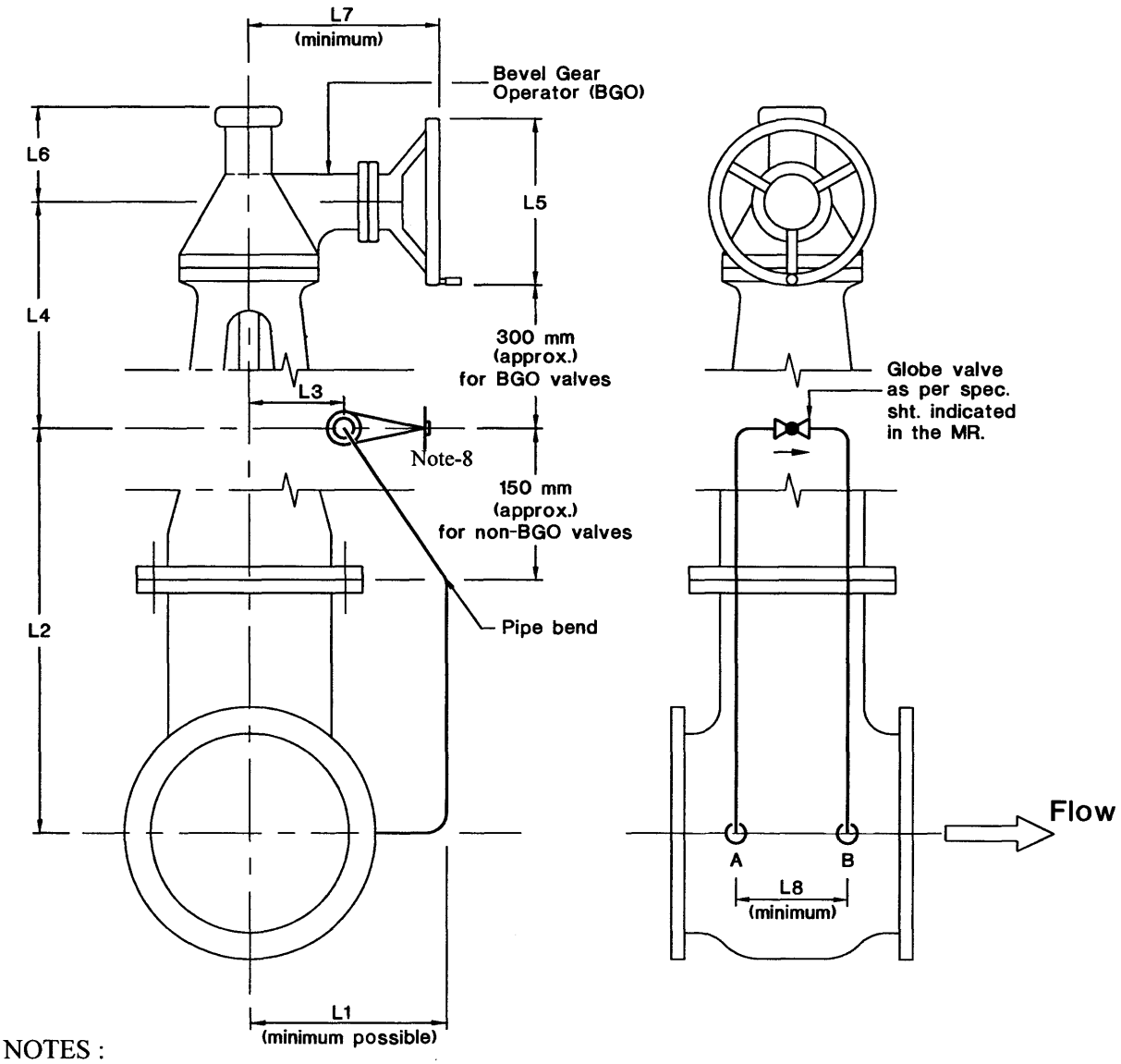
6-44-0052-A1	:	Bypass Piping Arrangement
6-44-0052-A2	:	Specifications for Bypass Piping, Fittings and Valves
6-44-0052-A3	:	Special Requirements for Low Temperature and Cryogenic Valves
6-44-0052-A4	:	Special Requirements for Hydrogen Service Valves

11.0 REFERENCES

6-78-0001	:	Specification for Quality management system requirements from bidders
6-78-0003	:	Specification for documentation requirements from suppliers
6-81-0001	:	Specification for Positive Material Identification (PMI) at Supplier's Works
6-81-0004	:	Inspection and Test plan for Valves

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BYPASS PIPING ARRANGEMENT



NOTES :

1. The orientation & location of handwheel of bevel gear operator & the bypass arrangement shall be strictly as per this sketch.

2. The bypass connection ends shall be socket welded upto 600# and butt welded for 900# and above rating.

3. The bypass arrangement shall be properly clamped to & supported by the body of the main valve.

4. Basic design of bypass shall be to MSS-SP-45.

5. Material of bypass pipe & 90° elbows shall be same or equivalent to the body material as indicated in Specification No. 6-44-0052-A2.

6. This sketch is applicable for both BGO & NON-BGO Valves.

7. Vendor shall furnish dimensions L1 to L8.

8. Stem shall not be horizontal in the case of CRYO Valves

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SPECIFICATIONS FOR BYPASS PIPING, FITTINGS AND VALVES

Class (Main Valve Sht.no.)	Pipe	Fittings	Bypass Valve Sht.no.
A1A(51301), A3A(51321), A9A(51301), A10A(51301), A11A(51301), A33A(51301), B1A(51401), B9A(51401), D1A(51501), D9A (51501)	ASTM A106 Gr.B (SMLS) 0.5"-0.75": S160 1.0"-1.5" : XS	ASTM A105 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52001
A6A(51301), B6A(51401)	ASTM A106 Gr.B (SMLS) 0.5"-0.5" : XXS 0.75"-1.5": S160	ASTM A105 0.5"-0.5" : SW 9000# 0.75"-1.5": SW 6000#	52001
A13A(51301), B13A(51401)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : XXS	ASTM A105 0.5"-1.5" : SW 9000#	52001
A2A(51302), B2A(51402), D2A (51502)	ASTM A106 Gr.B (SMLS)- IBR 0.5"-0.75": S160 1.0"-1.5" : XS	ASTM A105 - IBR 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52002
A4A (51303), B4A (51403), D4A (51503)	ASTM A333 Gr.6 (SMLS)- LT 0.5"-0.75": S160 1.0"-1.5" : XS	ASTM A350Gr.LF2-LT 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52003
A5A (51304), B5A (51404), D5A (51504)	ASTM A106 Gr.B (SMLS) -H2 0.5"-0.75": S160 1.0"-1.5": XS	ASTM A105 - H2 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52004
A7A (51307)	ASTM A106 Gr.B (SMLS) 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A105 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52007
A16A (51311), B16A (51411), D16A (51511)	ASTM A106 Gr.B (SMLS) - NACE 0.5"-0.5" : XXS 0.75"-1.5": S160	ASTM A105 - NACE 0.5"-0.5" : SW 9000# 0.75"-1.5": SW 6000#	52011
A19A (51313), B19A (51413), D19A (51513)	ASTM A106 Gr.B (SMLS) 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A105 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52013
E1A (51601), F1A (51701)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : S160	ASTM A234 Gr.WPB/ ASTM A105 0.5"-1.5" : BW, S160	52101
E2A (51602), F2A (51702)	ASTM A106 Gr.B (SMLS) - IBR 0.5"-1.5" : S160	ASTM A234 Gr.WPB/ ASTM A105 - IBR 0.5"-1.5" : BW, S160	52102
E5A (51604), F5A (51704)	ASTM A106 Gr.B (SMLS) - H2 0.5"-1.5" : S160	ASTM A234 Gr.WPB/ ASTM A105 - H2 0.5"-1.5" : BW, S160	52104
E9A (51605), F9A (51705)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : SCH XXS	ASTM A234 Gr.WPB/ ASTM A105 0.5"-1.5" : BW, SCH XXS	52105
E19A (51613), F19A (51713)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : SCH XXS	ASTM A234 Gr.WPB/ ASTM A105 0.5"-1.5" : BW, SCH XXS	52113

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Class (Main Valve Sht.no.)	Pipe	Fittings	Bypass Valve Sht.no.
A5Y (51384), A33Y (51384)	ASTM A106 Gr.B (SMLS) 0.5"-1.5" : S160	ASTM A105 0.5"-1.5" : SW 6000#	52085
A1D (51330), B1D (51430), D1D (51530)	ASTM A335Gr.P11(SMLS) 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A182 Gr.F11Cl.2 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52030
D2D (51531)	ASTM A335Gr.P11 (SMLS) - IBR 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A182 Gr.F11Cl.2 - IBR 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52031
B5D (51432), D5D (51532)	ASTM 335Gr.P11(SMLS)- H2 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A182 Gr.F11Cl.2 - H2 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52032
B1E (51433)	ASTM A335Gr.P22(SMLS) 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A182 Gr.F22Cl.3 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52033
D5E (51534)	ASTM A335Gr.P22(SMLS) - H2 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A182 Gr.F22Cl.3 - H2 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52034
A4F (51336), B4F (51436)	ASTM A335 Gr.P5(SMLS) 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A182 Gr.F5 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52036
B3F (51436)	ASTM A335 Gr.P5(SMLS) 0.5"-1.5" : XXS	ASTM A182 Gr.F5 0.5"-1.5" : SW 9000#	52036
A4G (51339), B4G (51439)	ASTM A335 Gr.P9(SMLS) 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A182 Gr.F9 0.5"-0.75": SW 6000# 1.0"-1.5" : SW 3000#	52039
F2D (51731)	ASTM A335 Gr.P11 (SMLS) - IBR 0.5"-1.5" : S160	ASTM A234Gr.WP11Cl.1/ A182 Gr.F11Cl.2 - IBR 0.5"-1.5" : BW, S160	52131
E5E (51634)	ASTM A335 Gr.P22(SMLS) - H2 0.5"-0.75" : S160 1.0"-1.5": XS	ASTM A234Gr.WP22Cl.1/ A182 Gr.F22Cl.3 - H2 0.5"-0.75" : BW, S160 1.0"-1.5" : BW, XS	52134
A1K (51345), A3K (51345), B1K (51445), D1K (51545)	ASTM A312 TP304(SMLS) 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F304 0.5"-1.5" : SW 3000#	52045
A2K (51346), B2K (51446), D2K (51546)	ASTM A312 TP304(SMLS) - CRYO 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F304 - CRYO 0.5"-1.5" : SW 3000#	52046
B4K (51448), B5K (51448)	ASTM A312 TP304H (SMLS) 0.5"-1.5" : 80S	ASTM A182 Gr.F304H 0.5"-1.5": SW 3000#	52048

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Class (Main Valve Sht.no.)	Pipe	Fittings	Bypass Valve Sht.no.
A6K (51350), B6K (51450)	ASTM A312 TP304L (SMLS) 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F304L 0.5"-1.5": SW 3000#	52050
A1M (51361), B1M (51461)	ASTM A312 TP316(SMLS) 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F316 0.5"-1.5": SW 3000#	52061
B5M (51462)	ASTM A312 TP316H (SMLS) - H2 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F316H - H2 0.5"-1.5": SW 3000#	52062
B3M (51463)	ASTM A312 TP321(SMLS) 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F321 0.5"-1.5": SW 3000#	52063
A1N (51366), B1N (51466)	ASTM A312 TP 316L (SMLS) 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F316L 0.5"-1.5": SW 3000#	52066
B6N (51471)	ASTM A312 TP316L (SMLS) 0.5"-0.75" : 80S 1.0"-1.5": 40S	ASTM A182 Gr.F316L 0.5"0.5"-1.5": SW 3000#	52071

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SPECIAL REQUIREMENTS FOR LOW TEMPERATURE & CRYOGENIC VALVES

1.0 SCOPE

All valves of Low Temperature Carbon Steel (LTCS) and all grades of austenitic SS (CRYO) material are categorized as cryogenic valves. All these valves shall have extended bonnet as per BS 6364 except check valves.

Following qualification criteria shall be met by the valve vendors to quote valves for cryogenic services:

2.0 QUALIFICATION CRITERIA

i) Both cryogenic test (clause 2.1) and reference list (clause 2.2) together shall be considered for vendor qualification and vendor shall furnish the same, along with his offer.

ii) Vendors who do not have cryogenic test reports and reference list covering valves of all sizes, materials and ratings required by MR, should confirm / furnish the following for consideration of their offer:

a. Evidence of having conducted successfully at least one cryogenic test as per BS 6364. Test certificate shall be furnished with the offer.

b. Vendor shall confirm to conduct cryogenic test per clauses 2.1 & 2.3 for the remaining valves not later than 12 weeks from the date of purchase order.

c. Vendor shall also furnish reference list for valves supplied for non-cryo service if reference list referred in 2.2.1 does not cover all the sizes of MR.

Offers of vendors who do not comply with above requirements would be rejected.

2.1 Cryogenic Test

Vendors to furnish copies of cryogenic test certificate for tests conducted as per details given below:

2.1.1 Test shall be as per BS 6364.

2.1.2 Test temperature, unless specifically called for otherwise in the individual MR, shall be -45°C for LTCS and -196°C for all grades of austenitic stainless steel.

2.1.3. Tests carried out on a particular size of one type of valve, pressure rating and material shall qualify all sizes equal to and below the test valve size for the same type, pressure rating and material. In case of austenitic SS any one grade would qualify for all other grades of austenitic SS.

2.1.4. Tests should have been witnessed and certified by any one of the following third party inspection agencies; M/s Lloyd, BV, DNV, TUV or EIL/ CEIL.

2.1.5. Cryogenic test need not be conducted for every order. Test conducted previously and witnessed by inspection agencies listed above shall be considered acceptable and need not be repeated.

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2.2 Reference List

Vendor shall furnish reference list for valves supplied for cryogenic service indicating the name of client, year of supply, size, material, pressure rating, type of valve and quantity.

2.3 Post Order Testing Procedure

2.3.1. Before conducting post order testing, vendor shall submit the following for approval:

a. Test procedure (as per BS 6364).
b. Cross-section drawing of the valve with material of construction.
c. Schematic of test rig (as per BS 6364) with complete details.

2.3.2. Test has to be conducted irrespective of the service on largest size for each type of valve and for each material and class rating. Vendor shall offer one, two or three valves for selection of test valve by inspector depending upon whether quantity of largest valve in the order is one, two or three and more than three respectively.

In the event of failure of the test valve to meet the specification requirements, the vendor shall conduct test on two more valves. These two valves which pass test successfully, are of lower size, then the qualification will be valid only to sizes upto which test has been conducted successfully.

2.3.3. In case of non-conductance of cryogenic test(s) within 12 weeks or failure in the test(s) conducted after receipt of order, the owner reserves the right to invoke any of the provisions of the purchase order including cancellation of the purchase order at the risk and cost of vendor.

3.0 Bonnet extension, wherever specified in the valve sheet to BS 6364 shall be for "non cold box application" unless otherwise specified in the MR. Even if not called for in valve sheet, valves indicated as "LT" or "CRYO" shall be supplied with bonnet extension.

4.0 Bonnet and Gland extension joints shall be of butt welded/integrally cast construction.

5.0 Repair welding procedure for austenitic stainless steel valves in "CRYO" service shall have to be qualified for impact test as per ASME B31.3. Minimum acceptable impact energy shall be 20 J or lateral expansion of 0.38 mm at temperature of -196°C.

6.0 Wherever impact test of SS studs / nuts is called for in the data sheet, the impact value shall be 27 J at the intended service temperature specified in the data sheets.

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SPECIAL REQUIREMENTS FOR HYDROGEN SERVICE

1.0 GENERAL

1.1 These requirements are applicable for valves used in Hydrogen service. These are in addition to the requirements described in "Technical Notes for Valves" Spec. No. 6-44-0052, and shall be read in conjunction with this specification.

1.2 All cast valve flanges & bodies with flange rating of Class 900 or greater shall be examined in accordance with paragraphs 7.2 through 7.5 of Appendix-VII of ASME SEC-VIII, DIV.1, regardless of casting quality factor.

1.3 Body / bonnet / cover joints & stuffing box of all valves shall have low emission. One valve per metallurgy, per rating, per size shall be helium leak tested as per ASME Sec.V, Subsection A, Article 10 (Detector Probe Technique), Appendix IV at a minimum of 25% of the allowable (rated) cold working pressure. Selection of valves for helium leak test shall be at random. Test duration shall be as follows:

Test Duration in Minutes					
Nominal Size	Pressure Class				
	Upto 300	600	800 & 900	1500	2500
Upto 2"	3	6	9	12	12
3" to 6"	6	9	12	15	18
8" to 16"	9	9	12	15	18
18" to 24"	9	12	15	18	21

The valve shall show no leakage. No leakage is defined as a total leakage rate of less than 0.0001 ml/s of helium.

2.0 Only normalized and tempered material shall be used in the following specifications:

Castings : A217 Gr.WC1, A217 Gr.WC4, A217 Gr.WC5, A217 Gr.WC6, A217 Gr.WC9, A217 Gr.C5, A217 Gr.C12

Forgings : A182 Gr.F11 Cl.2

3.0 CS & AS VALVES

3.1 Bend test and Magnetic Particle inspection of the entire surface of body and bonnet casting shall be in accordance with ASTM A217. Supplementary requirement S3 & S4 evaluation of magnetic particle, inspection shall be in accordance with MSS-SP-53 except that no linear discontinuities shall be allowed.

3.2 The Brinell hardness of heat treated casting shall not exceed 200 BHN for carbon steel & 225 for alloy steel.

3.3 Repair to defective casting shall be outlined in writing to the purchaser before repair starts. Repair method to be approved prior to welding.

3.4 Casting shall be preheated to a minimum of 400°F prior to welding and all Chromium-Molybdenum alloys shall be postweld heat treated after welding is complete. Stress relieving is essential for welds.

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3.5 Carbon steel shall be normalised and alloy steels shall be normalised & tempered.

3.6 Dye Penetrant test of welds shall be in accordance with ASTM B165 Procedure B-2. Interpretation as per Appendix-8 of ASME-VIII Div.1.

3.7 The tensile stress for AS shall be less than 100,000 psi.

3.8 Charpy V-notch impact testing is to be done for valve material (average 20 ft-lb for set of 3 [minimum value 15 ft-lb] at 30°F).

3.9 For radiography and acceptance criteria for valve castings, refer Cl. 4.2.

4.0 SS VALVES

4.1 Valve casting shall be in solution heat treated and pickled condition.

4.2 Critical body and bonnet casing section typically defined by ASME B16.34 shall be radiographed and shall meet ASTM E446 (upto 2" thick) Category A, B & CA Level 2, Category CB, OC & CD Level 3, Category D, B & F Level 0. For wall thickness 2" to 4.5" comparable plates of ASTM E186 shall be used. ASTM E94 and ASTM E142 shall be used for recommended practice & controlling quality of radiography as guide. The entire surface of all castings shall be dye-penetrant inspected after pickling.

4.3 Welds shall be 100% radiographed and evaluated in accordance with paragraph 344.5 of ASME B31.3 with a minimum casting quality factor of 0.95. Dye Penetration test shall be as per ASTM E165 Procedure B-2, Interpretation as per Appendix-8 of ASME-VIII Div.1.

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TECHNICAL NOTES FOR GASKETS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	30.03.18	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RN
4	21.03.13	REVISED & ISSUED AS STANDARD SPECIFICATION	UK	SH	RN	ATD DM
3	23.07.07	REVISED & ISSUED AS STANDARD SPECIFICATION	RN	ATD	DM	VC
2	15.06.98	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	SH	BRB	BN	AS
1	30.12.92	REVISED & ISSUED AS STANDARD SPECIFICATION	AKG	BPV	GRR	AS

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Abbreviations:

AARH	:	Average Arithmetic Root Height
BHN	:	Brinnel Hardness Number
CS	:	Carbon Steel
MR	:	Material Requisition
PMI	:	Positive Material Identification
RTJ	:	Ring Type Joint

Piping Standards Committee

Convenor : Mr. M. Ismaeel

Members :
Mr. Amrendra Kumar
Mr. G. Balaji
Mr. Udayan Chakravarty
Mr. K.J. Harinarayanan (S&ME)
Mr. Mr. S. Ghosal (Process-2)
Mr. G.K. Iyer (Projects)
Mr. Pankaj Kr. Rai (Construction)

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1.0 GENERAL

1.1 All gaskets shall conform to the codes/standards and specifications given in the requisition. Supplier shall strictly comply with MR/PR stipulations and no deviations shall be permitted.

1.2 Process of manufacture, dimensions and tolerances not specified in requisition shall be in accordance with the requirements of the manufacturer's standards.

1.3 Testing

1.3.1 Test reports shall be supplied for all mandatory tests for gaskets as per the standards specified in the requisition.

1.3.2 Chemical composition and hardness of RTJ gaskets shall also be furnished in the form of test reports on samples.

1.3.3 For Spiral wound material following shall be furnished:

a. Manufacturer's test certificate for filler material and spiral material as per the relevant material specifications.

b. Manufacturer's test certificate for raw materials and tests for compressibility/ seal-ability & recovery as per the relevant material specifications.

1.3.4 PMI shall be performed as per the scope and procedures defined in the Specification for PMI at Supplier's Works (6-81-0001) for ring type joint gaskets.

1.3.5 Refer Specification no 6-81-0008 for 'Inspection & Test Plan for Gaskets'.

1.4 Full face gaskets shall have bolt holes punched out.

1.5 Filler material for spiral wound gaskets shall not have any colour or dye.

1.6 All spiral wound gaskets shall be supplied with Outer ring. Material of the outer ring shall be CS unless otherwise specified in the MR.

1.7 For spiral wound gaskets, material of Inner Compression ring shall be same as Spiral Strip material. Inner rings shall be provided for all Spiral Wound Gaskets.

1.8 Hardness of metallic RTJ gaskets shall not exceed the values specified below unless otherwise specified in MR:

Ring Gasket Material	**Maximum Hardness (BHN)**
Soft Iron	90
Carbon steel	120
5 Cr. ½ Mo	130
Type 304, 316, 321, 347	140
Type 304L, 316L	120

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Inconel UNS N06625	200
Incoloy UNS N08825	190
Duplex SS UNS N032205, N031803	230

1.9 Face finish of metallic RTJ gaskets shall be 32 to 63 AARH.

1.10 Gaskets of different types and sizes shall be placed in separate shipping containers and each container clearly marked with the size, rating, material specification and item code.

1.11 All items shall be inspected and approved by EIL Inspector or any other agency authorized by EIL.

1.12 Any additional requirements specified in the requisition, shall be fully complied with.

1.13 Non-metallic ring gaskets as per ASME B16.21 shall match flanges to ASME B16.5 upto 24" and to ASME B16.47B above 24" unless specified otherwise.

1.14 Spiral wound gasket as per ASME B16.20 shall match flanges to ASME B16.5 upto 24" and to ASME B16.47B above 24" unless specifically mentioned otherwise.

1.15 The following abbreviations have been used in the Material Requisition for Spiral Wound Gaskets :

(I)	:	Inner Ring
(O)	:	Outer Ring
GRAFIL	:	Grafoil Filler

1.16 Specialties mentioned in item description like "IBR", "LT", "HIC1", "H2", etc. shall be ignored.

2.0 REFERENCES

6-81-0001	Specification for Positive Material Identification (PMI) at Supplier's Works
6-81-0008	Inspection & Test Plan for Gaskets
6-78-0001	Specification for Quality Management System Requirements from Bidders

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बोल्ट्स एवम नट्स के लिए तकनीकी टिप्पणियाँ

TECHNICAL NOTES FOR BOLTS AND NUTS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	30.03.18	REVISED & ISSUED AS STANDARD SPECIFICATION	PK	SH	MI	RN
4	21.03.13	REVISED & ISSUED AS STANDARD SPECIFICATION	UK	SH	RN	ATD DM
3	23.07.07	REVISED & ISSUED AS STANDARD SPECIFICATION	RN	ATD	DM	VC
2	15.06.98	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	SH	BRB	BN	AS
1	30.12.92	REVISED & ISSUED AS STANDARD SPECIFICATION	AKG	BPV	GRR	AS

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Abbreviations:

ASME	:	The American Society of Mechanical Engineers
ASTM	:	The American Society for Testing and Materials
MR	:	Material Requisition
PMI	:	Positive Material Identification
SS	:	Stainless Steel

Piping Standards Committee

Convenor : Mr. M. Ismaeel

Members :
Mr. Amrendra Kumar
Mr. G. Balaji
Mr. Udayan Chakravarty
Mr. K.J. Harinarayanan (S&ME)
Mr. Mr. S. Ghosal (Process-2)
Mr. G.K. Iyer (Projects)
Mr. Pankaj Kr. Rai (Construction)

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1.0 GENERAL

1.1 The process of manufacture, heat treatment, chemical & mechanical requirements and marking for all stud bolts, m/c bolts, jack screws & nuts shall be in accordance with the codes/standards and specifications given in the requisition. The applicable identification symbol in accordance with the material specification shall be stamped on each bolt and nut. Supplier shall strictly comply with MR/PR stipulations and no deviations shall be permitted.

1.2 Testing

1.2.1 Test reports shall be supplied for all mandatory tests as per the relevant material specifications.

1.2.2 Material test certificate shall also be furnished. (Heat Analysis, Product Analysis and Mechanical Requirement)

1.2.3 PMI shall be performed as per the scope and procedures defined in the Specification for PMI at Supplier's Works (6-81-0001).

1.2.4 Stress Rupture Test as detailed in ASTM A453 shall be carried out for all ASTM A453 bolting material irrespective of the temperature.

1.2.5 Refer Specification no 6-81-0007 for 'Inspection & Test Plan for Bolting Material'.

1.3 All bolting shall be as per ASME B 18.2.1 for studs, M/c bolts and jackscrews and ASME B18.2.2 for nuts.

1.4 Threads shall be unified (UNC for up to 1" dia and 8UN for > 1" dia) as per ASME B1.1 with class 2A fit for studs, M/c bolts and jackscrews and class 2B fit for nuts.

1.5 Stud bolts shall be threaded full length with two heavy hexagonal nuts unless otherwise specified. Length tolerance shall be in accordance with the requirement of Table D2 of Annexure-D of ASME B 16.5.

1.6 The nuts shall be double chamfered, semi-finished, heavy hexagonal type and shall be made by the hot forged process and stamped as per respective material specification.

1.7 Heads of jackscrews and m/c bolts shall be heavy hexagonal type. Jackscrew end shall be rounded.

1.8 Each size of studs & m/c bolts with nuts and jackscrews shall be supplied in separate containers marked with size and material specifications. 'CRYO' shall be marked additionally in case 'CRYO' is specified in the requisition.

1.9 All items shall be inspected and approved (stage-wise) by EIL inspector or any other agency authorized by EIL.

1.10 The heat treatment for stud bolts & nuts shall be as per code unless mentioned otherwise.

1.11 All austenitic stainless steel bolts, nuts, screws shall be supplied in solution annealed condition unless specified otherwise in the material specification.

1.12 Any additional requirements specified in the requisition shall be fully complied with.

1.13 Stud bolts, nuts & jackscrews shall be impact tested wherever specified in the material specification and also where the material specification is indicated as "CRYO". For S.S.

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nuts and bolts minimum impact energy absorption shall be 27 Joules and test temperature shall be -196°C unless mentioned otherwise. For other materials impact energy and test shall be as per respective code.

1.14 Bolts/nuts of material of construction B7M/2HM shall be 100% Hardness tested as per supplementary requirement S3 of ASTM A193.

1.15 When specified as galvanized, the studs, M/C bolts and nuts shall be 'hot dip zinc coated' in accordance with requirements of 'class C' of 'ASTM A 153'. As an alternative, electro-galvanizing as per IS 1573, 'Service Grade Number 2' is also acceptable.

1.16 All Stud Bolts of Bolt diameter size 1" and above shall be provided with three nuts irrespective of whatever has been specified elsewhere in the MR.

1.17 Bolting shall be protected by non-corrosive oil or grease before dispatch to prevent rusting.

1.18 For stud bolt diameters not covered in ASTM A320, mechanical properties shall match the values specified for the matching grades and stud bolt diameters in ASTM A193.

1.19 In cases where the lengths of Stud/Machine bolts specified in the MR are not multiples of 0.25", the length supplied shall be equal to the specified length rounded up to the next higher 0.25".

1.20 All Specialties mentioned in item description like "IBR", "LT", "H2", etc. other than **"CRYO" & "NACE"** shall be ignored.

2.0 ACCEPTABLE DEVIATIONS

2.1 'Nuts' to ASTM A194Gr.7 are acceptable in place of ASTM A194Gr.4.

2.2 Stud Bolts to ASTM A453 Gr.660 Cl.B are acceptable in lieu of ASTM A453 Gr.660 Cl.A and vice versa.

3.0 REFERENCES

6-81-0001	Specification for Positive Material Identification (PMI) at Supplier's Works
6-81-0007	Inspection & Test Plan for Bolting Material
6-78-0001	Specification for Quality Management System Requirements from Bidders

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तटीय पाइपलाइन हेतु बॉल वॉल्व्ज के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR PIPELINE BALL VALVES (ONSHORE)

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	17.03.17	REVISED & REISSUED AS STANDARD SPECIFICATION	RB/NR	MSG	VM	RN
4	01.03.12	REVISED & REISSUED AS STANDARD SPECIFICATION	ST	SKJ	VM	DM
3	22.11.06	REVISED & REISSUED AS STANDARD SPECIFICATION	MKM	VM	AS	VC
2	19-10-01	REVISED & REISSUED AS STANDARD SPECIFICATION	MKM	KKS	SJ	GRR
1	16-12-98	REVISED & REISSUED AS STANDARD SPECIFICATION	LD	ASr	VC	AS

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Abbreviations:

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
API	American Petroleum Institute
BHN	Brinell hardness number
DN	Nominal Size
HAZ	Heat Affected Zone
LC	Lock Close (valve locked in full close position)
LO	Lock Open (valve locked in full open position)
MSS-SP	Manufacturers Standardization Society – Standard Practice
NDT	Non Destructive Testing
NPS	Nominal Pipe Size
RJ	Ring Joint
SSPC	The Society for Protective Coatings

Pipeline Engineering Standards Committee

Convenor : Mr. Vinay Mittal

Members: Mr. Brij Raj Meena
Mr. M. S. Gunjiyal
Mr. Gagan Deep Singh
Mr. Raj Kishore
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1.0 SCOPE

This specification covers the minimum requirements for design, manufacture, testing and supply of carbon steel ball valves of size DN 50 mm (2") and above and ANSI pressure rating Class 150# thru 900# for use in onshore pipeline systems handling non-sour hydrocarbons in liquid or gaseous phase including Liquefied Petroleum Gas (LPG).

2.0 REFERENCE DOCUMENTS

2.1 All valves shall be manufactured and supplied in accordance with the American Petroleum Institute (API) Specification 6D, Twenty-Fourth Edition, August 2014, Specification for Pipeline and Piping Valves, with additions and modifications as indicated in the following sections of this specification.

2.2 Reference has also been made in this specification to the latest edition (edition enforce at the time of issue of enquiry) of the following Codes, Standards and Specifications.

ASME B31.3	-	Process Piping.
ASME B31.4	-	Pipeline Transportation Systems for Liquids and Slurries.
ASME B31.8	-	Gas Transmission and Distribution Piping Systems.
ASME B16.5	-	Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/ Inch Standard.
ASME B 16.10	-	Face-To-Face and End-To-End Dimensions of Valves.
ASME B 16.25	-	Buttwelding Ends.
ASME B16.34	-	Valves - Flanged, Threaded and Welding Ends.
ASME B16.47	-	Large Diameter Steel Flanges: NPS 26 through NPS 60 Metric/ Inch Standard.
API 1104	-	Welding of Pipelines and Related Facilities.
ASME Sec VIII	-	Boiler and Pressure Vessel Code - Rules for Construction of Pressure Vessels
ASME Sec IX	-	Boiler and Pressure Vessel Code - Welding, Brazing and Fusing Qualifications
ASTM A-370	-	Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
ASTM B 733	-	Standard Specification for Autocatalytic (Electroless) Nickel-Phosphorous Coatings on Metal.
MSS-SP-6	-	Standard Finishes for Contact Faces of Pipe Flanges and Connecting-end Flanges of Valves and Fittings.
MSS-SP-44	-	Steel Pipeline Flanges.

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SSPC-VIS-1 - Steel Structures Painting Council Visual Standard-Guide and Reference Photographs for Steel Surfaces prepared by Dry Abrasive Blast Cleaning.

2.3 In case of conflict between the requirements of this specification, API 6D and the Codes, Standards and Specifications referred in clause 2.2 above, the requirements of this specification shall govern.

3.0 MATERIALS

3.1 Material for major components of the valves shall be as indicated in Valve Data Sheet. Other components shall be as per Manufacturer's standard (suitable for the service conditions indicated in Data Sheet) and shall be subject to approval by Company. In addition, the material shall also meet the requirements specified hereinafter.

All process-wetted parts, metallic and non-metallic, sealant and lubricants shall be suitable for the service specified by the Company. Manufacturer shall confirm that all wetted parts are suitable for treated water/seawater environment, which may be used during field testing.

Non-metallic parts of the valves (including O-rings, soft seals etc.) intended for hydrocarbon gas service shall be resistant to explosive decompression.

3.2 Carbon steel used for the manufacture of valves shall be fully killed.

3.3 The carbon equivalent (CE) of valve end connections which are subject to further field welding by Company shall not exceed 0.43 on check analysis for each heat of steel used, as calculated by the following formula:

$$CE(IIW) = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

3.4 Charpy V-notch test on each heat of base material shall be conducted for all pressure containing parts such as Body, End Flanges, Stem and Welding Ends as well as Bolting materials for pressure containing parts.

Test procedure for Charpy V-Notch Test shall conform to ASTM A370.

For Carbon Steel, alloy steel & Stainless Steel (except Austenitic Grades) Materials, The impact test temperature shall be 0^0C or minimum design temperature indicated in valve data sheet, whichever is lower. The average absorbed energy value of three full sized specimens shall be 27 J (for materials with Specified Minimum Tensile Strength ≤100,000 psi)/ 34 J (for materials with Specified Minimum Tensile Strength >100,000 psi). The minimum impact energy value of any one specimen of the three specimens analysed as above, shall not be less than 22 J (for materials with Specified Minimum Tensile Strength ≤100,000 psi)/ 26 J (for materials with Specified Minimum Tensile Strength >100,000 psi).

For Low Temperature Carbon Steel Materials, The impact test temperature shall be as per requirement of Material Standard or minimum design temperature indicated in valve data sheet, whichever is lower. The average absorbed energy value of three full sized specimens shall be 27 J (for materials with Specified Minimum Tensile Strength ≤100,000 psi)/ 34 J (for materials with Specified Minimum Tensile Strength >100,000 psi). The minimum impact energy value of any one specimen of the three specimens analysed as above, shall not be less than 22 J (for materials with Specified Minimum Tensile Strength ≤100,000 psi)/ 26 J (for materials with Specified Minimum Tensile Strength >100,000 psi).

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Where the material specification requires impact values to be higher than specified in the above paragraphs, the higher values shall apply.

For duplex & super duplex stainless steel the Charpy V-Notch test values and test temperature shall be as per API 6D.

3.5 For Valves specified to be used for Gas service or LPG service, Hardness test shall be carried out as per ASTM A370 for each method of manufacture and each heat of steel used in the manufacture of valves. A full thickness cross section shall be taken for this purpose and the maximum hardness of the materials of valve components shall not exceed 248 HV_{10}.

3.6 For all such valves where Carbon Steel/ Low Temperature Carbon Steel is used as ball material, the ball shall have 75 micrometers (.003 inches) thick Electroless Nickel Plating (ENP) as per ASTM B 733 with following classification:

- SC2, Type II, Class 2.

The hardness of plating shall be minimum 50 RC.

4.0 DESIGN AND CONSTRUCTION REQUIREMENTS

4.1 Valve design shall meet the requirements of API Specification 6D and shall be suitable for the service conditions indicated in the Valve Data Sheet. The ASME Boiler & Pressure Vessel Code, Section VIII, Division 1 shall be used to design the valve body. Allowable stress requirements shall comply the provisions of above code. In addition, corrosion allowance indicated in Valve Data Sheet shall be considered in valve design. The manufacturer shall have valid license to use API monogram on valves manufactured as per API 6D.

4.2 For above ground valves, body design shall be either fully welded or bolted type. For buried valves, valve body design shall be fully welded type only. Valve body joints with threads are not permitted.

4.3 Ball shall be of single piece, solid type construction

4.4 Valves shall be Full bore (FB) or Reduced bore (RB) as indicated in the Valve Data Sheet. Full bore valves shall be suitable for the passage of all types of pipeline pigs including instrumented intelligent pigs and regular cleaning, batching and scraper pigs on regular basis without causing damage to either the valve component or the pig. The full bore valve shall provide an unobstructed profile for pigging operations in either direction. Full bore valves shall be designed to minimize accumulation of debris in the seat ring region to ensure that valve movement is not impeded.

The bore size of reduced bore valves shall be corresponding to that of a full bore valve of smaller nominal diameter as indicated in Table 4.4 of this specification. For sizes of a particular rating not covered in API 6D, the bore size of the reduced bore valve shall be as per Manufacturer's standard.

TABLE - 4.4

Nominal Valve Size	Nominal Valve size for Reduced Bore	Nominal Valve Size	Nominal Valve size for Reduced Bore
DN mm (NPS inches)	DN mm (NPS inches)	DN mm (NPS inches)	DN mm (NPS inches)
50 (2)	40 (1.5)	600 (24)	500 (20)
80 (3)	50 (2)	650 (26)	550 (22)

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TABLE - 4.4			
Nominal Valve Size	**Nominal Valve size for Reduced Bore**	**Nominal Valve Size**	**Nominal Valve size for Reduced Bore**
DN mm (NPS inches)	**DN mm (NPS inches)**	**DN mm (NPS inches)**	**DN mm (NPS inches)**
100 (4)	80 (3)	700 (28)	600 (24)
150 (6)	100 (4)	750 (30)	600 (24)
200 (8)	150 (6)	800 (32)	650 (26)
250 (10)	200 (8)	850 (34)	700 (28)
300 (12)	250 (10)	900 (36)	750 (30)
350 (14)	250 (10)	950 (38)	800 (32)
400 (16)	300 (12)	1000 (40)	850 (34)
450 (18)	350 (14)	1050 (42)	900 (36)
500 (20)	400 (16)	1200 (48)	1050 (42)
550 (22)	450 (18)		

4.5 Ball mounting shall be trunnion or pivot type only. Valve design shall minimize the possibility of debris ingress into the trunnion as far as practicable.

4.6 The valves shall either be a soft seated valve or metal seated valve or with primary metal-to-metal contact and secondary soft seats.

For soft seated valves, Metal seat rings may be provided with soft insert. The same shall be positively locked in position in Metal seat rings.

For valves with primary metal to metal contact and secondary soft seats, O-rings or other seals if used for drip tight sealing shall be encased in a suitable groove in such a manner that it can not be removed from seat ring and there is no extrusion during opening or closing operation of valve at maximum differential pressure corresponding to valve class rating. The seat rings shall be so designed as to ensure sealing at low as well as high differential pressures.

4.7 Valves shall be designed to withstand a sustained internal vacuum of at least 1 (one) milli-bar in both open and closed positions.

4.8 Valves shall have double block and bleed feature to facilitate complete flush, drain and venting of the valve body cavity.

4.9 Full Bore valves of nominal valve size DN 200 mm (8") & above and Reduced Bore valves of nominal valve size DN 250 mm (10") & above, shall have provision for secondary sealant injection under full line pressure for seat and stem seals. All sealant injection connections shall be provided with a block valve and internal non-return valve. Valve design shall have a provision to replace the sealant injection fitting under full line pressure. Location and arrangement of sealant point shall be as per Fig. 4.9.

4.10 Valves shall be provided with vent and drain connections. Location and arrangement of vents and drains shall be as per Fig. 4.9. Body vent and drain shall be provided with isolation valves (Ball or Plug type). Number and size shall be as per Fig. 4.9.

4.11 Valve design shall ensure repair of stem seals/packing under full line pressure.

4.12 Full Bore valves of nominal valve size DN 200 mm (8") & above and Reduced Bore valves of nominal valve size DN 250 mm (10") & above, shall be equipped with support foot and lifting

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lugs. Tapped holes and eyebolts shall not be used for lifting lugs. Height of support foot shall be kept minimum. The location and size of support foot/lifting lugs shall ensure unrestrictive operation of vent/drain valves. The design of support foot shall be such that it shall take minimum double the weight of the valve assembly.

4.13 Valve design shall be such as to avoid bimetallic corrosion between carbon steel and high alloy steel components. Suitable insulation shall be provided as required.

4.14 The valve body cavity over-pressure shall be prevented by self-relieving seat rings/assemblies. Valve Cavity relief pressure when added to the valve pressure rating shall not exceed 133% of the pressure rating of the valve at its maximum specified design temperature.

4.15 a) Valve ends shall be either flanged/or butt welded or one end flanged and one end butt welded as indicated in the Valve Data Sheet. Flanges of the flanged end cast/forged body valves shall be integrally cast/forged with the body of the valve. Face to face/end to end dimensions shall conform to API 6D. Face-to-face and end-to-end dimensions for valve sizes not specified in API 6D shall be in accordance with ASME B 16.10. Face-to-face and end-to-end dimensions not shown in API 6D or in ASME B 16.10 shall be as per Manufacturer Standard and shall be subject to approval by Company.

b) Flanged ends, if specified, shall have flanges as per ASME B16.5 for valve sizes upto DN 600 mm (24") excluding DN 550 mm (22"), as per MSS-SP-44 for valve sizes DN 550 mm (22") and as per ASME B 16.47 Series A for DN 650 mm (26 inches) and above. Flange face shall be either raised face or ring joint (RJ) with raised face as indicated in Valve Data Sheet. Flange face finish shall be serrated or smooth as indicated in Valve Data Sheet. In case of RJ flanges, the groove hardness shall be minimum 140 BHN.

c) Butt weld end preparation shall be as per ASME B16.25. The thickness of the pipe to which the valve has to be welded shall be as indicated in the Valve Data Sheet. In case difference exists between thickness of welding ends of valve and connecting pipe, the welding ends of valve shall have bevel preparation as per ASME B31.4 or ASME B31.8 as applicable.

d) In case of all Butt welded end valves (including soft seated valves or valves with primary metal to metal and secondary soft seats), actual yield strength of valve body shall not be less than 2/3 rd of the specified minimum yield strength (SMYS) of the connecting pipe material.

e) For soft seated valves with Butt welded end, valves shall be provided with pup pieces on either side of length 200 mm each for size up-to 8" & 250 mm for size 10" and above, with material as specified in valve data sheet. Length of pup piece shall be confirmed by manufacturer so as to avoid damage to seats during field welding or post weld heat treatment. Pup piece thickness shall be calculated for the class rating. Vendor shall provide for each type (considering size, grade and thickness of the pup pieces used for all offered valves) of pup piece, test rings (500 mm long) from pup piece material for field weld procedure qualification. Valves shall be tested along-with pup piece.

4.16 Design of weld end valves shall be such that during field welding operations, the soft seals or plastic components of the valve (where ever used) are not liable to be damaged. The manufacturer shall furnish necessary field welding instructions and post-weld test procedure to demonstrate integrity and leak-tightness of valves after field welding operations.

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4.17 Valve shall be provided with ball position indicator and stops of rugged construction at the fully open and fully closed positions. For actuated valves, additionally mechanical means of position indicator shall be provided.

4.18 Valves shall be suitable for either buried or above ground installation as indicated in Valve Data Sheet.

4.19 When stem extension requirement is indicated in Valve Data Sheet, the valves shall have the following provisions.

a) In case of below ground LTCS valves, Stem extension material shall be equivalent to Stem Material.

b) Valves provided with stem extension shall have water proof outer casing. Length of stem extension shall be as indicated in Valve Data Sheet. The length indicated corresponds to the distance between centerline of the valve opening and the top of mounting flange for valve operating device (gear operator/power actuator as applicable).

c) Vent and drain connections and sealant injection lines shall be terminated adjacent to the valve operator by means of suitable piping anchored to the valve body. The pipe used shall be API 5L Gr. B / ASTM A 106 Gr. B, with Sch. 160 for carbon steel valves and ASTM A 333 Gr. 6, with Sch. 160 for low temperature carbon steel valves. The material for the fittings for carbon steel valves shall be ASTM A105 and material for the fittings for low temperature carbon steel valves shall be ASTM A 350 Gr. LF2 Cl. 1. The fittings and valve ends shall be Socket Welded ANSI 6000# as per ASME B 16.11 (for piping class upto 600#) and BW ends (for piping class 900#).

d) Stem extension and stem housing design shall be such that the complete assembly will form a rigid unit giving positive drive under all conditions with no possibility of free movement between valve body, stem extension or its operator.

e) Outer casing of stem extension shall have ⅜"" or ½" NPT plugs at the top and bottom, for draining and filling with oil to prevent internal corrosion.

4.20 Operating Devices

a) Valves shall have a power actuator or manual operator as indicated in the Valve Data Sheet. In case of manual operator, valve sizes, DN ≤ 100 mm (4") shall be wrench operated and valve sizes, DN ≥ 150 mm (6") shall be gear operated. The length of the wrench shall not be longer than twice the face-to-face or end-to-end dimension of the valve. Each wrench-operated valve shall be supplied with wrench. Valve design shall be such that damage due to malfunctioning of the operator or its controls will only occur in the operator gear train or power cylinder and that damaged parts can be replaced without the valve cover being removed.

b) The power actuator shall be in accordance with the Company Specification issued for the purpose and as indicated in the Valve and Actuator Data Sheet. Operating time shall be as indicated in Valve Data Sheet. Valve operating time shall correspond to full close to full open /full open to full close under maximum differential pressure corresponding to the valve rating. For actuated valves, the actuator's rated torque output shall be 1.25 times the break torque required to operate the ball valve under the maximum differential pressure corresponding to the Valve Class Rating.

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c) For the manual operator of all valves, the diameter of the hand wheel or the length of operating wrench shall be such that under the maximum differential pressure, the total force required to operate the valve does not exceed 350N. However, failing to meet above requirement , vendor shall offer Gear operated valves. Manufacturer shall also indicate the number of turns of hand wheel in case of gear operators (along with their offer) required for operating the valve from full open to full close position. The number of turns shall not exceed 250 for valve sizes up-to 24" and 450 for valve sizes above 24".

d) Direction of operation of hand wheel or wrench shall be in clock-wise direction while closing the valve. Hand wheels shall not have protruding spokes.

e) Gear operators, when provided, shall have a self-locking provision and shall be fully encased in water proof/splash proof enclosure and shall be filled with suitable grease.

4.21 The tolerance on internal diameter and out of roundness at the ends for welded ends valves shall be as per connected pipe specification as indicated in the Valve Data Sheet.

4.22 When indicated in Material Requisition/ Tender, valves shall have locking devices to lock the valve either in full open (LO) or full close (LC) positions. Locking devices shall be permanently attached to the valve operator and shall not interfere with operation of the valve.

4.23 All welds shall be made by welders and welding procedures qualified in accordance with the provisions of ASME Section IX. The procedure qualification shall also include impact test and hardness test when required as per Clause 3.4 and 3.5 of this specification and shall meet the requirements as specified therein.

4.24 Repair by welding is not permitted for fabricated and forged body valves. However repair by welding as per ASME B16.34 is permitted for cast body valves. Such repairs shall be carried out at casting supplier's care only. Repair shall be carried out before any heat treatment of casting is done. Repair welding procedure qualification shall also include impact test and hardness test when required as per Clause 3.4 and 3.5 of this specification and shall meet the requirements as specified therein. Heat treatment and radiography shall be repeated after the weld repair.

4.25 No casting is permitted for stem and stem extension material of all valves. Valve stem shall be capable of withstanding the maximum operating torque required to operate the valve against the maximum differential pressure corresponding to applicable class rating. The combined stress shall not exceed the maximum allowable stresses specified in ASME section VIII, Division 1. For power actuated valves, the valve stem shall be designed for maximum output torque of the selected power actuator (including gear box, if any) at valve stem.

4.26 Wherever specified for the parts of valve in valve datasheets, minimum thickness of stelliting shall be 1.6 mm.

4.27 All soft seated valves shall be fire safe design and qualified as per API 6FA/ API 607/ ISO 10497.

4.28 Soft-seated valves shall have an antistatic device.

5.0 INSPECTION AND TESTS

5.1 The Manufacturer shall perform all inspection and tests as per the requirements of this specification and the relevant specifications, codes, prior to shipment, at his Works. Such inspection and tests shall be, but not limited to, the following:

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5.1.1 All valves shall be visually inspected. The internal and external surfaces of the valves shall be free from any strikes, gouges and other detrimental defects. The surfaces shall be thoroughly cleaned and free from dirt, rust and scales.

5.1.2 Dimensional check on all valves shall be carried out as per the Company approved drawings.

5.1.3 Chemical composition and mechanical properties shall be checked as per this specification and relevant material standards, for each heat of steel used.

5.1.4 Non-destructive examination of individual valve material and component consisting of but not limited to castings, forgings, plates and assembly welds shall be carried out by the Manufacturer.

a) Body castings of all valves shall be radiographically examined as per ASME B16.34. Procedure and acceptance criteria shall be as per ASME B16.34. The extent of the radiography shall be as under:

Pressure Class Rating	Valve Size	Extent of Radiography
ANSI 150 # Class	≤ DN 600 mm (24") ≥ DN 650 mm (26")	Nil 100%
ANSI 300 # Class	≤ DN 400 mm (16") ≥ DN 450 mm (18")	Nil 100%
ANSI 600 # Class and above	All sizes	100%

Radiography shall be performed after the final heat treatment also.

All castings shall be wet magnetic particle inspected 100% of the internal surfaces. Method and acceptance shall comply with ASME B16.34.

b) All valves, with body fabricated from plates or made by forgings, shall be ultrasonically examined in accordance with the procedure and acceptance standard of Appendix IV of ASME B16.34.

All forgings shall be wet magnetic particle inspected 100% of the internal surfaces. Method and acceptance shall comply with ASME B16.34.

c) Bodies and bonnets made by welded assembly of segments of castings, forgings, plates or combinations thereof shall be examined, as applicable, by methods of 5.1.4 (a) for cast components or 5.1.4 (b) for forged components and plates.

5.1.5 Full inspection by radiography shall be carried out on all welds of pressure containing parts. Acceptance criteria shall be as per ASME B 31.4 or ASME B31.8 as applicable and API 1104.

5.1.6 Welds, which in Company's opinion cannot be inspected by radiographic methods, shall be checked by ultrasonic or magnetic particle methods and acceptance criteria shall be as per ASME Sec. VIII, Division 1, Appendix 12 and Appendix 6 respectively.

5.1.7 a) All finished wrought weld ends subject to welding in field shall be 100% ultrasonically tested for lamination type defects for a distance of 50 mm from the end. Laminations shall not be acceptable.

b) Weld ends of all cast valves subject to welding in field shall be 100% radiographically examined and acceptance criteria shall be as per ASME B16.34.

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c) After final machining, all bevel surfaces shall be inspected by dye penetrant or wet magnetic particle methods. All defects longer than 6.35 mm are rejected, as are the defects between 6.35 mm and 1.59 mm that are separated by a distance less than 50 times their greatest length. Rejectable defects must be removed. Weld repair of bevel surface is not permitted.

5.1.8 All valves shall be tested in compliance with the requirements of API 6D. During pressure testing, valves shall not have sealant lines and other cavities filled with sealant, grease or other foreign material. The drain, vent and sealant lines shall be either included in the hydrostatic shell test or tested independently. Test pressure shall be held for at least 30 minutes for both Shell & Seat test. No leakage is permissible during hydrostatic testing. The body cavity self-relieving feature meeting the requirements of clause 4.14 of this specification shall also be checked.

5.1.9 A supplementary air seat test as per API 6D (Annex H, Para H.3.3, Type II) shall be carried out for all valves. A bubble tight seal is required without the use of any sealant. No leakage is allowed. Test pressure shall be held for at least 15 minutes.

5.1.10 Valves shall be subjected to Operational Torque Test as per API 6D (Annex H, Para H.6) under hydraulic pressure equal to maximum differential pressure corresponding to the applicable ANSI class rating of valve. It shall be established that the force required to operate the valve does not exceed the requirements stated in section 4.20 (c) of this specification.

5.1.11 Power actuated valves shall be tested after assembly of the valve and actuator, at the valve Manufacturer's works. At least five Open-Close-Open cycles without internal pressure and five Open-Close-Open cycles with maximum differential pressure corresponding to the valve rating shall be performed on the valve actuator assembly. The time for Full Open to Full Close shall be recorded during testing. If required, the actuator shall be adjusted to ensure that the opening and closing time is with in the limits stated in Valve Data Sheet.

Hand operator provided on the actuator shall also be checked after above testing, for satisfactory manual over-ride performance.

These tests shall be conducted on minimum one valve out of a lot of five (5) valves of the same size, rating and the actuator model/type. In case, the tests do not meet the requirements, retesting/rejection of the lot shall be decided by the Company's Inspector.

5.1.12 Subsequent to successful testing as specified in clause 5.1.10 and 5.1.11 above, one (1) valve out of the total ordered quantity shall be randomly selected by the Company Representative for cyclic testing as mentioned below:

a) The valve shall be subjected to at least 100 Open-Close-Open cycles with maximum differential pressure corresponding to the valve rating.

b) Subsequent to the above, the valve shall be subjected to hydrostatic test and supplementary air seat test in accordance with clause 5.1.8 and 5.1.9.

In case this valve fails to pass these tests, the valve shall be rejected and two more valves shall be selected randomly and subjected to testing as indicated above. If both valves pass these tests, all valves manufactured for the order (except the valve that failed) shall be deemed acceptable. If either of the two valves fails to pass these tests, all valves shall be rejected or each valve shall be tested at the option of manufacturer.

Previously carried out test of similar nature shall be considered acceptable if the same has been carried out by Manufacturer in last two years. Valves of two sizes below and two sizes

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above the size of valve previously tested, and rating similar or one rating lower of valve tested previously, shall be qualified.

5.1.13 Checks shall be carried out to demonstrate that the dissimilar metals used in the valves are successfully insulated as per the requirement of clause 4.13 of this specification.

5.1.14 Anti-static testing for soft seated valves in accordance with H.5 of API 6D.

5.2 Company reserves the right to perform stage wise inspection and witness tests as indicated in clause 5.1 above at Manufacturer's works prior to shipment. Manufacturer shall give reasonable access and facilities required for inspection to the Company's Inspector. Company reserves the right to require additional testing at any time to confirm or further investigate a suspected fault. The cost incurred shall be to Manufacturer's account.

In no case shall any action of Company or his inspector shall relieve the Manufacturer of his responsibility for material, design, quality or operation of valves.

Inspection and tests performed/witnessed by the Company's Inspector shall in no way relieve the Manufacturer's obligation to perform the required inspection and tests.

6.0 TEST CERTIFICATES

Manufacturer shall submit the following certificates:

a) Mill test certificates relevant to the chemical analysis and mechanical properties of the materials used for the valve construction as per the relevant standards.

b) Test certificates of hydrostatic and pneumatic tests complete with records of timing and pressure of each test.

c) Test reports of radiograph and ultrasonic inspection.

d) Test report on operation of valves conforming to clause 5.1.10, 5.1.11 and 5.1.12 of this specification.

e) All other test reports and certificates as required by API 6D and this specification.

The certificates shall be considered valid only when signed by Company's Inspector. Only those valves which have been certified by Company's Inspector shall be dispatched from Manufacturer's works.

7.0 PAINTING, MARKING AND SHIPMENT

7.1 Valve surface shall be thoroughly cleaned, freed from rust and grease and applied with sufficient coats of corrosion resistant paint. Surface preparation shall be carried out by shot blasting to SA-2½ / SSPC-SP10. For coastal area, painting shall be suitable for industrial marine environment. For the valves to be installed underground, when indicated in Valve Data Sheet, the external surfaces of buried portion of the valve shall be painted with 100% solid high build epoxy with a minimum dry film thickness of 800 microns or 1.5 mm thick polyurethane coating.

7.2 All valves shall be marked as per API 6D. The units of marking shall be metric except nominal diameter, which shall be in inches.

7.3 Valve ends shall be suitably protected to avoid any damage during transit. All threaded and machined surfaces subject to corrosion shall be well protected by a coat of grease or other

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suitable material. All valves shall be provided with suitable protectors for flange faces, securely attached to the valves. Bevel ends shall be protected with metallic or high impact plastic bevel protectors.

7.4 All sealant lines and other cavities of the valve shall be filled with sealant before shipment.

7.5 Packaging and shipping instructions shall be as per API 6D.

7.6 On packages, following shall be marked legibly with suitable marking ink:

a) Order Number

b) Manufacturer's Name

c) Valve size and rating

d) Tag Number

e) Serial Number

8.0 SPARES AND ACCESSORIES

8.1 Manufacturer shall furnish list of recommended spares and accessories for valves required during start-up and commissioning and supply of such spares shall be included in the price quoted by Manufacturer.

8.2 Manufacturer shall furnish list of recommended spares and accessories required for two years of normal operation and maintenance of valves and price for such spares shall be quoted separately.

9.0 DOCUMENTATION

Documentation to be submitted by Manufacturer to Company is summarized below. Number of Copies (Hard copies / soft copies etc.) shall be as indicated in CONTRACT document.

9.1 At the time of bidding, Manufacturer shall submit the following documents:

a) Reference list of similar ball valves manufactured and supplied in last seven years indicating all relevant details including project, year, client, location, size, rating, service etc.

b) Torque curves for the power actuated valves along with the break torque, running torque for the valve stem and maximum allowable stem torque.

c) Copy of valid API 6D Certificate.

d) Fire Safe test certificate qualifying the valves as per API 6FA/ API 607/ ISO 10497 carried out in last 10 years shall be furnished.

e) Details of support foot including dimensions and distance from valve centreline to bottom of support foot.

f) List of recommended spares required during start-up and commissioning & 2 years of normal operation and maintenance.

9.2 After placement of order, the Manufacturer shall submit the following drawings, documents and specifications for Company's approval:

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a) General arrangement & detailed sectional drawings showing all parts with reference numbers and material specifications, overall dimensions and features. Number of turns of hand wheel required for operating the valve from full open to full close position for Gear Operated valves, painting/ coating scheme, Complete dimensional details of support foot (where applicable), shall be indicated in the GA.

Manufacture of valves shall commence only after approval of the above documents. Once the approval has been given by Company, any changes in design, material and method of manufacture shall be notified to Company whose approval in writing of all changes shall be obtained before the valve is manufactured.

9.3 Within 30 days from the approval date, Manufacturer shall submit to Company the approved drawings, documents and specifications as listed in clause 9.2 above.

9.4 Prior to shipment, Manufacturer shall submit to Company following:

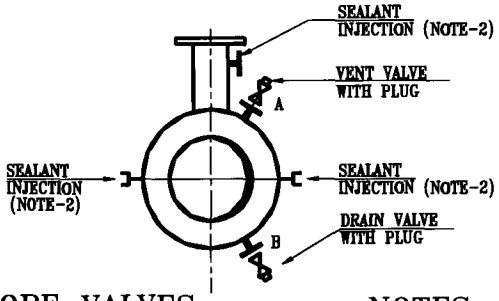
a) Test certificates as per clause 6.0 of this specification.

b) Manual for installation, erection, maintenance and operation instructions including a list of recommended spares for the valves.

9.5 All documents shall be in English language only.

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ABOVE GROUND INSTALLATION



FULL BORE VALVES

VALVE SIZE, DN(mm)	A, DN(mm)	B, DN(mm)
50 TO 150	–	15
200 TO 600	15	25
650 & ABOVE	15	40

REDUCED BORE VALVES

VALVE SIZE, DN(mm)	A, DN(mm)	B, DN(mm)
50 TO 200	–	15
250 TO 750	15	25
ABOVE 750	15	40

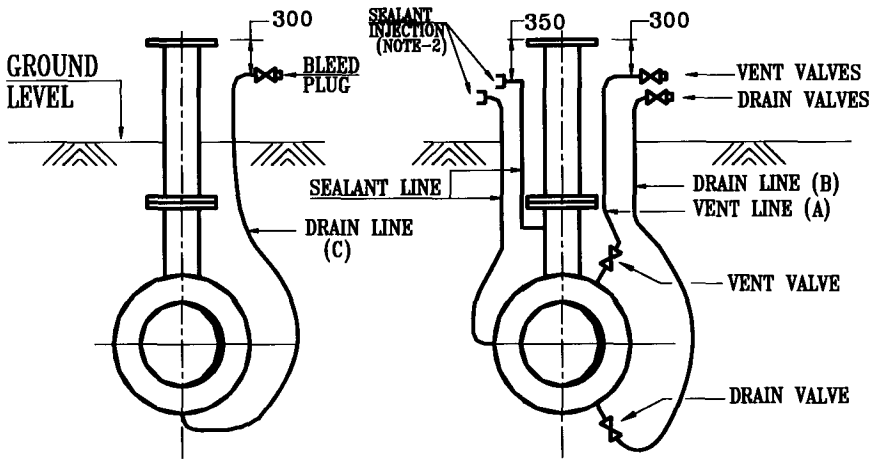
NOTES:–

1 ALL VALVES (BALL OR PLUG) AND PLUGS FOR A AND B SHALL BE APPROVED BY THE PURCHASER.

2 SEALANT POINTS SHALL BE PROVIDED FOR FULL BORE VALVES OF NOMINAL VALVE SIZE 200 mm (8") & ABOVE AND REDUCED BORE VALVES OF NOMINAL VALVE SIZE, DN 250 mm (10") AND ABOVE ONLY. SEALANT LINES SHALL HAVE PROVISION TO REPLACE THE SEALANT INJECTION FITTING UNDER FULL LINE PRESSURE. SEALANT LINES SHALL HAVE BLOCK VALVE & INTERNAL NON RETURN VALVE.

3 ALL VENT/DRAIN CONNECTION SHALL BE WELDED WITH THE BODY.

UNDERGROUND INSTALLATION



FB VALVES DN 50 mm(2") TO DN 150 mm(6") FB VALVES ≥ DN 200 mm(8")
RB VALVES DN 50 mm(2") TO DN 200 mm(8") RB VALVES ≥ DN 250 mm(10")

FULL BORE (FB) VALVES

VALVE SIZE, DN(mm)	A, DN(mm)	B, DN(mm)	C, DN(mm)
50 TO 150	–	–	15
200 TO 300	25	25	–
350 TO 600	25	25	–
650 & ABOVE	40	40	–

REDUCED BORE (RB) VALVES

VALVE SIZE, DN(mm)	A, DN(mm)	B, DN(mm)	C, DN(mm)
50 TO 200	–	–	15
250 TO 400	25	25	–
450 TO 750	25	25	–
800 & ABOVE	40	40	–

NOTES:–

1 ALL VALVES (BALL OR PLUG) AND PLUGS FOR A AND B SHALL BE APPROVED BY THE PURCHASER.

2 SEALANT POINTS SHALL BE PROVIDED FOR FULL BORE VALVES OF NOMINAL VALVE SIZE 200 mm (8") & ABOVE AND REDUCED BORE VALVES OF NOMINAL VALVE SIZE, DN 250 mm (10") AND ABOVE ONLY. SEALANT LINES SHALL HAVE PROVISION TO REPLACE THE SEALANT INJECTION FITTING UNDER FULL LINE PRESSURE. SEALANT LINES SHALL HAVE BLOCK VALVE & INTERNAL NON RETURN VALVE.

3 ALL VENT/DRAIN CONNECTION IN BURIED SECTION SHALL BE OF WELDED CONSTRUCTION. ALL PIPING INCLUDING VALVE ENDS IN BURIED PORTIONS OF VENT & DRAIN SHALL BE WELDED TYPE.

FIGURE-4.9

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फ्लेन्जेस एवं वेल्डेड फिटिंग्स के लिए मानक विनिर्देश (साइज डीएन 450 मि.मी. (18") तथा ऊपर)

STANDARD SPECIFICATION FOR FLANGES & WELDED FITTINGS (SIZE DN 450 mm (18") AND ABOVE)

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	10-02-17	REVISED & REISSUED AS STANDARD SPECIFICATION	RB	NR	VM	RN
4	16-02-12	REVISED & REISSUED AS STANDARD SPECIFICATION	GD	SKJ	VM	DM
3	21-11-06	REVISED & REISSUED AS STANDARD SPECIFICATION	MKM	SK	AS	
2	25-10-01	REVISED & REISSUED AS STANDARD SPECIFICATION	MKM	KKS	SJ	GRR
1	12-10-98	REVISED & REISSUED AS STANDARD SPECIFICATION	PKM	ASr	VC	AS

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Abbreviations:

API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society of Testing of Materials
BHN	:	Brinell Hardness Number
CE	:	Carbon Equivalent
DN	:	Nominal Diameter
HAZ	:	Heat Affected Zone
LPG	:	Liquefied Petroleum Gas
LTCS	:	Low Temperature Carbon Steel
MSS-SP	:	Manufacturers Standardization Society – Standard Practice
RJ	:	Ring Joint
SSPC	:	The Society for Protective Coatings

Pipeline Engineering Standards Committee

Convenor : Mr. Vinay Mittal

Members :
Mr. Brij Raj Meena
Mr. M. S. Gunjiyal
Mr. Gagan Deep Singh
Mr. Raj Kishore
Mr. S. Ghosal (Process-2)
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1.0 SCOPE

This specification covers the minimum requirements for the design, manufacture and supply of following carbon steel flanges and fittings of size DN 450 mm (18") and above to be installed in onshore pipeline systems handling non-sour hydrocarbons in liquid or gaseous phase including Liquefied Petroleum Gas (LPG):

- Flanges such as weld neck flanges, blind flanges, spectacle blinds, spacers & blinds, etc.
- Welded fittings such as tees, elbows, reducers, caps, outlets etc. and forged weldolets.

2.0 REFERENCE DOCUMENTS

Reference has been made in this specification to the latest edition (edition enforce at the time of issue of enquiry) of the following Codes, Standards and Specifications.

a)	ASME B31.3	-	Process Piping
b)	ASME B31.4	-	Pipeline Transportation Systems for Liquids and Slurries
c)	ASME B31.8	-	Gas Transmission and Distribution Piping Systems
d)	ASME B16.5	-	Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/ Inch Standard
e)	ASME B16.9	-	Factory Made Wrought ButtWelding Fittings
f)	ASME B16.25	-	Butt-welding Ends
g)	ASME B16.47	-	Large Diameter Steel Flanges
h)	ASME B 16.48	-	Steel Line Blanks
i)	API 1104	-	Welding of Pipelines and Related Facilities
j)	ASME Sec VIII	-	Boiler and Pressure Vessel Code - Rules for Construction of Pressure Vessels
k)	ASME Sec IX	-	Boiler and Pressure Vessel Code-Welding, Brazing and Fusing Qualifications
l)	ASTM A 370	-	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
m)	MSS-SP-25	-	Standard Marking System for Valves, Fittings, Flanges and Unions
n)	MSS-SP-44	-	Steel Pipeline Flanges
o)	MSS-SP-75	-	High-Strength, Wrought, Butt-Welding Fittings
p)	MSS-SP-97	-	Integrally Reinforced Forged Branch outlet Fittings-Socket Welding, Threaded and Buttwelding Ends

In case of conflict between the requirements of this specification and the Codes, Standards and Specifications referred above, the requirements of this specification shall govern.

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3.0 MANUFACTURER'S QUALIFICATION

Manufacturer who intends bidding for fittings must possess the records of a successful proof test in accordance with the provisions of ASME B16.9/MSS-SP-75, as applicable. These records shall be submitted when specified, at the time of bidding qualifying the entire range of fittings offered.

4.0 MATERIAL

4.1 The Carbon Steel used in the manufacture of flanges and fittings shall be fully killed. Material for flanges and fittings shall comply with the material standards indicated in the Material/ Purchase Requisition/ Tender. In addition, the material shall also meet the requirements specified hereinafter.

4.2 Each heat of steel used for the manufacture of flanges and fittings shall have Carbon Equivalent (CE) not greater than 0.45 calculated from check analysis in accordance with the following formula:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

4.3 For all flanges and fittings, Charpy V-notch test shall be conducted for each heat treatment lot and for each heat of steel used. Unless specified otherwise, the Charpy V-notch test shall be conducted at 0° C in accordance with the impact test provisions of ASTM A 370 for flanges and MSS-SP-75 for all fittings. Results of charpy test shall be recorded.

The average absorbed impact energy values of three full-sized specimens shall be 27 joules. The minimum impact energy value of any one specimen of the three specimens analysed as above, shall not be less than 22 Joules.

When Low Temperature Carbon Steel (LTCS) materials are specified in Requisition/ Tender for flanges and fittings, the Charpy V-notch test requirements of applicable material standard shall be complied with.

4.4 For flanges and fittings specified to be used for Gas service or LPG service, Hardness test shall be carried out as per ASTM A 370 for each heat treatment lot and for each heat of steel used. A full thickness cross section shall be taken for this purpose and the maximum hardness of base metal, weld metal and HAZ shall not exceed 248 HV_{10}.

Hardness testing shall cover at least 10% per item, per size, per heat treatment lot, per heat, per manufacturing method. The hardness shall be recorded in the test reports.

4.5 In case of RJ (Ring Joint) flanges, the groove hardness shall be minimum 140 BHN. Ring Joint flanges shall have octagonal section of Ring Joint.

5.0 DESIGN AND MANUFACTURE

5.1 Flanges such as weld neck flanges and blind flanges shall conform to the requirements of ASME B16.5 upto sizes DN 600 mm (24") excluding DN 550 mm (22"), and MSS-SP-44 for sizes DN 550 mm (22") and ASME B16.47 (Series A) for sizes DN 650 mm (26") and above.

5.2 Spectacle blind and spacer & blind shall conform to the requirements of ASME B 16.48 upto sizes DN 600 mm (24"). For sizes DN 650 mm (26") and above, spectacle blind and spacer & blind shall conform to EIL standard. For sizes upto DN 600 mm (24") handle projection dimensions of spacers & blinds shall be as per EIL Std. 7-44-0166. For sizes above DN 600

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mm (24") handle projection shall be as per EIL Standard, it shall be ensured that both the holes (hole for lifting lug and the hole for identification as spacer) are minimum 75 mm outside the outside diameter of the corresponding weld neck end flange of ASME B-16.47 series A. Ring joint Fig.8 flanges, spacers & blinds shall be female type only.

5.3 Type, face and face finish of flanges shall be as specified in Material/Purchase Requisition/ Tender.

5.4 Fittings such as tees, elbows, reducers, etc. shall be either welded or seamless type. All welded fittings shall be subjected to heat treatment. All fittings (except weldolets) shall comply with the requirements of MSS-SP-75/ ASME B16.9. Welded pipes used for fittings shall be SAWL (Longitudinally Seam Submerged Arc Welded) type only.
Weldolet Fittings for branch size of 18 inch and above shall be manufactured in accordance with MSS-SP-97. The Weldolet Fitting shall be of Forged Seamless Type only.

5.5 For reducing butt weld fittings having different wall thickness at each end, the greater thickness of fitting shall be employed and inside bore at each end shall be matched with the specified inside diameter.

5.6 Tees shall be manufactured by forging or forming method. Stub-in or pipe to pipe connection shall not be used in the manufacture of tees. The longitudinal weld seam shall be kept at 90^0 from the extrusion. Fittings shall not have any circumferential weld joint.

5.7 All butt weld ends shall be bevelled as per ASME B16.5/MSS-SP-44/ASME B16.47 as applicable for flanges and MSS-SP-75/ ASME B16.9/ MSS-SP-97 as applicable for fittings.

5.8 Inside weld projection for welded fittings shall not exceed 1.6 mm. The reinforcement of inside weld seam shall be removed for a distance of 100 mm from each end of welded fittings.

5.9 All welds shall be made by welders and welding procedures qualified in accordance with provisions of ASME Sec. IX. The procedure qualification shall include Charpy V-notch test for weld/heat affected zone and hardness test in accordance with clause 4.3 and 4.4 of this specification respectively.

5.10 Repair by welding on flanges and parent metal of fittings is not permitted. Repair of weld seam by welding shall be carried out by welders and welding procedures duly qualified as per ASME Section IX and records for each repair shall be maintained. Repair welding procedure qualification shall include all tests, which are applicable for regular production welding procedure qualification. All heat treatment and radiography shall be repeated after the repair.

5.11 The tolerance on internal diameter and out of roundness at the ends for welded fittings shall be as per connected pipe specification / as indicated in Requisition/ tender.

6.0 INSPECTION AND TESTS

6.1 The Manufacturer shall perform all inspections and tests as per the requirement of this specification and the relevant codes, prior to shipment at his works. Such inspections and tests shall be, but not limited to the following:

6.1.1 All flanges and fittings shall be visually inspected. The internal and external surfaces of the flanges and fittings shall be free from any strikes, gouges and other detrimental defects.

6.1.2 Dimensional checks shall be carried out on finished products as per ASME B16.5/MSS-SP-44/ASME B16.47 (Series A) as applicable for flanges, ASME B 16.48 for spacers and blinds and ASME B16.9/MSS-SP-75/ MSS-SP-97 as applicable for fittings and as per this specification.

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6.1.3 Chemical composition and mechanical properties for parent material and weld shall be checked as per relevant material standards and this specification, for each heat treatment lot and for each heat of steel used.

6.1.4 The non-destructive inspection shall be carried out as given below:

a) All butt and repair welds for welded fittings shall be examined 100 % by radiography. Acceptance criteria shall be as per ASME B 31.4 or ASME B 31.8 as applicable and API 1104. Radiography shall be performed after the final heat treatment.

b) When elbows of size ≥ DN 450 mm (18") are manufactured, the first elbow of each radius, diameter and wall thickness shall be ultrasonically checked for sufficient wall thickness in areas where a minimum wall thickness is to be expected. This shall be followed by random inspection of one out of every three elbows of the same radius, diameter and wall thickness.

c) All finished wrought weld ends shall be 100% tested for lamination type defects by ultrasonic test. Any lamination larger then 6.35 mm shall not be acceptable.

d) Magnetic particle or liquid penetrant examination shall be performed on cold formed butt welding tees with extruded outlets as per applicable material standard.

e) Welds, which cannot be inspected by radiographic methods, shall be checked by ultrasonic or magnetic particle methods. Acceptance criteria shall be as per ASME Section VIII Appendix U and Appendix VI respectively.

6.2 Purchaser's Inspector reserves the right to perform stage wise inspection and witness tests, as indicated in clause 6.1 of this specification at Manufacturer's Works prior to shipment. Manufacturer shall give reasonable notice of time and shall provide, without charge, reasonable access and facilities required for inspection, to the Purchaser's Inspector.

Inspection and tests performed/witnessed by Purchaser's Inspector shall in no way relieve the Manufacturer's obligation to perform the required inspection and tests.

7.0 TEST CERTIFICATES

Manufacturer shall furnish the following certificates:

a) Test certificates relevant to the chemical analysis and mechanical properties of the materials used for manufacture of flanges and fittings as per relevant standards and this specification.

b) Test Reports on radiography, ultrasonic inspection, and magnetic particle / liquid penetrant examination.

c) Test reports of heat treatment carried out as per the specification.

d) Welding procedures and welders qualification reports.

e) Test certificate for each fitting stating that it is capable of withstanding without leakage a test pressure, which results in a hoop stress equivalent to 100 % of the specified minimum yield strength for the pipe with which the fitting is to be attached without impairment of serviceability.

f) Batch Test Certificates for Weld consumables used.

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8.0 PAINTING, MARKING AND SHIPMENT

8.1 After all inspection and tests required have been carried out; all external surfaces shall be thoroughly cleaned to remove grease, dust and rust. Surface preparation for the fittings & flanges (other than flange facing) shall be as per SA2½/ SSPC-SP-10. External surfaces of flanges & fittings shall be applied with standard mill coating for protection against corrosion during transit and storage. The coating shall be easily removable in the field.

8.2 Ends of all fittings and weld neck flanges shall be suitably protected to avoid any damage during transit. Metallic or high impact plastic bevel protectors shall be provided for flanges and fittings. Flange face shall be suitably protected to avoid any damage during transit.

8.3 All flanges and fittings shall be marked as per applicable dimension/manufacturing standard.

9.0 DOCUMENTATION

Documentation to be submitted by Manufacturer to Company is summarized below. Number of Copies (Hard copies / soft copies etc.) shall be as indicated in CONTRACT document/Material Requisition.

9.1 Prior to shipment, the Manufacturer shall submit the test certificates as listed in clause 7.0 of this specification.

9.2 All documents shall be in English Language only.

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सीमवर्जित फिटिंग्स एवं फ्लेन्जेस के लिए मानक विनिर्देश (साइज डीएन 400 मि.मी. (16") तक)

STANDARD SPECIFICATION FOR SEAMLESS FITTINGS & FLANGES (SIZE UP TO DN 400 mm (16"))

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	10-02-17	REVISED & REISSUED AS STANDARD SPECIFICATION	RB	NR	VM	RN
4	16-02-12	REVISED & REISSUED AS STANDARD SPECIFICATION	GD	SKJ	VM	DM
3	21-11-06	REVISED & REISSUED AS STANDARD SPECIFICATION	MKM	SK	AS	
2	25-10-01	REVISED & REISSUED AS STANDARD SPECIFICATION	MKM	KKS	SJ	GRR
1	21-09-98	REVISED & REISSUED AS STANDARD SPECIFICATION	ALP	ASo	VC	AS

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Abbreviations:

API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society of Testing of Materials
BHN	:	Brinell Hardness Number
CE	:	Carbon Equivalent
DN	:	Nominal Diameter
HAZ	:	Heat Affected Zone
LPG	:	Liquified Petroleum Gas
LTCS	:	Low Temperature Carbon Steel
MSS-SP	:	Manufacturers Standardization Society – Standard Practice
RJ	:	Ring Joint
SSPC	:	The Society for Protective Coatings

Pipeline Engineering Standards Committee

Convenor : Mr. Vinay Mittal

Members :
Mr. Brij Raj Meena
Mr. M. S. Gunjiyal
Mr. Gagan Deep Singh
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Mr. S. Ghosal (Process-2)
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Mr. R.K. Singh (Inspection)
Mr. K.V.K. Naidu (Projects)

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1.0 SCOPE

This specification covers the minimum requirements for the design, manufacture and supply of following carbon steel flanges and fittings of size upto DN 400 mm (16") to be installed in onshore pipeline systems handling non-sour hydrocarbons in liquid or gaseous phase including Liquefied Petroleum Gas (LPG):

- Flanges such as welding neck flanges, blind flanges, spectacle blinds, spacers and blinds etc.

- Seamless fittings such as tees, elbows, reducers, caps, outlets, forged weldolets, etc.

2.0 REFERENCE DOCUMENTS

Reference has been made in this specification to the latest edition (edition enforce at the time of issue of enquiry) of the following Codes, Standards and Specifications:

a.	ASME B31.4	-	Pipeline Transportation Systems for Liquids and Slurries
b.	ASME B31.8	-	Gas Transmission and Distribution Piping Systems
c.	ASME B16.5	-	Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/ Inch Standard
d.	ASME B16.9	-	Factory Made Wrought Buttwelding Fittings
e.	ASME B 16.11	-	Forged Fittings, Socket-Welding and Threaded
f.	ASME B 16.48	-	Line Blanks
g.	API 1104	-	Welding of Pipelines and Related Facilities
h.	ASME Sec VIII	-	Boiler and Pressure Vessel Code - Rules for Construction of Pressure Vessels
i.	ASME Sec IX	-	Boiler and Pressure Vessel Code-Welding, Brazing and Fusing Qualifications
j.	ASTM A 370	-	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
k.	MSS-SP-25	-	Standard Marking System for Valves, Fittings, Flanges and Unions
l.	MSS-SP-97	-	Integrally Reinforced Forged Branch outlet Fittings-Socket Welding, Threaded and Buttwelding Ends
m.	MSS-SP-75	-	High-Strength, Wrought, Butt-Welding Fittings

In case of conflict between the requirements of this specification and the Codes, Standards and Specifications referred above, the requirements of this specification shall govern.

3.0 MANUFACTURER'S QUALIFICATION

Manufacturer who intends bidding for fittings must possess the records of a successful proof test, in accordance with the provisions of ASME B 16.9/ MSS-SP-75, as applicable. These

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records shall be submitted when specified, at the time of bidding qualifying the entire range of fittings offered.

4.0 MATERIAL

4.1 The Carbon Steel used in the manufacture of flanges and fittings shall be fully killed. Material for flanges and fittings shall comply with the material standard indicated in the Material/ Purchase Requisition/ Tender. In addition, the material shall also meet the requirements specified hereinafter.

4.2 Each heat of steel used for the manufacture of flanges and fittings shall have Carbon Equivalent (CE) not greater than 0.45 calculated from check analysis in accordance with the following formula:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

4.3 For all flanges and fittings of DN 50 mm (2") and above, Charpy V-notch test shall be conducted for each heat treatment lot and for each heat of steel used. Unless specified otherwise, the Charpy V-notch test shall be conducted at 0° C in accordance with the impact test provisions of ASTM A 370 for flanges and fittings. Results of charpy test shall be recorded.

The average absorbed impact energy values of three full-sized specimens shall be 27 joules. The minimum impact energy value of any one specimen of the three specimens analysed as above, shall not be less than 22 Joules.

When Low Temperature Carbon Steel (LTCS) materials are specified in Requisition/ Tender for flanges and fittings, the Charpy V-notch test requirements of applicable material standard shall be complied with.

4.4 For flanges and fittings specified to be used for Gas service or LPG service, Hardness test shall be carried out in accordance with ASTM A 370 for each heat treatment lot and for each heat of steel used. Hardness testing shall cover at least 10% per item, per size, per heat treatment lot, per heat, per manufacturing method. A full thickness cross section shall be taken for this purpose and the maximum hardness shall not exceed 248 HV_{10}. Hardness shall be recorded.

4.5 In case of RJ (Ring Joint) flanges, the groove hardness shall be minimum 140 BHN. Ring Joint flanges shall have octagonal section of Ring Joint.

5.0 DESIGN AND MANUFACTURE

5.1 Flanges such as weld neck flanges and blind flanges shall conform to the requirements of ASME B16.5.

5.2 Spectacle blind and spacer & blind shall conform to the requirements of ASME B 16.48. For sizes upto DN 400 mm (16") handle projection dimensions of spacers & blinds shall be as per EIL Std. 7-44-0166.

5.3 Butt welded end fittings such as tees, elbows, reducers, etc. shall be seamless type and shall conform to ASME B16.9/ MSS-SP-75. Socket weld and screwed end fittings shall conform to ASME B 16.11 . Ring joint Fig.8 flanges, spacers & blinds shall be female type only.

5.4 Fittings such as weldolets, sockolets, nippolets, etc. shall be manufactured in accordance with MSS-SP-97.

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5.5 Type, face and face finish of flanges shall be as specified in Requisition/ tender.

5.6 Flanges and fittings manufactured from bar stock are not acceptable.

5.7 All butt weld ends shall be bevelled as per ASME B 16.5/ASME B 16.9/MSS-SP-97 as applicable.

5.8 Repair by welding on flanges and fittings are not permitted.

6.0 INSPECTION AND TESTS

6.1 The Manufacturer shall perform all inspections and tests as per the requirement of this specification and the relevant codes, prior to shipment at his works. Such inspections and tests shall be, but not limited to the following:

6.1.1 All flanges and fittings shall be visually inspected. The internal and external surfaces of the flanges and fittings shall be free from any strikes, gouges and other detrimental defects.

6.1.2 Dimensional checks shall be carried out on finished products as per ASME B16.5 for flanges, ASME B 16.48 for spacers and blinds and ASME B16.9/MSS-SP-97 as applicable for fittings and as per this specification.

6.1.3 Chemical composition and mechanical properties shall be checked as per relevant material standards and this specification, for each heat treatment lot and for each heat of steel used.

6.1.4 All finished wrought weld ends shall be 100% tested for lamination type defects by ultrasonic test. Any lamination larger then 6.35 mm shall not be acceptable.

6.1.5 Magnetic particle or liquid penetrant examination shall be performed on cold formed butt welding tees with extruded outlets as per applicable material standard.

6.2 Purchaser's Inspector reserves the right to perform stage wise inspection and witness tests, as indicated in clause 6.1 of this specification at Manufacturer's Works prior to shipment. Manufacturer shall give reasonable notice of time and shall provide, without charge, reasonable access and facilities required for inspection, to the Purchaser's Inspector.

Inspection and tests performed/witnessed by Purchaser's Inspector shall in no way relieve the Manufacturer's obligation to perform the required inspection and tests.

7.0 TEST CERTIFICATES

Manufacturer shall furnish the following certificates:

a) Test certificates relevant to the chemical analysis and mechanical properties of the materials used for manufacture of flanges and fittings as per relevant standards and this specification.

b) Test Reports on non destructive testing.

c) The certificates for each fitting stating that it is capable of withstanding without leakage a test pressure, which results in a hoop stress equivalent to 100 % of the specified minimum yield strength for the pipe with which the fitting is to be attached without impairment of serviceability.

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8.0 PAINTING, MARKING AND SHIPMENT

8.1 After all inspection and tests required have been carried out; all external surfaces shall be thoroughly cleaned to remove grease, dust and rust. Surface preparation for the fittings & flanges (other than Flange Facing) shall be as per SA2½/ SSPC-SP-10, External surfaces of Flanges & Fittings shall be applied with standard mill coating for protection against corrosion during transit and storage. The coating shall be easily removable in the field.

8.2 Ends of all fittings and weld neck flanges shall be suitably protected to avoid any damage during transit. Metallic or high impact plastic bevel protectors shall be provided for fittings and flanges. Flange face shall be suitably protected to avoid any damage during transit.

8.3 All flanges and fittings shall be marked as per applicable dimension/manufacturing standard.

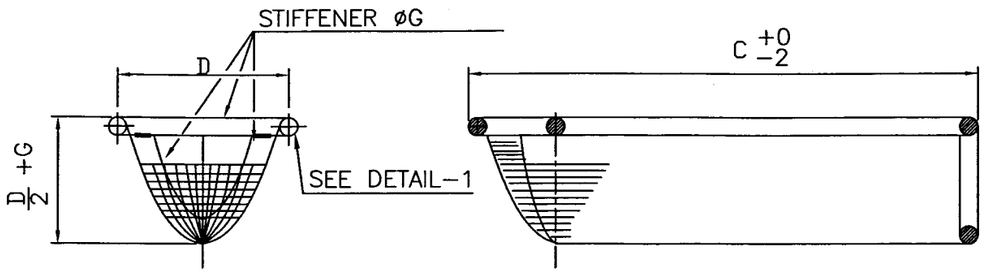
9.0 DOCUMENTATION

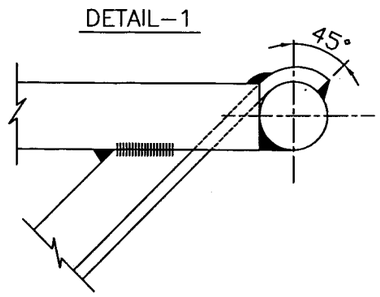
Documentation to be submitted by Manufacturer to Company is summarized below. Number of Copies (Hard copies / soft copies etc.) shall be as indicated in CONTRACT document/Material Requisition.

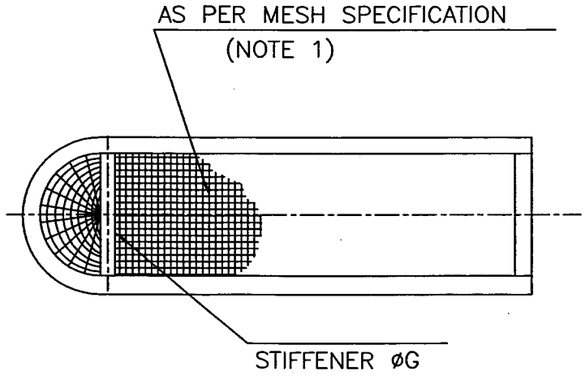
9.1 Prior to shipment, the Manufacturer shall submit test certificates as listed in clause 7.0 of this specification.

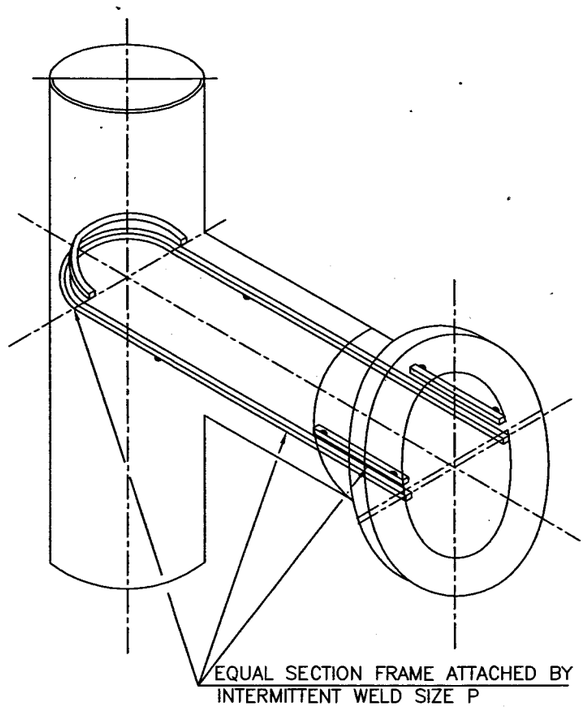
9.2 All documents shall be in English Language only.

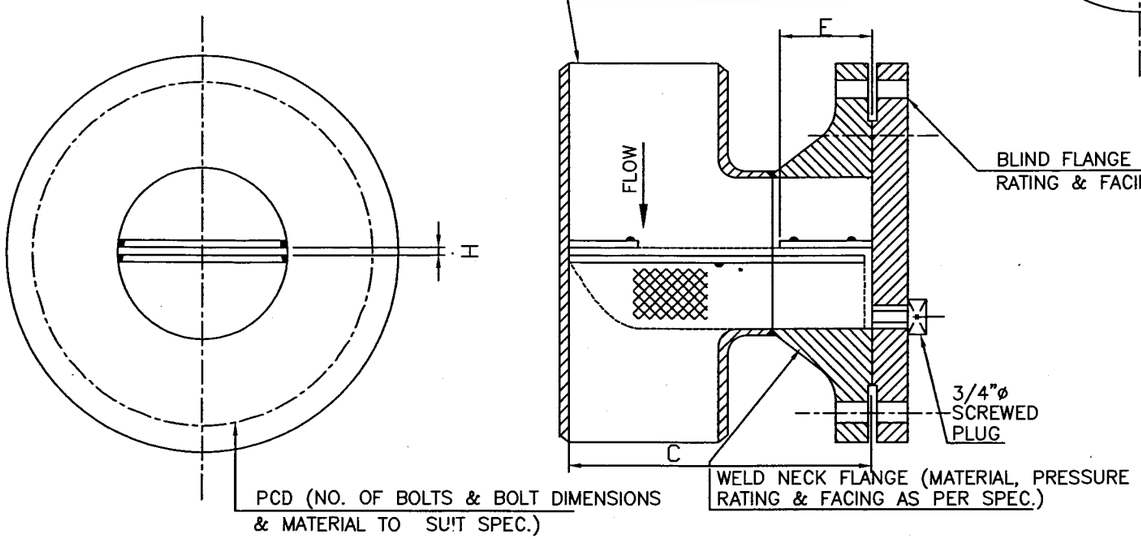
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NOM ø	SCH	C 150CL RF	C 300CL RF	C 300CL RTJ	C 600CL RF	C 600CL RTJ	D	E	H	G	P
2"	40, STD	154	160	168	170	171	51	58	8	6	6X6
	80, XS	152	158	166	168	169	48				
	160	149	155	163	165	166	40				
	XXS	147	153	161	163	164	35				
$2\frac{1}{2}$"	40, STD	177	183	190	192	198	61	64	8	6	6X6
	80, XS	175	181	194	190	196	57				
	160	172	179	192	188	194	51				
3"	40, STD	194	204	211	213	214	76	64	8	6	6X6
	80, XS	192	202	209	211	212	72				
	160	189	198	206	208	209	64				
	XXS	185	194	202	204	205	54				
4"	40, STD	232	242	250	264	266	100	64	8	6	6X6
	80, XS	229	239	247	261	263	95				
	120	227	237	245	259	261	89				
	160	224	234	242	256	258	83				
	XXS	221	231	239	253	255	75				

MESH SPECIFICATIONS (NOTE–1)

SERVICE		OPENING (IN)	MESH SPECIFICATION	OPEN AREA%	MESH DESIGNATION
OIL VISCOSITY IN cP	LOW VISCOCITY 0 < ɣ < 2	0.097	8 MESH 22 SWG	62.2	TYPE 4
	MIDIUM VISCOSITY 2 ≤ ɣ ≤ 8	0.111	7 MESH 21 SWG	60.3	TYPE 3
	HIGH VISCOSITY ɣ > 8	0.202	4 MESH 18 SWG	65.3	TYPE 2
GASOLINE, PROPANE		0.053	14 MESH 26 SWG	55.1	TYPE 5
WATER		0.053	14 MESH 26 SWG	55.1	TYPE 5

NOTES:–

1. THE MESH SPECIFICATIONS AS GIVEN IN THE TABLE ARE TO BE USED WHEN STRAINER IS INTENDED TO BE USED AS PERMANENT STRAINER. IN CASE OF TEMPORARY STRAINER THE MESH SPECIFICATION SHALL BE AS FOLLOWS:
   FOR LINES UPTO $2\frac{1}{2}$"–
   S.S STD. STOCK MESH 0.047" DIA WIRE X0.203 SQ.CLEAR OPENING–65.9 % OPEN AREA
   FOR LINES 3"& ABOVE –
   S.S STD. STOCK MESH 0.08" DIA WIRE X0.253 SQ.CLEAR OPENING– 57.6 % OPEN AREA.
2. MATERIAL AS PER LINE SPECIFICATION.
3. 3/4"ø SCREWED PLUG FOR DRAIN CONNECTION SHALL BE PROVIDED.

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (भारत सरकार का उपक्रम) (A Govt. of India Undertaking)

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	22.03.18	REAFFIRMED AND ISSUED AS STANDARD	PK	SH	MI	RN
5	28.03.13	REVISED AND ISSUED AS STANDARD	UK	SH	RN ATD	DM
					Approved by	

T-STRAINER TYPE-1 2"-4"

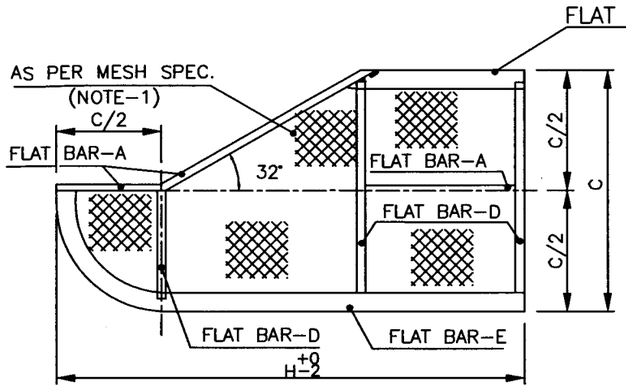
(150CL RF,300CL RF AND RTJ, 600CL RF AND RTJ)

STANDARD No.

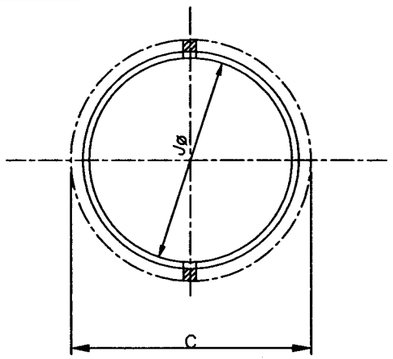
7-44-0303 Rev. 6

Page 1 of 1

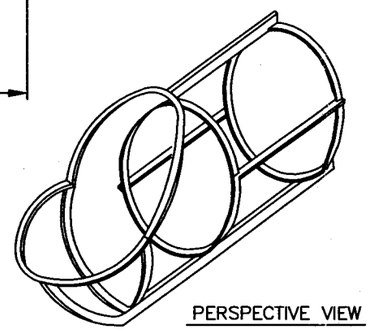
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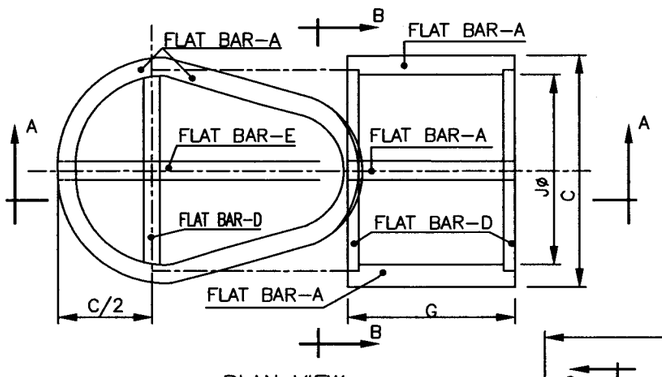
SECTION-A FILTER DETAIL



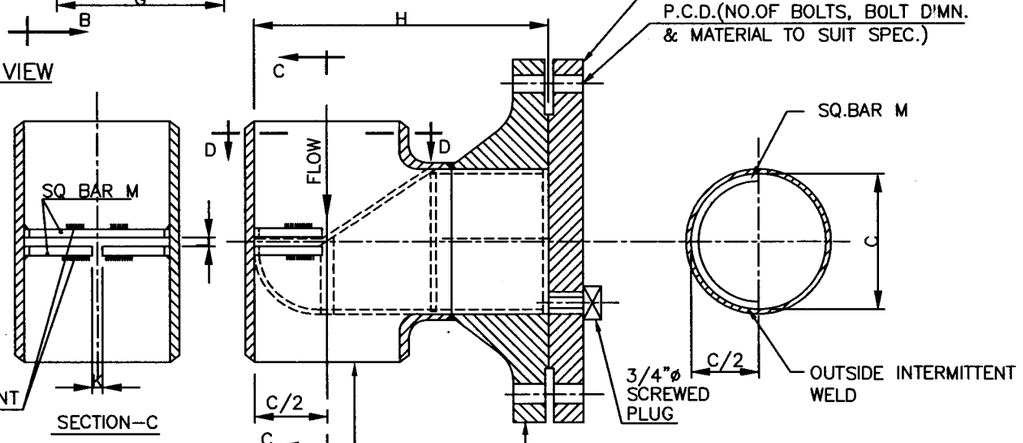
SECTION-B



PERSPECTIVE VIEW



PLAN VIEW



SECTION-D

MESH SPECIFICATION(NOTE-1)

SERVICE		STRAINER SIZE NOM.(IN)	OPENING (IN)	MESH SPECIFICATION	OPEN AREA %	MESH DESIGNATION
OIL VISCOSITY IN cP	LOW VISCOCITY 0 <ν< 2	6"	0.097	8MESH 22SWG	60.2	TYPE 4
		8"AND ABOVE	0.111	7MESH 21SWG	60.3	TYPE 3
	MEDIUM VISCOSITY 2 <ν< 8	6"	0.111	7MESH 21SWG	60.3	TYPE 3
		8"AND ABOVE	0.202	4MESH 18SWG	65.3	TYPE 2
	HIGH VISCOSITY ν > 8	6"	0.202	4MESH 18SWG	65.3	TYPE 2
		8"AND ABOVE	0.269	3MESH 16SWG	65.2	TYPE 1
GASOLINE PROPANE		6" AND 8"	0.053	14MESH 26SWG	55.1	TYPE 5
		10"AND ABOVE	0.087	8MESH 22SWG	60.2	TYPE 4
WATER		6" ABOVE	0.115	7MESH 21SWG	60.3	TYPE 3

NOM ø	SCH	H 150# RF	H 300# RF	H 300# RTJ	H 600# RF	H 600# RTJ	C	J	G 150# RF	G 300# RF	G 300# RTJ	G 600# RF	G 600# RTJ	FLAT BAR D	FLAT BAR E	FLAT BAR A	L	K	SQ BAR M
6"	40	308	318	331	343	349	151	131	121	131	144	156	162	15X5	10X5	10X5	7	8	10X10
	80	304	314	327	339	345	143	123	129	139	152	164	170						
	120	301	311	324	336	342	137	117	133	143	156	168	174						
	160	297	307	321	332	338	129	109	139	149	162	174	180						
	XXS	293	303	316	328	334	122	102	144	154	167	179	185						
8"	20-30	382	391	404	420	425	203	183	129	138	151	167	172	15X5	10X5	10X5	7	8	10X10
	40-60	378	387	400	416	421	197	177	132	141	154	170	175						
	80	376	386	399	415	420	192	172	137	147	160	176	181						
	120	370	380	393	409	414	180	160	146	156	169	185	190						
	XXS-160	366	376	389	405	410	171	151	154	164	177	193	198						
10"	20-30	446	462	475	503	509	256	216	125	141	154	182	188	15X5	20X10	20X5	7	14	10X10
	40	444	460	473	501	508	253	213	127	143	156	184	191						
	60	441	457	470	498	504	246	206	133	149	162	190	196						
	80	439	455	468	496	502	241	201	137	153	166	194	200						
	120	432	448	461	489	495	228	188	147	163	176	204	210						
	160	–	–	–	482	488	214	174	–	–	–	215	221						
12"	20	523	539	552	571	577	310	270	132	148	161	180	186	15X5	20X10	20X5	8	14	12X12
	30	521	537	550	569	575	305	265	137	153	166	185	191						
	STD-40	519	535	548	567	573	302	262	139	155	168	187	193						
	XS-60	515	531	544	563	569	294	254	145	161	174	193	199						
	80	512	528	541	560	566	287	247	151	167	180	199	205						
	120	504	520	533	552	558	271	231	163	179	192	211	217						
	160	–	–	–	544	550	255	215	–	–	–	224	230						
14"	10	577	593	606	621	627	341	291	148	164	177	192	198	15X5	25X10	25X6	10	16	12X12
	20	575	591	604	619	625	338	288	150	166	179	194	200						
	30-40	572	588	601	616	623	332	282	155	171	184	199	206						
	XS	570	586	599	614	620	328	278	158	174	187	202	208						
	60	–	584	597	612	618	324	274	–	177	190	205	211						
	80	–	580	593	608	614	316	266	–	183	196	211	217						
16"	10	628	647	660	686	691	392	332	135	154	167	193	198	20X5	30X12	30X7	10	16	14X14
	20	627	646	659	685	690	389	329	138	157	170	196	201						
	30	625	644	657	683	688	386	326	140	159	172	198	203						
	XS-40	–	641	654	680	685	379	319	–	165	178	204	209						
	60	–	–	–	676	681	371	311	–	–	–	210	215						
	80	–	–	–	671	676	361	301	–	–	–	218	223						
18"	10	704	724	737	755	761	443	373	146	166	179	197	203	20X5	35X12	35X7	10	16	14X14
	20	703	722	735	753	759	440	370	149	168	181	199	205						
	STD	701	720	733	751	757	437	367	151	170	183	201	207						
	30	700	719	732	750	756	433	363	155	174	187	205	211						
	XS	698	717	730	748	754	430	360	157	176	189	207	213						
	40	–	–	–	747	753	427	357	–	–	–	209	215						
	60	–	–	–	743	749	419	349	–	–	–	216	222						
20"	10	773	790	805	825	832	493	413	153	170	185	205	212	20X5	40X15	40X8	11	20	14X14
	STD-20	769	787	802	822	829	487	407	156	174	189	209	216						
	XS-30	766	784	799	819	826	480	400	162	180	195	215	222						
	40	–	–	–	816	823	476	396	–	–	–	217	224						
	60	–	–	–	811	818	464	384	–	–	–	227	234						
24"	10	882	898	914	940	949	594	504	132	148	164	190	199	20X5	45X15	45X8	11	20	14X14
	STD-20	879	895	911	937	946	588	498	136	152	168	194	203						
	XS	876	892	908	934	943	582	492	141	157	173	199	208						
	30	–	–	–	932	941	579	489	–	–	–	201	210						
	40	–	–	–	928	937	572	482	–	–	–	206	215						

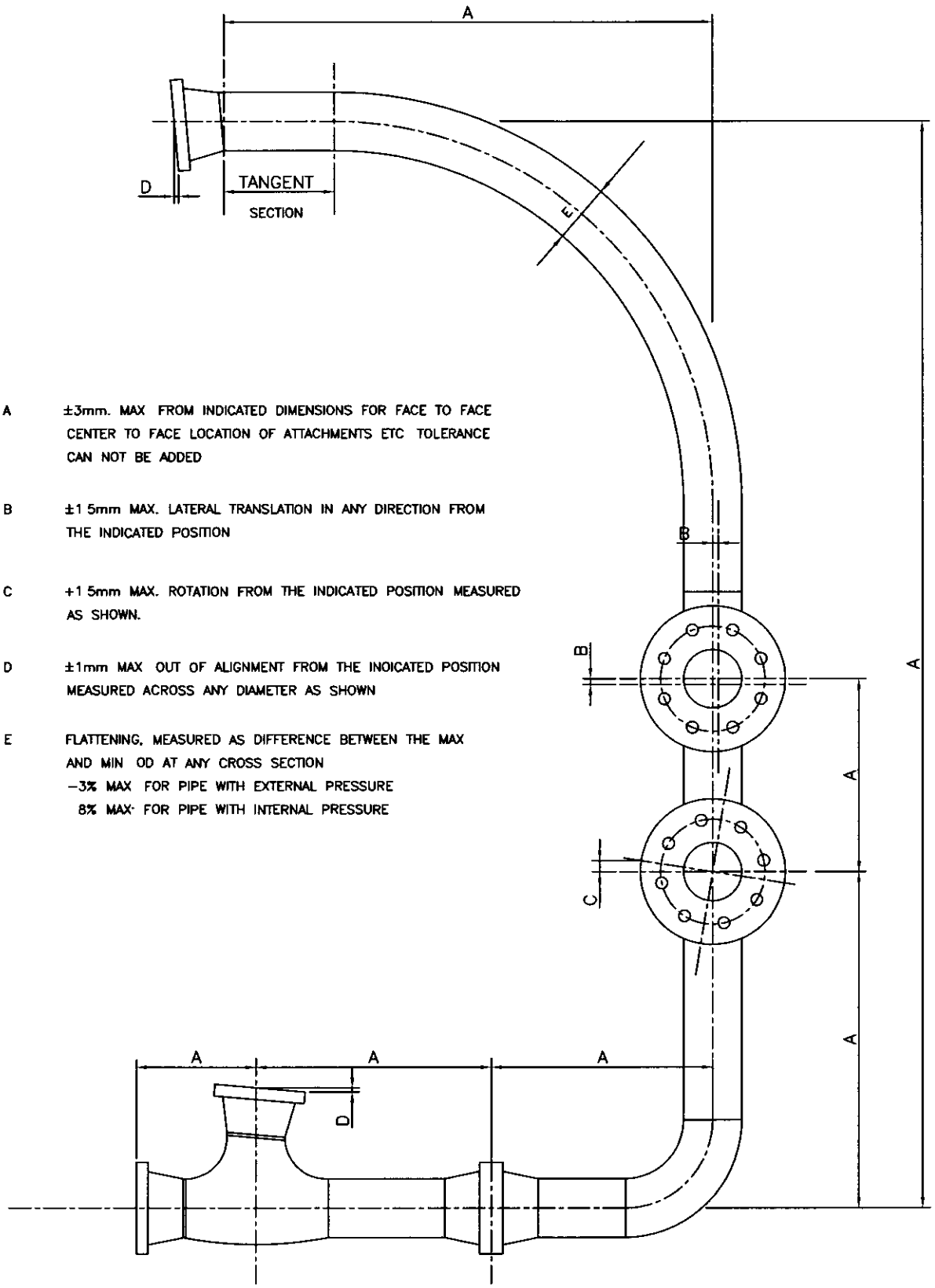
NOTES:–
1. THE MESH SPECIFICATION AS GIVEN IN THE TABLE IS TO BE USED WHEN STRAINER IS INTENDED TO BE USED AS PERMANENT STRAINER IN CASE OF TEMPORARY STRAINER THE MESH SPECIFICATIONS SHALL BE AS FOLLOWS: FOR LINE UPTO2½"–S.S STD. STOCK MESH 0.07" DIA WIRE X0.203 SQ.CLEAR OPENING–65.9% OPEN AREA FOR LINES 3"& ABOVE S.S.STD. STOCK MESH 0.08" DIA WIRE X0.253 SQ.CLEAR OPENING– 57.6% OPEN AREA.
2. MATERIAL AS PER LINE SPECIFICATION
3. 3/4"ø SCREWED PLUG FOR DRAIN CONNECTION SHALL BE PROVIDED

इंजीनियर्स इंडिया लिमिटेड (भारत सरकार का उपक्रम) ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
6	30/03/2017	Revised and Issued as Standard	PK	SH	MI	RN
5	05/09/2011	Revised and Issued as Standard	SH	RN	ATD	DM

T STRAINER TYPE-1
6"-24" (150# RF, 300# RF AND RTJ, 600# RF AND RTJ)

STANDARD No.
7-44-0304 Rev. 6



A ±3mm. MAX FROM INDICATED DIMENSIONS FOR FACE TO FACE CENTER TO FACE LOCATION OF ATTACHMENTS ETC TOLERANCE CAN NOT BE ADDED

B ±1 5mm MAX. LATERAL TRANSLATION IN ANY DIRECTION FROM THE INDICATED POSITION

C +1 5mm MAX. ROTATION FROM THE INDICATED POSITION MEASURED AS SHOWN.

D ±1mm MAX OUT OF ALIGNMENT FROM THE INOICATED POSITION MEASURED ACROSS ANY DIAMETER AS SHOWN

E FLATTENING, MEASURED AS DIFFERENCE BETWEEN THE MAX AND MIN OD AT ANY CROSS SECTION
−3% MAX FOR PIPE WITH EXTERNAL PRESSURE
8% MAX· FOR PIPE WITH INTERNAL PRESSURE

Rev No.	Date	Purpose	Prepared by	Checked by	Stds Committee Convenor	Stds Bureau Chairman
5	31.12.18	REAFFIRMED & ISSUED AS STANDARD	PK	SH	MI	RKT
4	31 12.13	REAFFIRMED & ISSUED AS STANDARD	UK	SH	AK RN	SC

Approved by

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OVERHEAD CLEARANCES :

Equipment, structure, platforms, piping & its supports shall be arranged to provide the following clearances overhead :

Over rail roads, top of rail to bottom of any obstruction	7 m
Over plant roads for major mobile equipment	7 m
Over secondary roads (bottom of pipe) and access ways for mobile equipment	5 m
Over grade & bottom of pipe (inside battery limit) at pump row access way	3.5 m
Over walk-ways, pass-ways & platforms to nearest obstruction and inside building	2.2 m
Over exchangers at grade, shell cover channel end	1.5 m
Clearance below offsite Pipe rack	2.2 m

HORIZONTAL CLEARANCES:

Between exchangers (aisles between piping)	0.9 m
Around pumps (aisles between piping)	0.9 m
Fired heaters to pumps handling flammable stock	15 m
Fired heaters to other flammable containing equipment not closely associated with heaters	15 m
At driver end of pumps, where truck access is required	3 m
At driver end of pumps, where truck access is not required	1.8 m
At shell cover end of exchangers at grade, for access way	1.3 m
Between shells of adjacent horizontal vessels	1.2 m

Rev. No	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
3	01.07.15	REAFFIRMED & ISSUED AS STANDARD	SH	AK	RN	SC
2	10.07.10	REVISED & ISSUED AS STANDARD	PK	RN	SC	DM ND

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PIPE BERTHING :

Under ground	300 mm minimum clear gap between pipes	
Above ground	Normal-	Flange to bare pipe (or insulation) plus 25 mm

EQUIPMENT SPACING :

Small pumps (3.7 kw & less)	Mounted on common foundations Suitable centre to centre distance
Medium pumps (22.5 kw & less)	900 mm clear aisle
Larger pumps (above 22.5 kw)	900 mm clear aisle
Exchangers and other equipment on structures	900 mm minimum clear aisle

PLATFORMS :

Towers, vertical & horizontal vessels :

Distance of platform below centreline of manhole flange - side platform	900-1050 mm
Width of manhole platform from manhole cover to outside edge of platform	900 mm
Platform extension beyond centreline of manhole - side platform	900 mm
Distance of platform below underside of flange - head platform	175 mm
Width of platform from three sides of manhole - head platform	750 mm

Rev. No	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
3	01.07.15	REAFFIRMED & ISSUED AS STANDARD	SH	AK	RN	SC
2	10.07.10	REVISED & ISSUED AS STANDARD	PK	RN	SC	DM ND

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HORIZONTAL EXCHANGER :

Clearance in front of channel or bonnet flange	1200 mm
Heat exchanger tube bundle removal space	Bundle length+1 m
Min. clearance from edge of flanges	300 mm

VERTICAL EXCHANGER :

Distance of platform below top flange of channel or bonnet	1500 mm

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ACCESSIBILITY FOR VALVES AND INSTRUMENTS

VALVES, INSTRUMENTS, EQUIPMENT TO BE OPERATED	CENTRE LINE OF ITEM TO BE OPERATED, LOCATED LESS THAN 3.6m ABOVE GRADE, 2.75m ABOVE FLOOR OR PLATFORM OR 1.8m ABOVE WING PLATFORM	CENTRE LINE OF ITEM TO BE OPERATED, LOCATED MORE THAN 3.6m ABOVE GRADE, 2.75m ABOVE FLOOR OR PLATFORM OR 1.8m ABOVE WING PLATFORM
EXCHANGER HEADS	NIL	PLATFORM
OPER. VALVES 2" & SMALLER	FIXED LADDER	FIXED LADDER
OPER. VALVES 3" & ABOVE	PLATFORM	PLATFORM
MOTOR OPERATED VALVES	PLATFORM	PLATFORM
CONTROL VALVES	PLATFORM	PLATFORM
RELIEF VALVES 2" & SMALLER	FIXED LADDER	FIXED LADDER
RELIEF VALVES 3" & ABOVE	PLATFORM	PLATFORM
BLOCK VALVES 2" & SMALLER	PORTABLE LADDER	PLATFORM
BLOCK VALVES 3" & ABOVE	PLATFORM (NOTE-1)	PLATFORM (NOTE-1)
BATTERY LIMIT VALVES	PLATFORM	PLATFORM
PRESSURE INSTRUMENT	FIXED LADDER IF ABOVE 2.2 m HEIGHT	FIXED LADDER
TEMPERATURE INSTRUMENT	FIXED LADDER IF ABOVE 2.2 m HEIGHT	FIXED LADDER
SAMPLE POINTS	PLATFORM	PLATFORM
GAUGE GLASSES	FIXED LADDER	FIXED LADDER
LEVEL CONTROLLERS	PLATFORM	PLATFORM
PROCESS BLINDS & SPACERS 2" & SMALLER	PORTABLE LADDER / PLATFORM	PLATFORM
PROCESS BLINDS & SPACERS 3" & ABOVE	PLATFORM	PLATFORM
MANWAYS / MANHOLES	PLATFORM	PLATFORM
HANDHOLES/ INSPECTION HOLES	PLATFORM	PLATFORM
NOZZLES	NO ACCESS REQD. (NOTE-2)	NO ACCESS REQD. (NOTE-2)
VESSEL VENTS	PORTABLE LADDER	FIXED LADDER
LINE DRAINS & VENTS	PORTABLE LADDER	PORTABLE LADDER
ORIFICE FLANGES	PORTABLE LADDER	PORTABLE LADDER

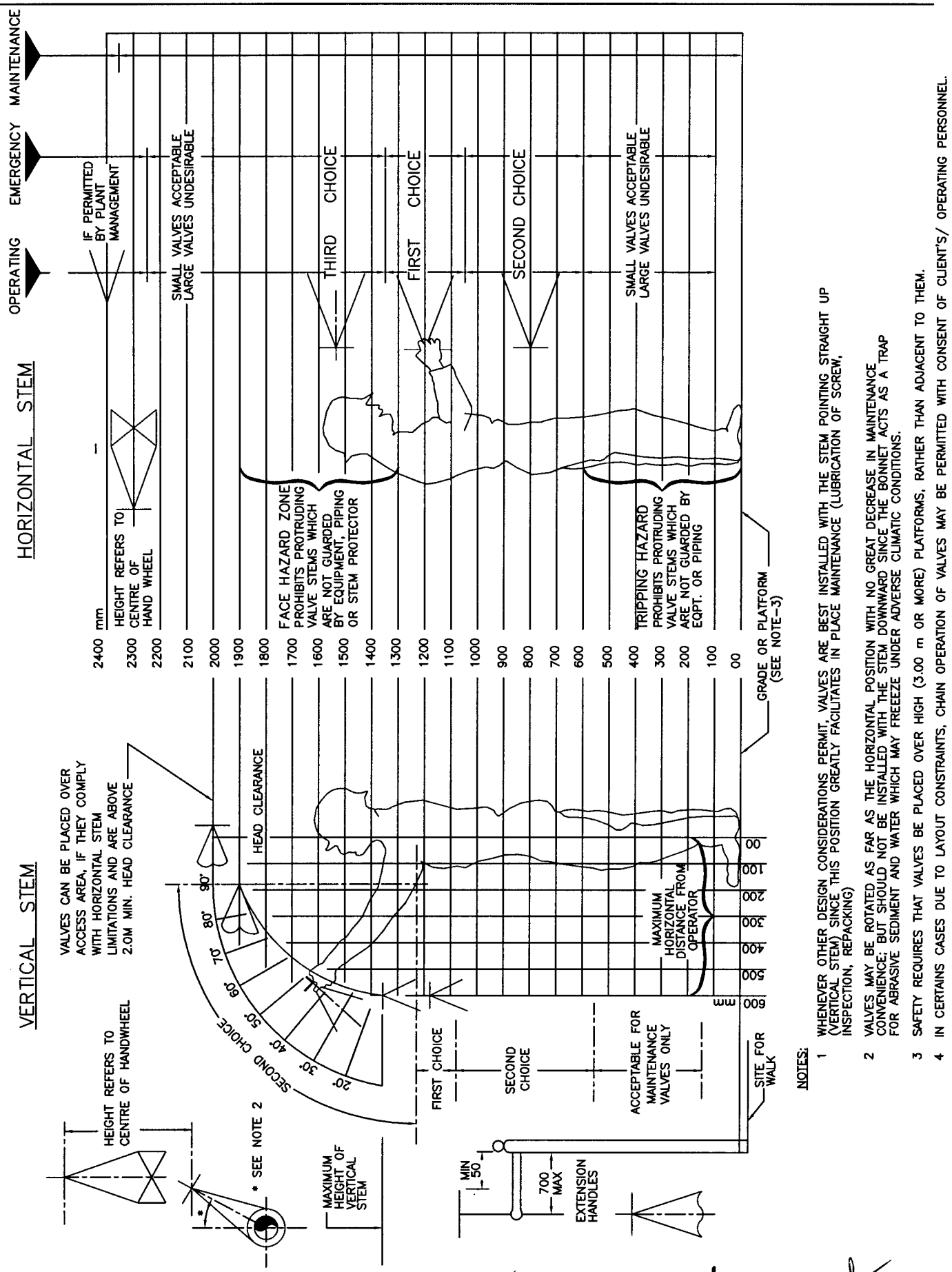
NOTE -1 : BLOCK VALVES WITH CENTRELINE LOCATED ABOVE 2m FROM THE OPERATING FLOOR, WHICH ARE REQUIRED FOR NORMAL OPERATION SHALL BE PROVIDED WITH PORTABLE PLATFORM OR CHAIN FOR OPERATION OF VALVES.

NOTE-2 : TEMPORARY ARRANGEMENT FOR ACCESS SHOULD BE FEASIBLE.

Rev. No	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
3	01.07.15	REAFFIRMED & ISSUED AS STANDARD	SH	AK	RN	SC
2	10.07.10	REAFFIRMED & ISSUED AS STANDARD	PK	RN	SC	DM ND

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VALVE ACCESSIBILITY AND CLEARANCES



NOTES:

1 WHENEVER OTHER DESIGN CONSIDERATIONS PERMIT, VALVES ARE BEST INSTALLED WITH THE STEM POINTING STRAIGHT UP (VERTICAL STEM) SINCE THIS POSITION GREATLY FACILITATES IN PLACE MAINTENANCE (LUBRICATION OF SCREW, INSPECTION, REPACKING)

2 VALVES MAY BE ROTATED AS FAR AS THE HORIZONTAL POSITION WITH NO GREAT DECREASE IN MAINTENANCE CONVENIENCE; BUT SHOULD NOT BE INSTALLED WITH THE STEM DOWNWARD SINCE THE BONNET ACTS AS A TRAP FOR ABRASIVE SEDIMENT AND WATER WHICH MAY FREEEZE UNDER ADVERSE CLIMATIC CONDITIONS.

3 SAFETY REQUIRES THAT VALVES BE PLACED OVER HIGH (3.00 m OR MORE) PLATFORMS, RATHER THAN ADJACENT TO THEM.

4 IN CERTAINS CASES DUE TO LAYOUT CONSTRAINTS, CHAIN OPERATION OF VALVES MAY BE PERMITTED WITH CONSENT OF CLIENT'S/ OPERATING PERSONNEL.

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TABLE OF BASIC SPAN

		PIPE–VAPOR–INSULATION			PIPE–LIQUID–INSULATION			BARE PIPE EMPTY		BARE PIPE WATER FILLED		
		BASIC SPAN (L)M			BASIC SPAN (L)M			UP TO 175°C		UP TO 175°C		
PIPE SIZE IN	SCH/ THK	UP TO 175°C	176°C TO 315°C	316°C TO 400°C	UP TO 175°C	176°C TO 315°C	315°C TO 400°C	SPAN (L) M	WEIGHT KG/M	SPAN (L) M	WEIGHT KG/M	PIPE SIZE IN
3/4	40	3.5	3.5	2.5	3.5	3.0	2.0	4.5	1.68	4.0	2.04	3/4
1	40	4.5	4.0	3.0	4.5	3.5	3.0	5.0	2.52	4.5	3.07	1
1 1/2	40	5.0	5.0	4.5	5.0	4.5	3.5	6.0	4.08	5.0	5.4	1 1/2
2	40	5.5	5.0	3.5	5.0	4.5	3.5	6.5	5.47	5.5	7.65	2
2 1/2	40	6.5	6.0	3.0	6.0	5.5	4.5	7.5	8.7	6.5	11.79	2 1/2
3	40	7.5	6.5	5.5	6.5	6.0	5.0	8.0	11.35	6.5	16.15	3
4	40	8.0	7.5	6.5	7.5	7.0	6.0	9.0	16.2	7.5	24.45	4
6	40	10.0	9.5	8.5	9.0	8.0	7.5	10.5	28.3	9.0	46.7	6
8	40	12.0	11.0	10.0	10.0	10.0	9.0	12.0	42.84	10.0	75.22	8
10	40	13.5	13.0	12.0	11.5	10.5	10.5	14.0	60.74	11.5	111.9	10
12	9.53mm	14.5	13.5	13.0	12.0	11.5	11.0	15.0	74.40	12.0	147.5	12
14	9.53mm	15.0	14.5	13.5	12.0	12.0	11.5	16.0	82.5	12.5	172.05	14
16	9.53mm	16.0	15.5	14.5	13.0	12.5	12.0	17.0	94.5	13.0	213.15	16
18	9.53mm	17.0	16.5	15.0	13.5	13.0	12.0	18.0	106.5	13.5	258.3	18
20	9.53mm	18.0	17.5	16.0	14.0	13.5	12.5	19.0	118.5	14.0	307.5	20
24	9.53mm	20.0	19.0	17.5	14.5	14.5	13.0	21.0	142.5	15.0	418.2	24
3/4	80	3.5	3.5	2.5	3.5	3.0	2.0	4.5	2.20	4.0	2.49	3/4
1	80	4.5	4.0	3.0	4.5	3.5	3.0	5.0	3.25	4.5	3.72	1
1 1/2	80	5.0	5.0	4.5	5.0	4.5	4.0	6.0	5.45	5.0	6.60	1 1/2
2	80	6.0	5.0	4.5	5.5	5.0	4.0	6.5	7.53	6.0	9.45	2
2 1/2	80	6.5	6.0	5.5	6.0	6.0	5.0	7.5	11.49	6.5	14.25	2 1/2
3	80	7.5	6.5	6.0	6.5	6.5	6.0	8.0	15.37	7.0	19.66	3
4	80	8.0	8.0	7.0	7.5	7.5	6.5	9.0	22.47	8.0	29.94	4
6	80	10.5	10.0	9.0	9.5	9.0	8.5	10.5	42.90	9.5	59.85	6
8	12.7mm	12.0	11.5	10.5	10.5	10.0	10.0	12.0	65.10	11.0	94.8	8
10	12.7mm	13.5	13.0	12.0	11.5	11.5	10.5	14.0	82.20	12.0	130.69	10
12	12.7mm	14.5	13.5	13.0	12.5	12.0	11.5	15.0	98.13	13.0	168.64	12
14	12.7mm	15.0	14.5	13.5	13.0	12.5	12.0	16.0	108.15	13.5	194.4	14
16	12.7mm	16.0	15.5	15.0	13.5	13.0	13.0	17.0	124.2	14.0	240.0	16
18	12.7mm	17.5	17.0	16.0	14.5	14.0	13.5	18.0	140.25	14.5	286.64	18
20	12.7mm	18.0	17.5	17.0	15.0	14.5	14.0	19.0	157.5	15.0	341.8	20
24	12.7mm	20.0	19.0	18.5	16.0	15.0	15.0	21.0	188.25	16.0	458.44	24
1	10 S	4.0	3.5	3.0	4.0	3.0	2.5	4.5	2.08	4.0	2.7	1
1 1/2	10 S	5.0	4.5	3.0	4.5	4.0	3.0	5.5	3.12	5.0	4.57	1 1/2
2	10 S	5.0	4.5	3.5	4.5	4.0	3.0	6.0	3.94	5.5	6.33	2
2 1/2	10 S	6.5	5.5	4.5	5.5	5.0	4.5	7.0	5.26	6.0	8.85	2 1/2
3	10 S	7.0	6.0	5.0	6.0	5.5	5.0	7.5	6.45	6.0	11.91	3
4	10 S	7.5	7.0	6.0	6.5	6.0	6.0	8.0	8.34	7.0	17.67	4
6	10 S	9.5	9,0	8.0	8.0	7.5	7.5	10.0	13.82	8.5	34.54	6
8	10 S	11.0	10.5	10.0	10.95	9.5	8.5	11.5	19.94	10.0	55.5	8
10	10 S	12.5	12.0	11.0	10.5	10.0	9.5	13.0	27.83	11.0	83.4	10
12	10 S	14.0	13.0	12.0	11.0	11.0	10.0	14.5	36.00	11.5	114.6	12
14	10 S	14.5	14.0	13.0	11.5	11.0	11.0	15.5	41.18	11.5	132.6	14
16	10 S	16.5	14.5	14.0	12.0	11.5	11.5	16.5	47.33	12.5	172.2	16
18	10 S	16.5	15.5	14.5	12.5	12.5	11.5	17.5	53.18	13.0	212.1	18
20	10 S	17.5	16.5	15.5	13.0	13.0	12.0	18.5	68.50	13.0	264.5	20
24	10 S	19.0	18.0	17.0	14.0	13.5	12.5	20.5	94.37	14.0	376.8	24

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
3	01.07.15	REAFFIRMED & ISSUED AS STANDARD	SH	AK	RN	SC
2	10.07.10	REAFFIRMED & ISSUED AS STANDARD	PK	RN	SC	DM ND

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MAXIMUM SPACING OF GUIDES FOR VERTICAL & HORIZONTAL PIPES

NOM PIPE SIZE(INCHES)	VERTICAL SPACING (M)	HORIZONTAL SPACING (M) (NOTE-1)
1	6.0	6.0
1 ½	6.0	6.0
2	6.0	6.0
3	8.0	12.0
4	8.0	12.0
6	8.0	12.0
8	8.0	12.0
10	12.0	18.0
12	12.0	18.0
14	12.0	18.0
16	12.0	18.0
18	12.0	18.0
20	16.0	18.0
24	16.0	18.0
26 and above	16.0	18.0

Notes :

1. These spacings may be varied to suit column spacing of rack. The above spacing is for straight runs of pipe & does not include guides which are used for control of thermal movements, as decided by stress group.

2. The guide spacings given in the above table are indicative only.

Rev. No	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
3	01.07.15	REAFFIRMED & ISSUED AS STANDARD	SH	AK	RN	SC
2	10.07.10	REAFFIRMED & ISSUED AS STANDARD	PK	RN	SC	DM ND

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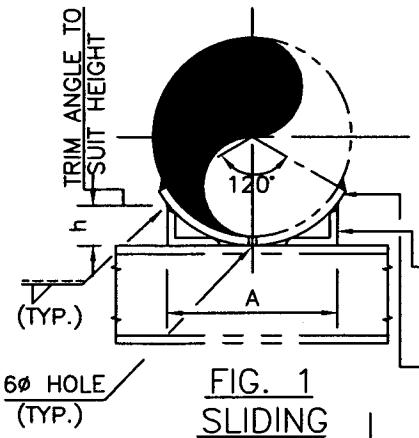
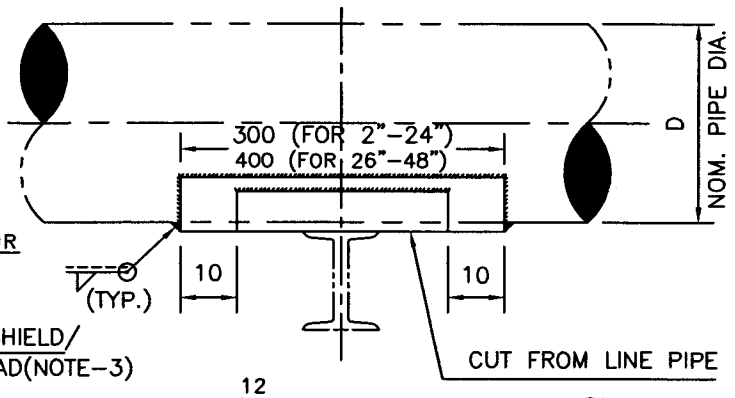


FIG. 1 SLIDING



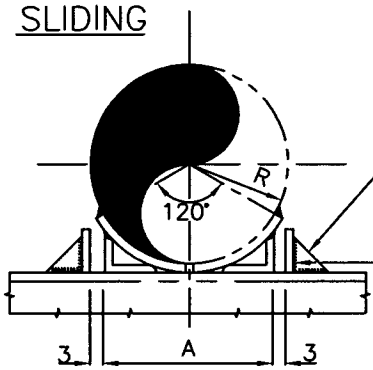
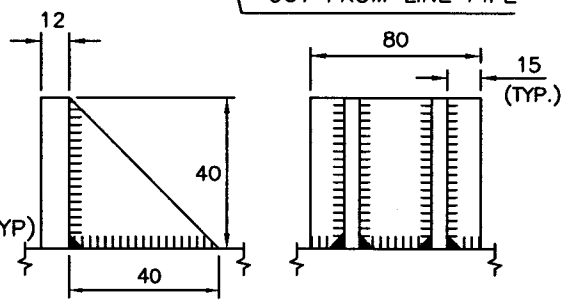


FIG. 2 GUIDE



DETAIL-M(FOR 14"-48")
(REFER NOTE-7 FOR SIZE 2" TO 12")

D IN INCH	PIPE SCH.	R	A	h	ANGLE-SIZE
2 TO 12	REFER NOTE-6				
14	STD	178	258	52	75 x 75 x 8
16	STD	203	266	47	
18	STD	229	272	43	
20	STD	254	279	40	
22	STD	279	335	54	100 x 75 X 8
24	STD	305	341	50	
26	STD	330	347	48	
28	STD	356	352	45	
30	STD	381	357	43	
32	STD	406	362	42	
34	STD	432	487	73	150 x 75 X 10
36	STD	457	492	70	
38	XS	483	498	67	
40	XS	508	503	65	
42	XS	533	508	63	
48	XS	610	522	57	

MAXIMUM ALLOWABLE LOAD ON FILLET-WELD OF RESTRAINT (KG/CM)				
WELD SIZE (MM)	TEMPERATURE (IN DEG.C)			
	200	250	300	343
6	340	250	220	200
8	450	340	300	270
10	560	420	370	330

NOTES:-

1. LOADS ON FILLET WELDS OF GUIDE SHALL BE LIMITED TO THE VALUES TABULATED BELOW AGAINST VARIOUS TEMPERATURES, FOR THE RESPECTIVE WELD-SIZE, FOR RUNNING LENGTH OF WELD. LOADS MAY BE INTERPOLATED FOR INTERMEDIATE TEMPERATURES.
2. IN CASE THE PIPE-SCHEDULE IS NOT THE SAME AS TABULATED ABOVE, THE DIMENSIONS "A" AND "h" SHALL BE MODIFIED ACCORDINGLY.
3. PROTECTION-SHIELD SHALL BE CUT FROM LINE-PIPE OR ROLLED FROM PLATE OF MATERIAL EQUIVALENT TO THAT OF PIPE. THICKNESS OF PROTECTION-SHIELD SHALL BE SAME AS THAT OF LINE-PIPE OR 12MM, WHICHEVER IS LESS.
4. GUIDE-PLATES SHALL BE TO IS-2062.
5. IN CASE OF SIZE REDUCTION(S) IN A STRAIGHT RUN WITH SAME BOP, PROTECTION SHIELD THICK-NESS FOR ALL SIZES SHALL BE EQUAL TO THAT FOR THE LARGEST DIAMETER PIPE.
6. FOR SIZES 2" TO 12", PROTECTION SHIELD/ CORROSION PAD SHALL BE USED AS PER JOB REQUIREMENT. NO ANGLES SHALL BE WELDED TO PROTECTION SHIELD/CORROSION PAD FOR PIPE SIZES 2" TO 12".
7. REFER STD. 6-44-0752 FOR DETAILS OF GUIDE PLATES FOR SIZES 2" TO 12".

SYMBOL

S6A - 1 - D	W

TYPE
FIG.NO.
NOM.PIPE SIZE
WELD SIZE (NOTE-1)

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
5	08.12.2017	REVISED AND ISSUED AS STANDARD	MK	SH	MI	RN
4	14.06.2012	REVISED AND ISSUED AS STANDARD	SH	RN	ATD	DM

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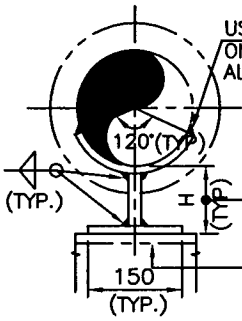


FIG.1
SLIDING

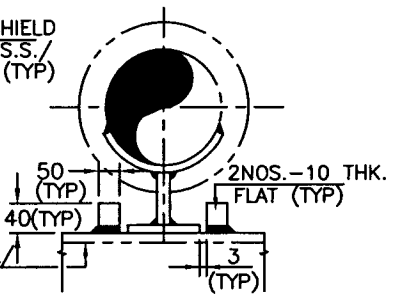


FIG.2
GUIDE

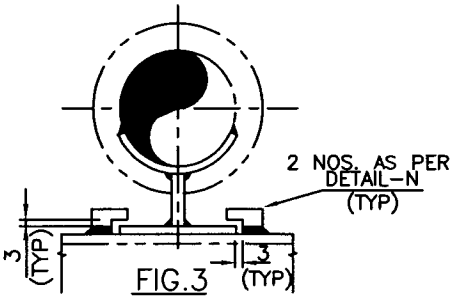


FIG.3
GUIDE
(RESTRAINED IN VERTICAL)

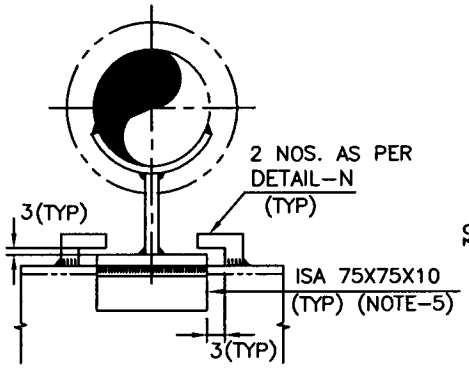
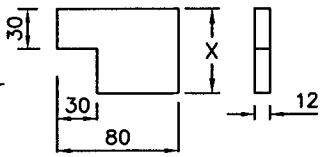
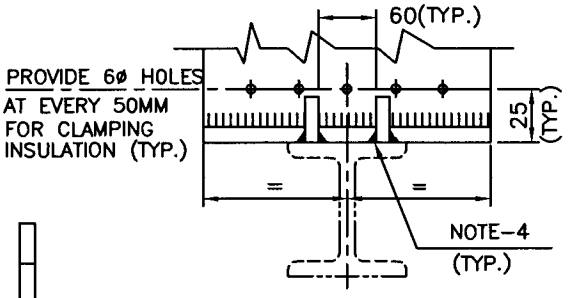


FIG.4
PARTIAL RESTRAINT
(THREE DIRECTIONAL STOP)
(NOTE-6)



DETAIL-N
(NOTE-3)



SIDE VIEW SHOWING GUIDE ARRANGEMENT
(TYPICAL FOR FIG. 2, 3 & 4)

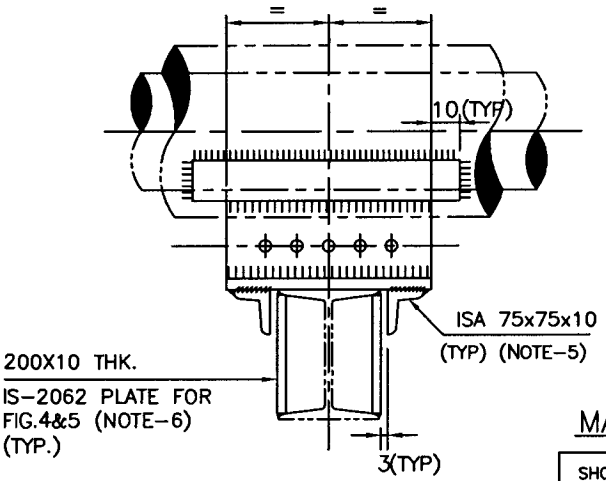


FIG. 5
CROSS-GUIDE

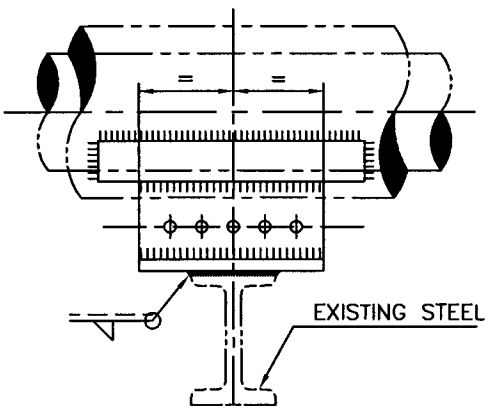
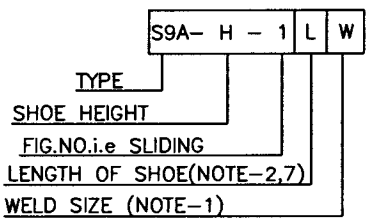


FIG. 6
ANCHOR

(SHOE DETAIL AS PER FIG.1 TO BE WELDED TO EXISTING STEEL)



SYMBOL

MATERIAL:

SHOE –						
PIPE MATL.	TEMPERATURE	SHOE MATERIAL			X	SHOE TYPE
		VERT. PLATE	BASE PLATE	PLATE THK.		
CS/AS/ SS	UPTO 343°C	IS-2062	IS-2062	12	45	S9A
	344°C TO 427°C	ASTM A516/A515 (GR 60/65/70) / IS-2002 GR 2	IS-2062	12	45	S9B
AS/SS	ABOVE 427°C	AISI-304/316/321/347 PLATE		10	43	S9C
GUIDE-PLATE : IS-2062						

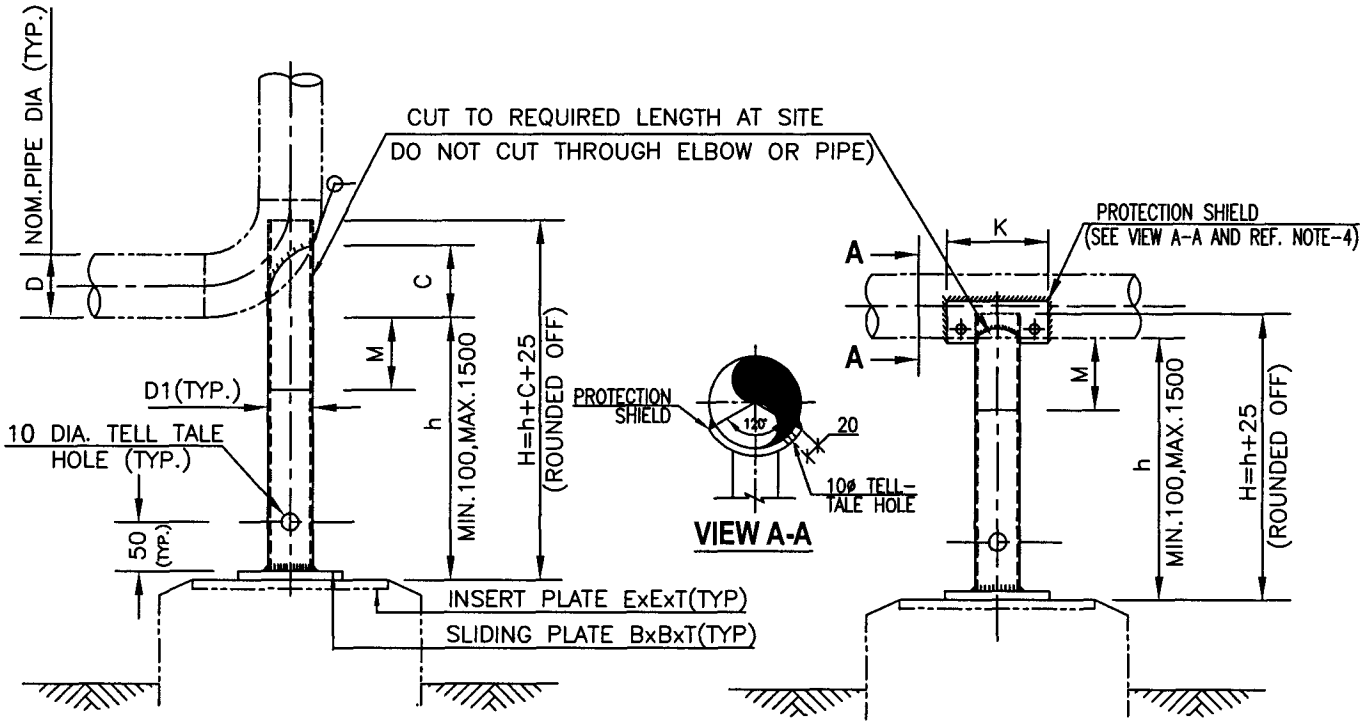
NOTES:- FOR NOTES NOS. 1 THRU 6 REFER STD 7-44-0601

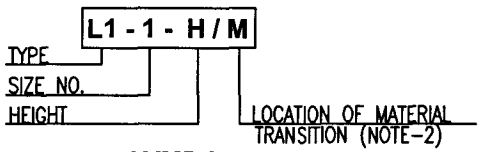
7. LONGITUDINAL PIPE MOVEMENT NOT TO EXCEED 150 MM. AND SHOE LENGTH NOT TO EXCEED 400MM

8 PROTECTION-SHIELD SHALL BE CUT FROM LINE-PIPE OR ROLLED FROM PLATE OF MATERIAL EQUIVALENT TO THAT OF PIPE. THICKNESS OF PROTECTION-SHIELD SHALL BE SAME AS THAT OF LINE-PIPE OR 12MM, WHICHEVER IS LESS.

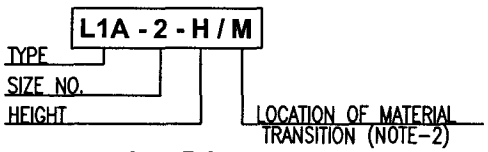
Rev No	Date	Purpose	Prepared by	Checked by	Stds Committee Convenor	Stds Bureau Chairman
					Approved by	
5	24.01.2019	REAFFIRMED AND ISSUED AS STANDARD	PK	SH	MI	RKT
4	28.01.2014	REAFFIRMED AND ISSUED AS STANDARD	UK	SH	AK	RN SC

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SYMBOL



SYMBOL

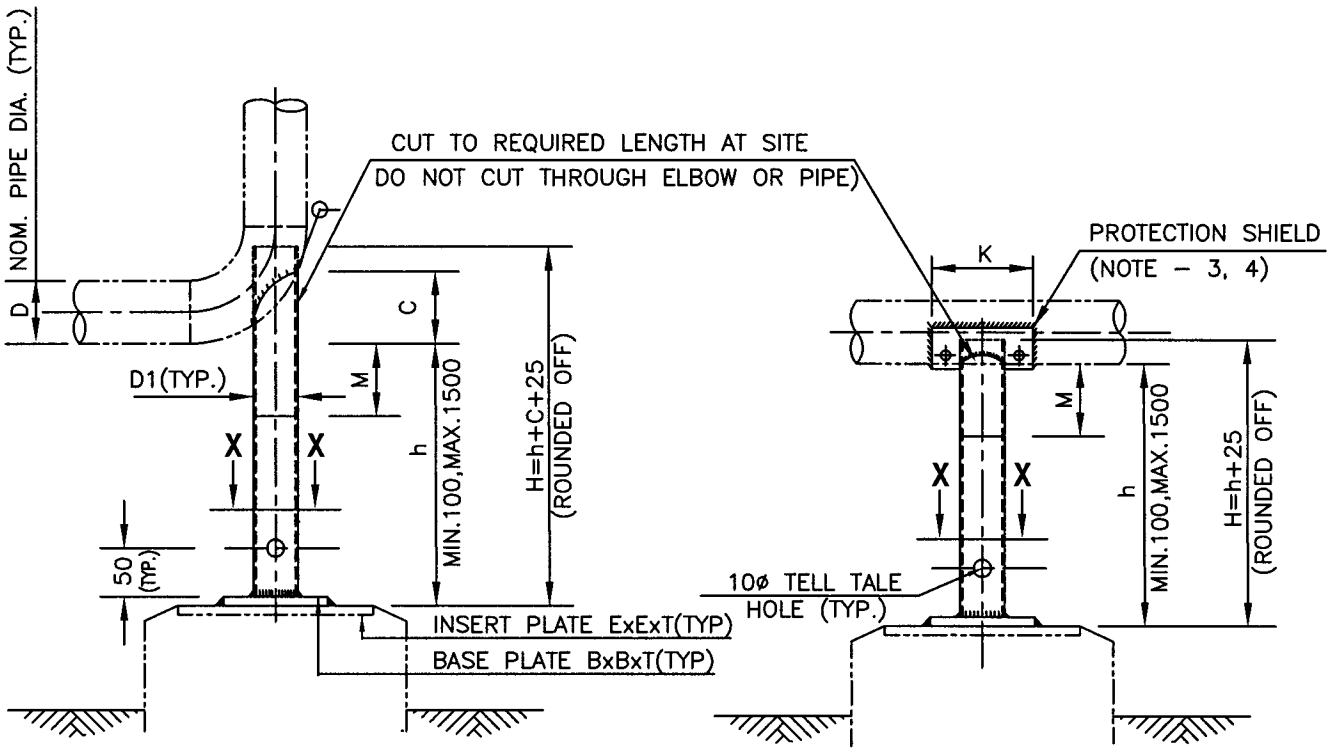
SIZE NO.	D	D1 (NOTE-3)	B	T	C (NOTE-5)	E	K (NOTE-4)
1	2"	2" S40/10S	150	10	70	250	160
	3"				115		
2	4"	3" S40/10S	200	10	137	300	190
	6"				174		
3	8"	4" S40/10S	200	12	205	300	215
	10"				262		
	12"				287		
4	14"	6" S40/10S	250	12	388	350	270
	16"				418		
5	18"	8" S40/10S	300	12	454	400	320
6	20"	10" S40/10S	350	12	554	450	375
	24"				615		
7	26"	12" S20/10S	400	16	675	500	425
	30"				800		
	36"				950		

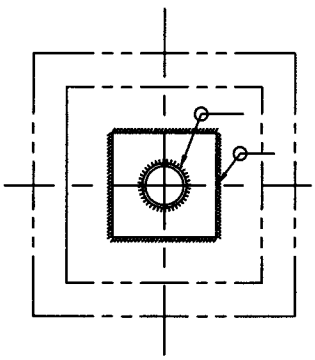
NOTES:-

1. INSERT AND SLIDING PLATE MATERIAL SHALL BE CARBON STEEL. WHERE DESIGN TEMP. IS $\geq$ 343°C WITH h $\leq$ 200MM, SLIDING PLATE MATERIAL SHALL BE EQUIVALENT TO PIPE MATERIAL.
2. DIMENSION 'M' LOCATES THE POINT OF MATERIAL TRANSITION ON THE SUPPORT. THE STUB MATERIAL SHALL BE EQUIVALENT TO THAT OF LINE PIPE AND THE LOWER SUPPORT PIPE SHALL BE CARBON STEEL. MINIMUM VALUE OF M SHALL BE "INSULATION THICKNESS+25MM."
   A. FOR CARBON STEEL(CS) LINE PIPE, THE ENTIRE SUPPORT PIPE SHALL BE CS, THAT IS M=0.
   B. FOR ALLOY STEEL(AS) OR STAINLESS STEEL(SS) LINE-PIPE, SUPPORT PIPE SHALL CONSIST OF THE FOLLOWING -
      - FOR h LESS THAN OR EQUAL TO 500MM, ENTIRE SUPPORT PIPE MATERIAL SHALL BE EQUIVALENT TO THAT OF LINE PIPE, THAT IS M=h.
      - FOR h GREATER THAN 500MM, SUPPORT PIPE SHALL BE COMPOSITE WITH M=INSULATION THK.+25MM OR 100MM, WHICHEVER IS GREATER.
3. IN CASE SIZE AND/OR SCH. OF SUPPORT PIPE (D1) LISTED IN THE TABLE IS NOT AVAILABLE, USE NEXT HIGHER SIZE AND/OR NEAREST HIGHER THICKNESS AVAILABLE.
4. PROTECTION SHIELD (LENGTH=K MM) CUT FROM LINE-PIPE OR EQUIVALENT PLATE SHALL BE PROVIDED ON HORIZONTAL LINE AS FOLLOWS -
   A. FOR 150# AND 300# CLASS PIPING
      CS AND AS LINES - 10" AND ABOVE
      SS LINES - 2" AND ABOVE
   B. FOR 600# AND HIGHER CLASS PIPING
      CS, AS AND SS LINES - 10" AND ABOVE
5. DIMENSION 'C' IS TO BE MODIFIED IF OTHER THAN 1.5D RADIUS ELBOWS ARE USED.
6. IN CASE CALCULATED h EXCEEDS THE MAX. VALUE, PEDESTAL SHALL BE RAISED ACCORDINGLY.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
5	11.08.2016	REAFFIRMED AND ISSUED AS STANDARD	SH	AK	MI	RN
4	27.06.2011	REAFFIRMED AND ISSUED AS STANDARD	RSB	ATD	VKB	DM

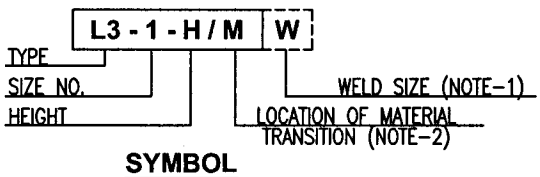
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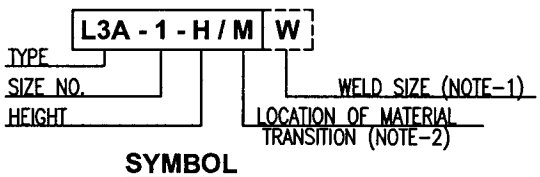


VIEW X-X

MAXIMUM ALLOWABLE LOAD ON FILLET-WELD (KG/CM)				
WELD SIZE (MM)	LINE DESIGN TEMPERATURE (IN DEG.C)			
	200	250	300	350
6	340	250	220	200
8	450	340	300	270
10	560	420	370	330



SYMBOL



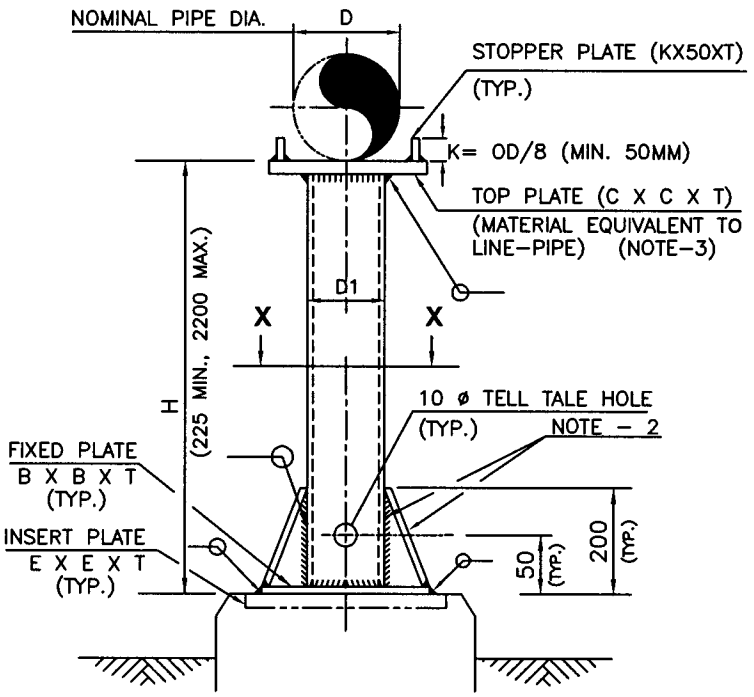
SYMBOL

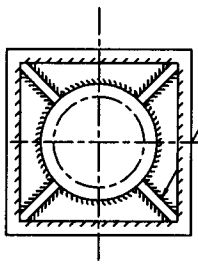
NOTES:-

1. LOADS ON FILLET WELDS ON BASE / INSERT PLATES SHALL BE LIMITED TO THE VALUES TABULATED ABOVE AGAINST VARIOUS TEMPERATURES, FOR THE RESPECTIVE WELD-SIZE, FOR RUNNING LENGTH OF WELD. LOADS MAY BE INTERPOLATED FOR INTERMEDIATE TEMPERATURES. WELD SIZE SHALL BE DEEMED 6MM, UNLESS SPECIFIED OTHERWISE.
2. FOR THE APPLICABLE SIZE NOS., DIMENSION TABLE AND NOTES REFER EIL STD. 7-44-0621.
3. REFER VIEW A-A OF EIL STD. 7-44-0621.
4. REFER NOTE 4 OF EIL STD. 7-44-0621.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
5	11.08.2016	REAFFIRMED AND ISSUED AS STANDARD	SH	AK	MI	RN
4	27.06.2011	REVISED AND ISSUED AS STANDARD	RSB	ATD	VKB	DM

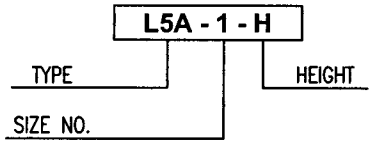
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4 - 10 THK. PLATE TO BE
WELDED WHEN H EXCEEDS 1000

VIEW - X-X



SYMBOL

SIZE NO.	D	D1 (NOTE-1)	C	B	E	T
1	3/4"	2" HEAVY IS : 1239	150	150	200	12
	1"					
	1 1/2"		200			
	2"					
2	3"	2" HEAVY IS : 1239	200	150	200	12
	4"					
3	6"	3" HEAVY IS : 1239	300	200	250	16
	8"					
4	10"	4" HEAVY IS : 1239	350	200	250	16
	12"					
5	14"	6" HEAVY IS : 1239	400	250	300	20
	16"					
6	18"	8" SCH. 40	400	300	350	20
7	20"	10" SCH. 40	450	350	400	20
	24"					
8	26"	12" SCH. 40	550	400	500	20
	30"					
	36"					

NOTES:-

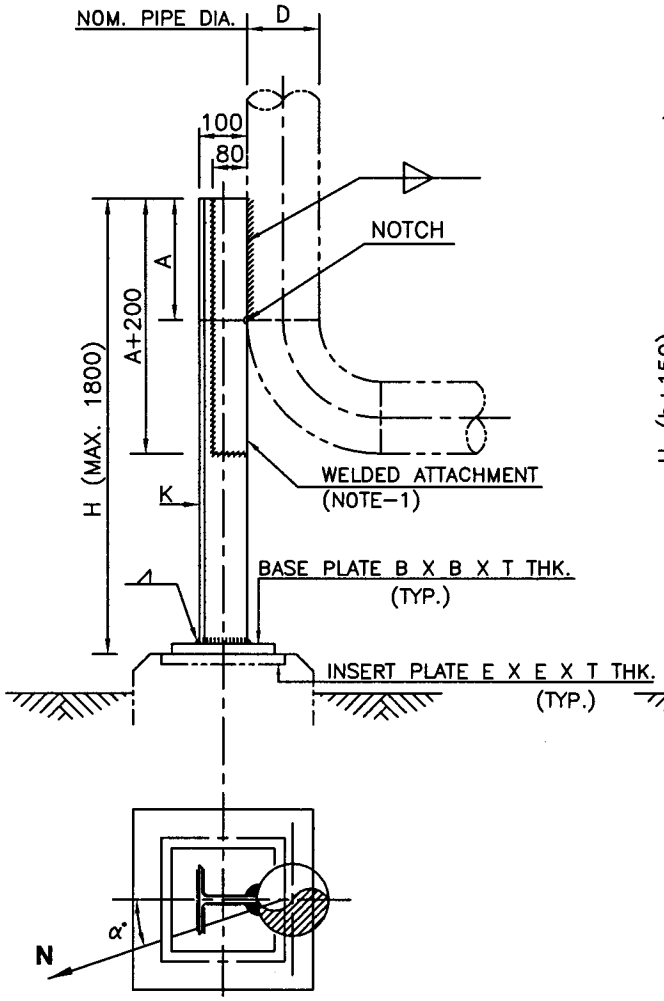
1. IN CASE SIZE AND/OR SCH. OF SUPPORT PIPE (D1) LISTED IN THE TABLE IS NOT AVAILABLE, USE NEXT HIGHER SIZE AND/OR NEAREST HIGHER THICKNESS AVAILABLE.
2. SUPPORT PIPE AND PLATE MATERIAL SHALL BE CARBON STEEL, UNLESS SPECIFIED OTHERWISE.
3. FOR L5A TYPE, PROTECTION-SHIELD CUT FROM LINE-PIPE, FOR PIPE-SIZES 14"NB AND ABOVE, SHALL BE PROVIDED. IN SUCH CASES TOP-PLATE SHALL BE OF CARBON-STEEL.
4. IN CASE CALCULATED H EXCEEDS THE MAXIMUM VALUE, PEDESTAL SHALL BE RAISED ACCORDINGLY.

FOR TEMP. UPTO 343°C ONLY

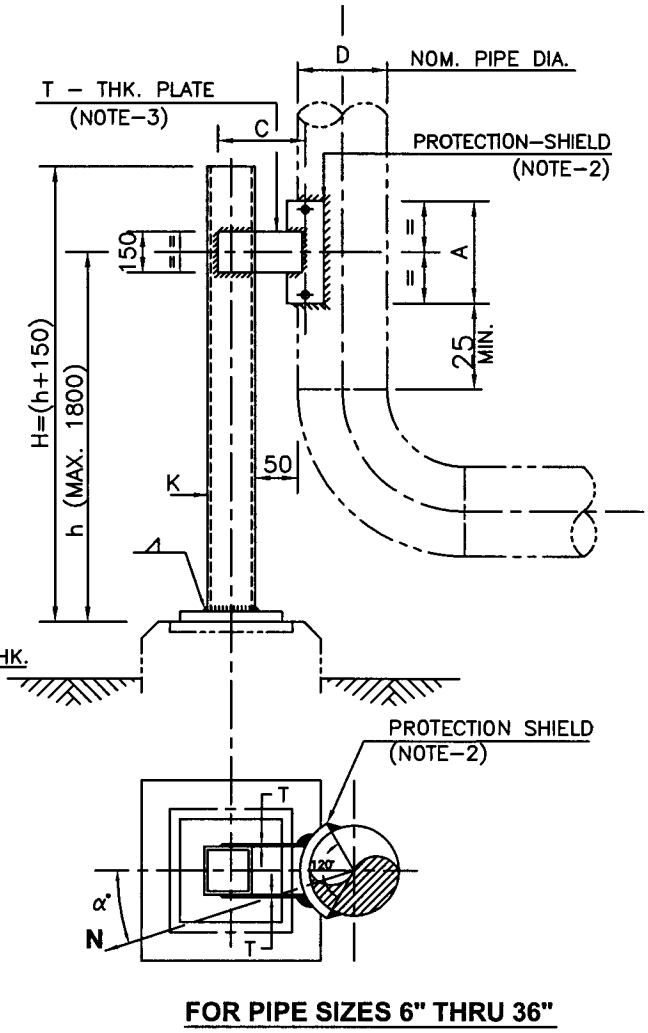
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
5	11.08.2016	REAFFIRMED AND ISSUED AS STANDARD	SH	AK	MI	RN
4	27.06.2011	REVISED AND ISSUED AS STANDARD	RSB	ATD	VKB	DM

Approved by

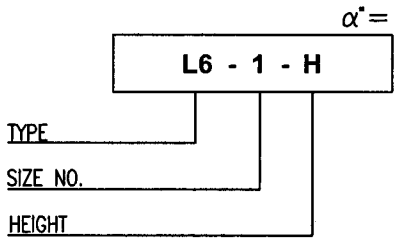
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FOR PIPE SIZES 2" THRU 4"



FOR PIPE SIZES 6" THRU 36"



SYMBOL

NOTES:-

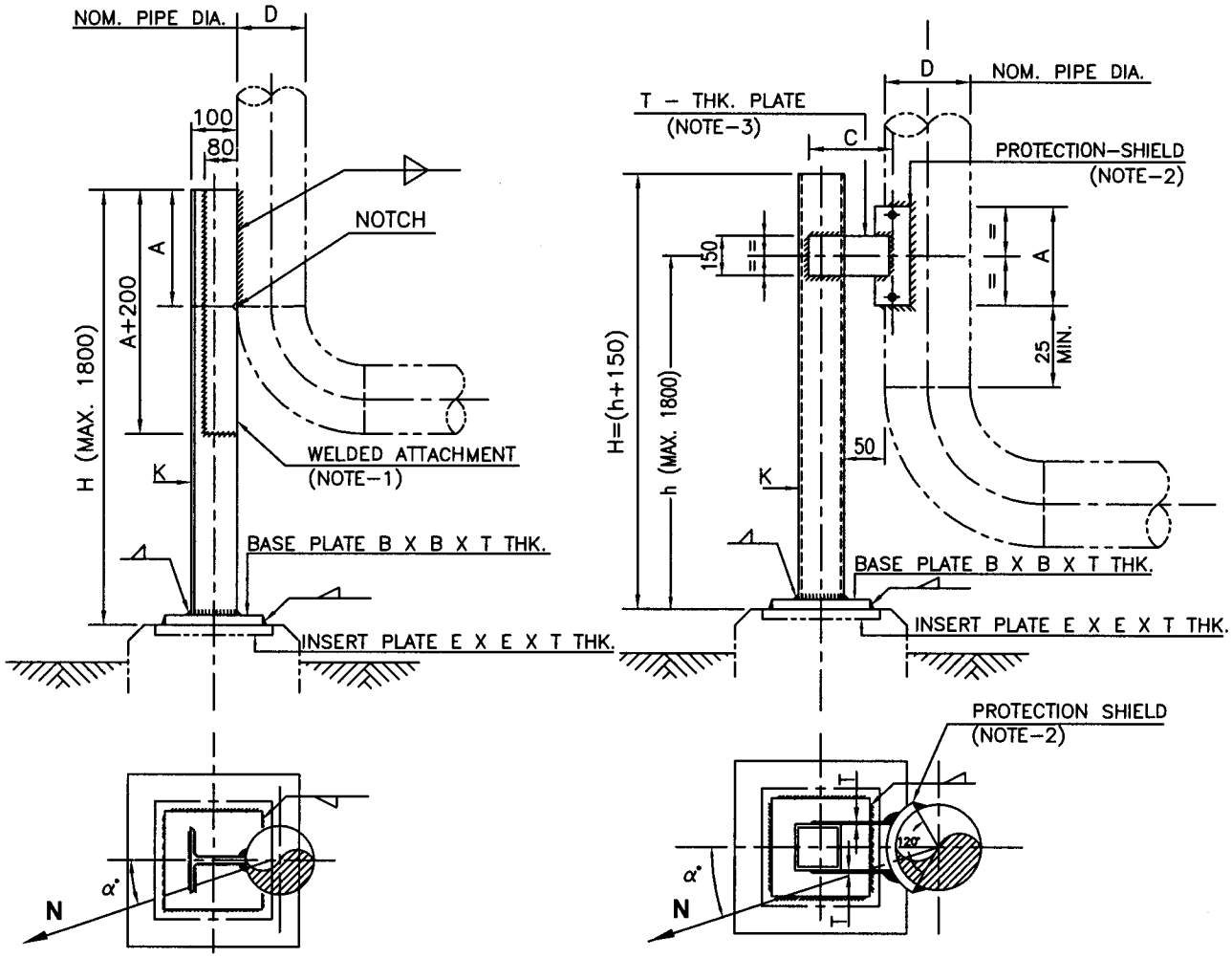
1. WELDED ATTACHMENT (6MM THICK) REQUIRED ONLY IN CASE OF STAINLESS-STEEL/ALLOY-STEEL LINE-PIPE. MATERIAL OF WELDED ATTACHMENT SHALL BE EQUIVALENT TO PIPE MATERIAL.
2. PROTECTION SHIELD SHALL BE CUT FROM LINE-PIPE OR EQUIVALENT PLATE AND SHALL BE AS PER VIEW A-A OF EIL STD. 7-44-0621.
3. FOR LINE-TEMPERATURES UPTO 343°C CONNECTING PLATE SHALL BE CARBON STEEL(C.S.). FOR HIGHER TEMPERATURES IT SHALL BE EQUIVALENT TO THAT OF LINE-PIPE.
4. IN CASE CALCULATED H/h EXCEEDS THE MAXIMUM VALUE, PEDESTAL SHALL BE RAISED ACCORDINGLY.

SIZE NO.	D	K	A	T	C	E	B
1	2" TO 4"	CUT FROM ISMB-200	200	10	–	200	150
2	6" TO 10"	ISMC-125, 2 NOS.	200	12	150	250	200
3	12" TO 24"	ISMC-250, 2 NOS.	300	12	230	350	300
	26" TO 36"			16			

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
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4	27.06.2011	REAFFIRMED AND ISSUED AS STANDARD	RSB	ATD	VKB	DM

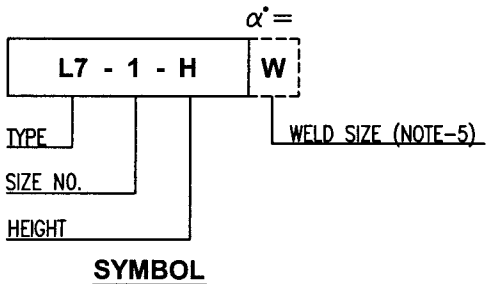
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FOR PIPE SIZES 2" THRU 4"

FOR PIPE SIZES 6" THRU 36"



SYMBOL

NOTES:-

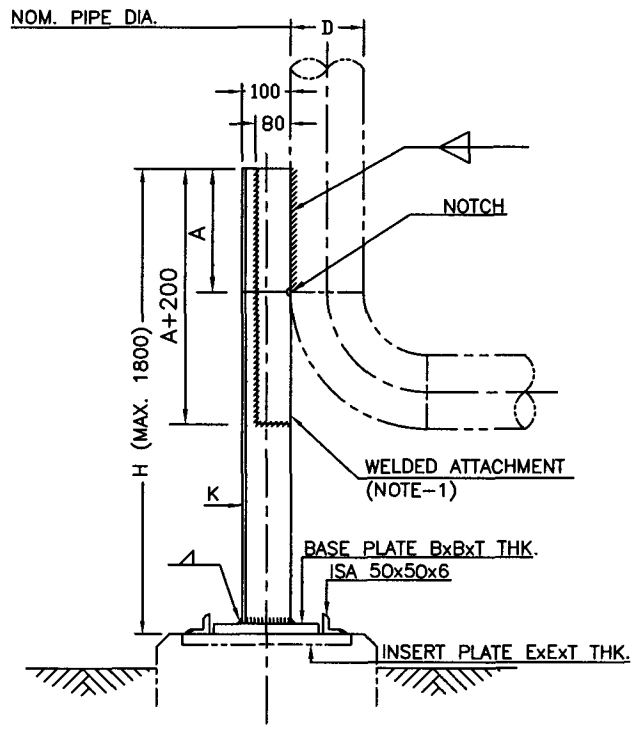
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2. PROTECTION SHIELD SHALL BE CUT FROM LINE-PIPE OR EQUIVALENT PLATE AND SHALL BE AS PER VIEW A-A OF EIL STD. 7-44-0621.
3. FOR LINE-TEMPERATURES UPTO 343°C CONNECTING PLATE SHALL BE CARBON STEEL(C.S.). FOR HIGHER TEMPERATURES IT SHALL BE EQUIVALENT TO THAT OF LINE-PIPE.
4. IN CASE CALCULATED H/h EXCEEDS THE MAXIMUM VALUE, PEDESTAL SHALL BE RAISED ACCORDINGLY.
5. REFER NOTE-1 OF EIL STD. 7-44-0623.

SIZE NO.	D	K	A	T	C	E	B
1	2" TO 4"	CUT FROM ISMB-200	200	10	–	200	150
2	6" TO 10"	ISMC-125, 2 NOS.	200	12	150	250	200
3	12" TO 24"	ISMC-250, 2 NOS.	300	12	230	350	300
	26" TO 36"			16			

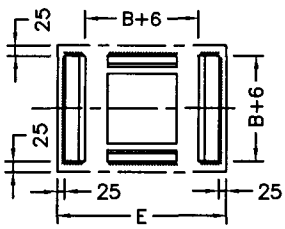
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
5	11.08.2016	REAFFIRMED AND ISSUED AS STANDARD	SH	AK	MI	RN
4	27.06.2011	REAFFIRMED AND ISSUED AS STANDARD	RSB	ATD	VKB	DM

Approved by

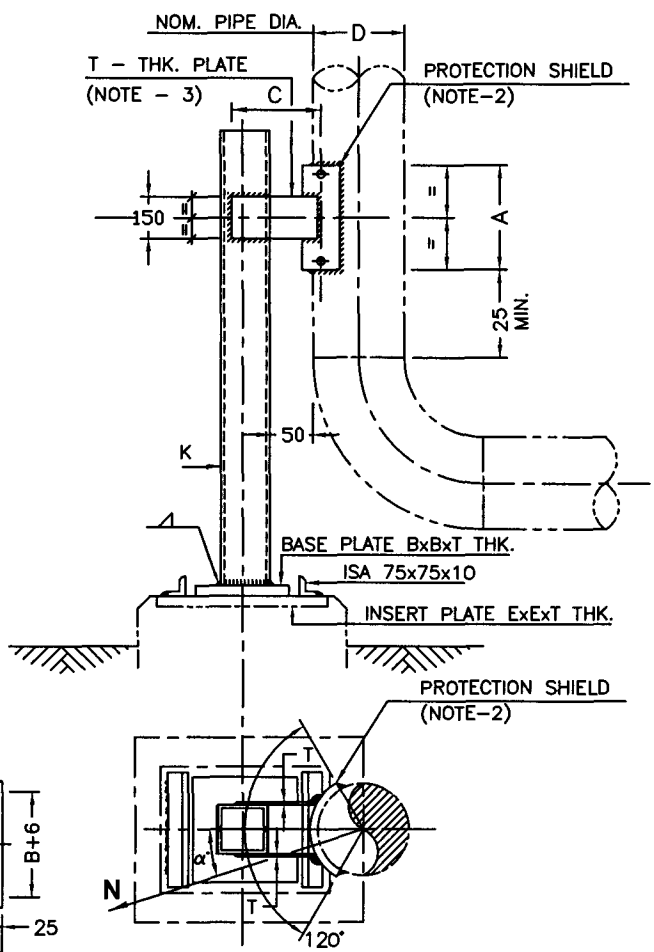
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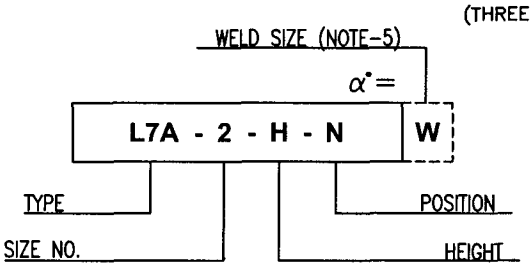
FOR PIPE SIZES 2" THRU 4"



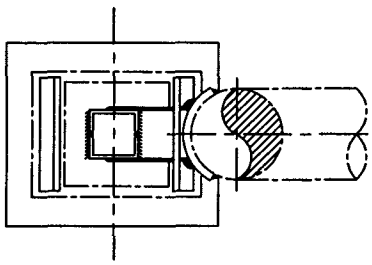
POSITION-T
(THREE DIRECTIONAL STOP)



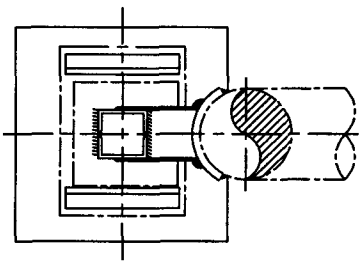
FOR PIPE SIZES 6" THRU 36"



SYMBOL



POSITION - N
(CROSS GUIDE)



POSITION - S
(GUIDE)

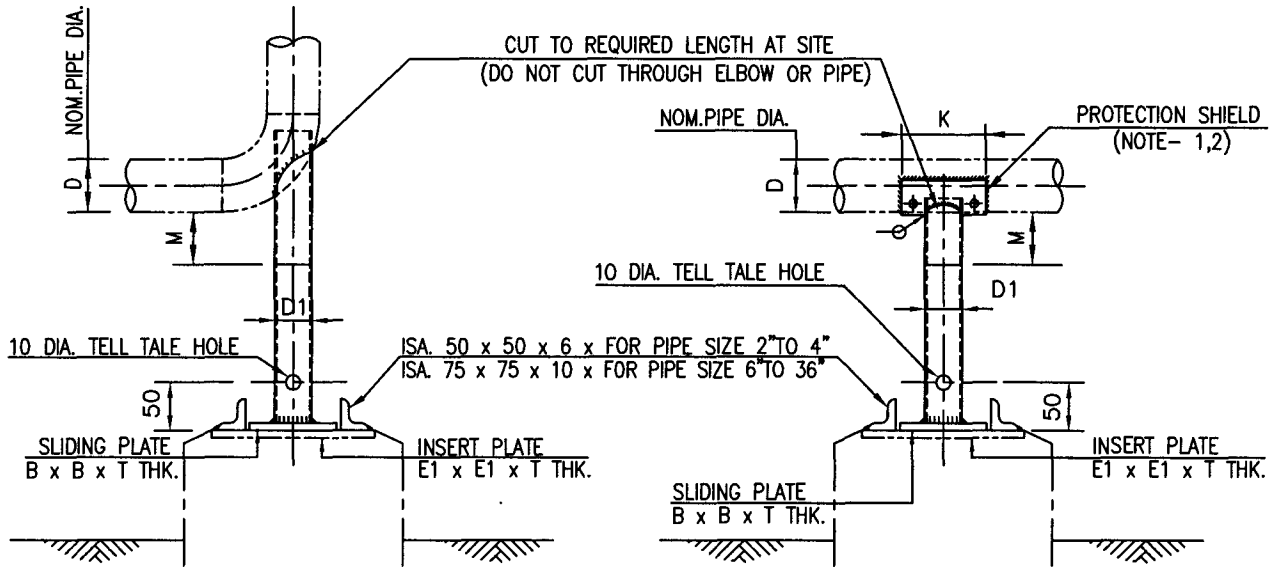
SIZE NO.	D	K	A	T	C	E	B
1	2" TO 4"	CUT FROM ISMB 200	200	10	–	306	150
2	6" TO 10"	ISMC-125, 2 NOS.	200	12	150	406	200
3	12" TO 24"	ISMC-250, 2 NOS.	300	12	230	506	300
	26" TO 36"			16			

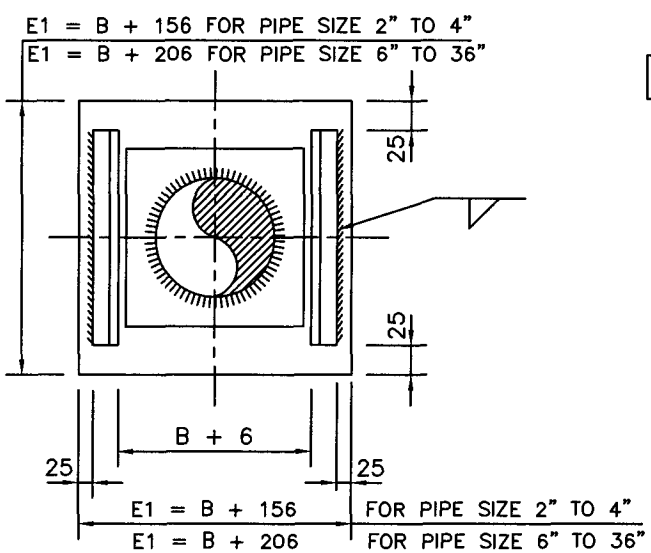
NOTES:-

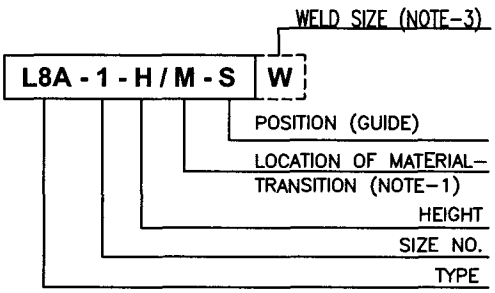
1. WELDED ATTACHMENT (6MM THICK) REQUIRED ONLY IN CASE OF STAINLESS-STEEL/ALLOY-STEEL LINE-PIPE. MATERIAL OF WELDED ATTACHMENT SHALL BE EQUIVALENT TO PIPE MATERIAL.
2. PROTECTION SHIELD SHALL BE CUT FROM LINE-PIPE OR EQUIVALENT PLATE AND SHALL BE AS PER VIEW A-A OF EIL STD. 7-44-0621.
3. FOR LINE-TEMPERATURES UPTO 343°C CONNECTING PLATE SHALL BE CARBON STEEL(C.S.). FOR HIGHER TEMPERATURES IT SHALL BE EQUIVALENT TO THAT OF LINE-PIPE.
4. IN CASE CALCULATED H/h EXCEEDS THE MAXIMUM VALUE, PEDESTAL SHALL BE RAISED ACCORDINGLY.
5. REFER NOTE-1 OF EIL STD. 7-44-0623.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
5	11.08.2016	REAFFIRMED AND ISSUED AS STANDARD	SH	AK	MI	RN
4	27.06.2011	REAFFIRMED AND ISSUED AS STANDARD	RSB	ATD	VKB	DM

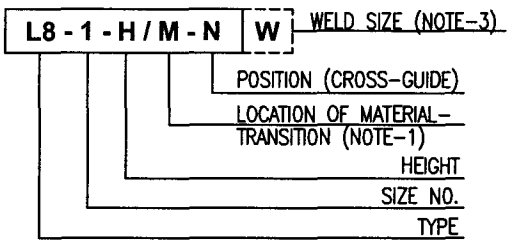
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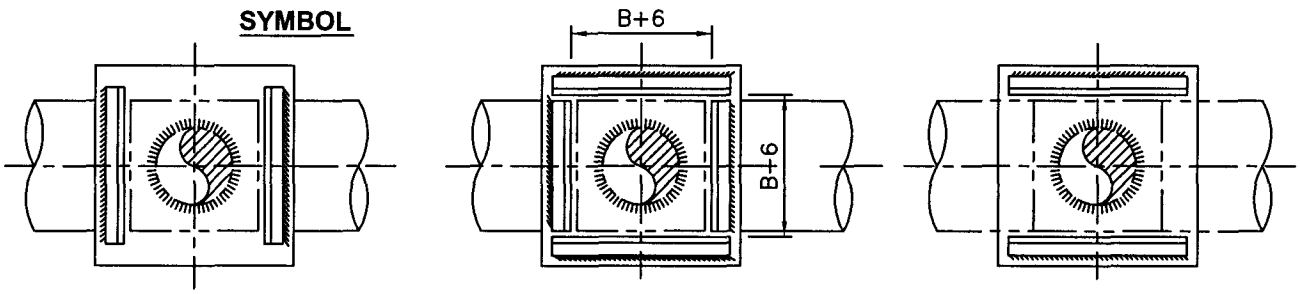
SYMBOL



SYMBOL

NOTES:-

1. FOR THE APPLICABLE SIZE NOS., DIMENSION TABLE AND NOTES REFER EIL STD. 7-44-0621.
2. REFER VIEW A-A OF EIL STD. 7-44-0621.
3. REFER NOTE-1 OF EIL STD. 7-44-0623.



POSITION - N
(CROSS GUIDE)

POSITION - T
(THREE DIRECTIONAL STOP)

POSITION - S
(GUIDE)

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
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4	27.06.2011	REAFFIRMED AND ISSUED AS STANDARD	RSB	ATD	VKB	DM

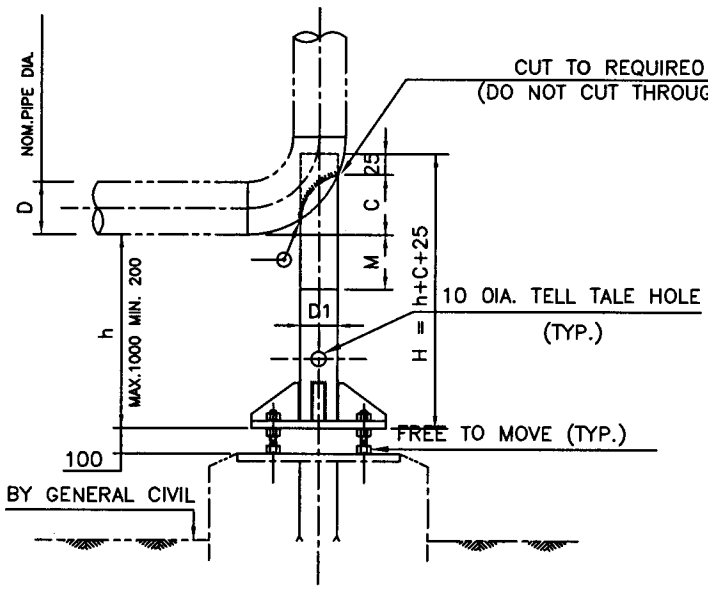
Approved by

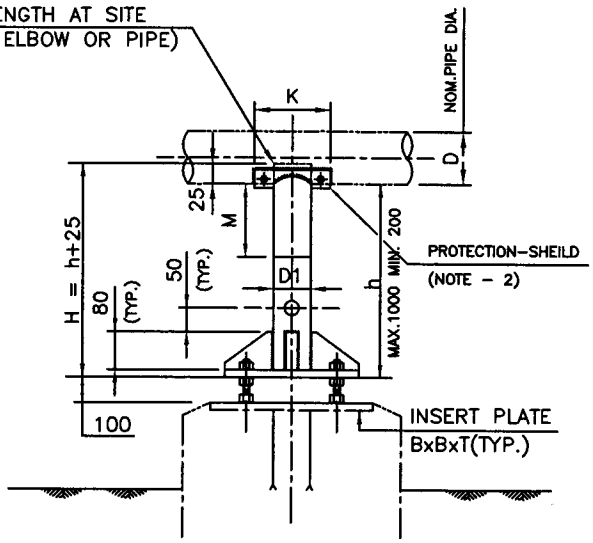
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ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

ADJUSTABLE LOW SUPPORT WITH FOUR BOLTS FOR PIPE SIZE 8" THRU. 24" TYPE - L17 AND L17A

STANDARD No.
7-44-0637 Rev. 5





L17 - 1 - H / M

TYPE
SIZE NO.
HEIGHT
LOCATION OF MATERIAL TRANSITION (NOTE-2)

SYMBOL

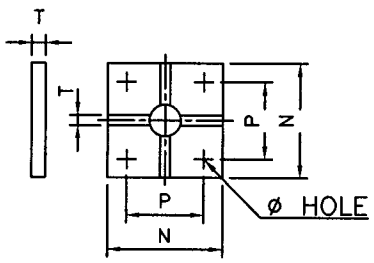
L17A - 1 - H / M

TYPE
SIZE NO.
HEIGHT
LOCATION OF MATERIAL TRANSITION (NOTE-2)

SYMBOL

INSTALLATION PROCEDURE:-

PLACE SUPPORT UNDER PIPE BEFORE CONNECTING PIPE TO EQUIPMENT.
TURN ADJUSTING NUT UNTIL PIPE FLANGE IS ALIGNEO WITH EQUIPMENT OR VALVE FLANGE.



NOTES:-

1. ALL PLATES SHALL BE CARBON STEEL.
2. REFER VIEW A-A ANO NOTE NOS. 2,4,5 ANO 6 OF EIL STO. 7-44-0621.
3. IN CASE SIZE ANO/OR SCHEOULE OF SUPPORT PIPE (01) LISTEO IN THE TABLE BELOW IS NOT AVAILABLE, USE THE NEXT HIGHER SIZE ANO/OR NEAREST HIGHER THICKNESS AVAILABLE.
4. BOTTOM OF HEX. HEAD OF SLIOING-BOLTS TO BE GROUND SMOOTH.
5. MATERIALS OF BOLTS ANO NUTS SHALL BE TO A193 GR.B7 ANO AI94 GR.2H, OR TO A193 GR.B16 ANO A194 GR.4, RESPECTIVELY

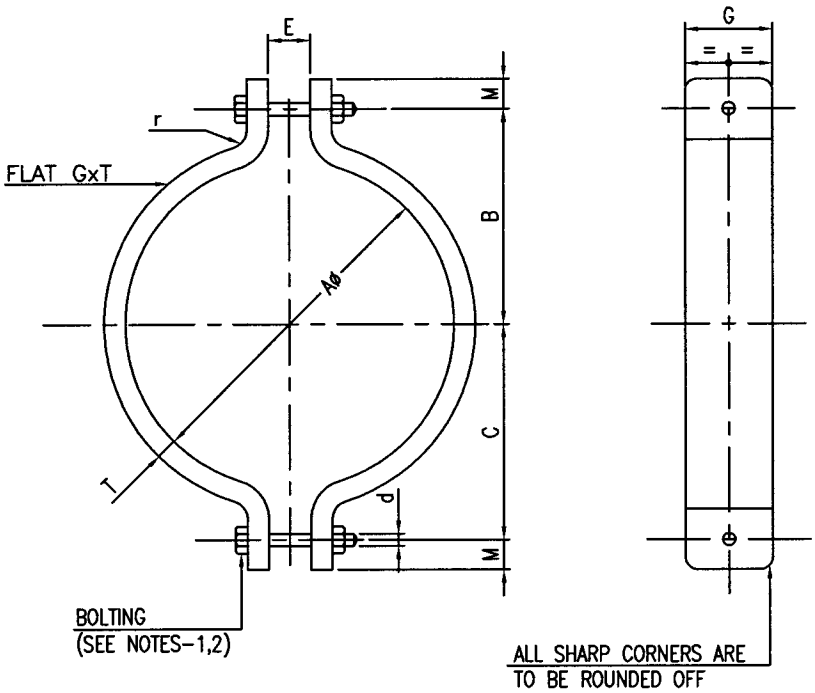
SIZE NO.	O	01 (NOTE-3)	B	T	K	C	HEX. HEADEO FULLY THREADED BOLT WITH TWO NUTS (NOTE-5)	N	P	ø
1	8"	4" SCH.40	350	12	215	205	0.75" x 6.0" LONG	250	140	22
	10"					262	0.875" x 7.0" LONG	300	180	25
	12"					287		300	180	25
2	14"	6" SCH.40	400	12	270	383	1.0" x 7.0" LONG	350	230	27
	16"					418		350	230	27
3	18"	8" SCH.40	400	12	320	454		350	230	27
4	20"	10" SCH.20	450	12	375	554	1.25" x 8.0" LONG	400	280	33
	24"					615		400	280	33

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
5	11.08.2016	REAFFIRMED ANO ISSUEO AS STANOARO	SH	AK	MI	RN
4	27.06.2011	REVISEO ANO ISSUEO AS STANOARO	RSB	ATO	VKB	OM

Approved by

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PIPE CLAMP FOR BARE CS/AS/SS PIPE SIZE 1/2" THRU 24" TYPE - C1



PIPE MATL.	TEMPERATURE	CLAMP TYPE
CS / AS	UPTO 343°C	C1A
	344°C TO 427°C	C1B
	ABOVE 427°C	C1C
SS	ALL TEMP.	C1C

CLAMP TYPE	MATERIAL	
	CLAMP	BOLTS AND NUTS
C1A	IS-2062	IS-1367 CLASS 10.9 IS-1367 CLASS 12
C1B	ASTM A516/A515 (GR.60/65/70)/ IS-2002 GR.2	ASTM A193 GR.B7 ASTM A194 GR.2H
C1C	SS-316 PLATE	ASTM A193 GR.B16 ASTM A194 GR.4

D = NOM. PIPE DIA IN INCHES.

D	DIMENSIONS								BOLT SIZE (REF. NOTE-2)		MAX. ALLOWABLE LOAD (Kg.)
	A	B	C	G	M	E	r	T	M/C BOLTS	STUD BOLTS	
1/2"	22	35	35	35	18	15	9	6	M12x55	M12x70	450
3/4"	27	40	40								
1"	35	45	45								
1½"	50	50	50								
2"	62	60	55								
3"	92	80	75								
4"	116	90	85	50	25	20	12	8	M16x70	M16x95	800
6"	170	125	120	70	30	25			M20x80	M20x110	1200
8"	222	160	155								
10"	276	190	185	80	40	28	15	10	M24x95	M24x135	1500
12"	327	220	215								
14"	358	230	225	100	40	30	18	12	M24x100	M24x150	2100
16"	410	270	265								
18"	460	290	285								
20"	511	320	315	100	50	33	20	14	M27x120	M27x170	2800
24"	613	370	365								

NOTES: –

1. WHEREVER THE PIPE CLAMPS ARE SUBJECTED TO VIBRATION AN ADDITIONAL LOCK-NUT SHALL BE USED. M/C-BOLT/STUD-BOLT LENGTH SHALL BE SUITABLY INCREASED TO ACCOMODATE THE LOCK-NUT.
2. FOR CARBON STEEL PIPE, M/C-BOLTS SHALL BE USED,WHEREAS FOR ALLOY STEEL AND STAINLESS STEEL PIPE,STUD-BOLTS SHALL BE USED.

SYMBOL

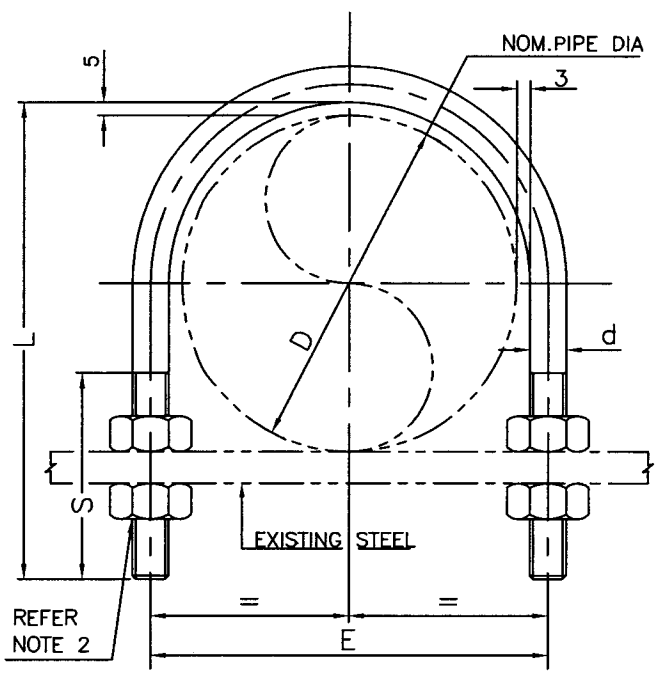
C1A - D
TYPE — NOM.PIPE DIA. (INCH)

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
4	01.07.2015	REAFFIRMED AND ISSUED AS STANDARD	SH	AK	RN	SC
3	24.01.2011	REVISED AND ISSUED AS STANDARD	SH	RSB	VKB	DM

Approved by

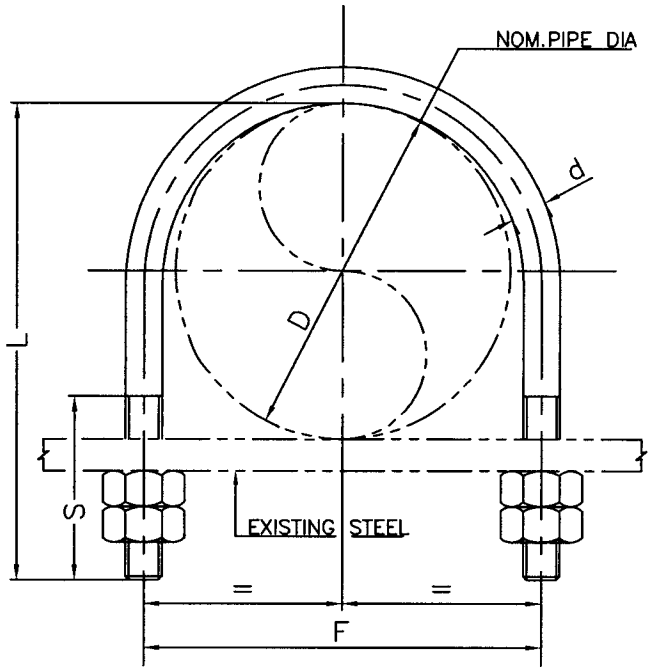
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U-BOLT FOR BARE C.S. PIPE SIZE 1/2" THRU 24" TYPE - C4 (FOR OPERATING TEMP. UPTO 232°C)



GUIDE
(1/2" TO 24")

FIG-1



FIXED
(1/2" TO 1-1/2")

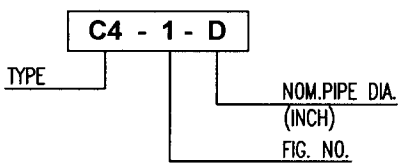
FIG-2

D	O.D (MM)	'U' BOLT					ALLOWED LOAD (KG)
		L	E	F	d	S	
1/2"	22	65	34	28	6	50	150
3/4"	27	70	39	33	6	50	
1"	34	75	48	42	8	55	300
1 1/2"	49	90	63	57	8	55	
2"	60	105	74	68	8	60	
3"	89	145	107	101	12	80	700
4"	115	170	133	127	12	80	
6"	169	240	191	185	16	100	1200
8"	220	290	242	236	16	100	
10"	274	345	296	290	16	100	
12"	324	420	350	344	20	130	2000
14"	356	450	382	376	20	130	
16"	407	500	433	427	20	130	
18"	458	565	489	483	25	140	2800
20"	508	620	539	533	25	140	
24"	610	720	641	635	25	140	

NOTES: –

1. BOLTS SHALL BE TURNED FROM CS ROD MATERIAL CONFORMING TO IS–2062 GR.A WITH DIMENSIONS TO IS–1367 CLASS 10.9 AND NUTS SHALL BE TO IS–1367 CLASS 12.

2. WHEREVER THE U–BOLTS ARE SUBJECTED TO VIBRATION AN ADITIONAL LOCK–NUT SHALL BE USED. U–BOLT LENGTH SHALL BE SUITABLY INCREASED TO ACCOMODATE THE LOCK–NUT.

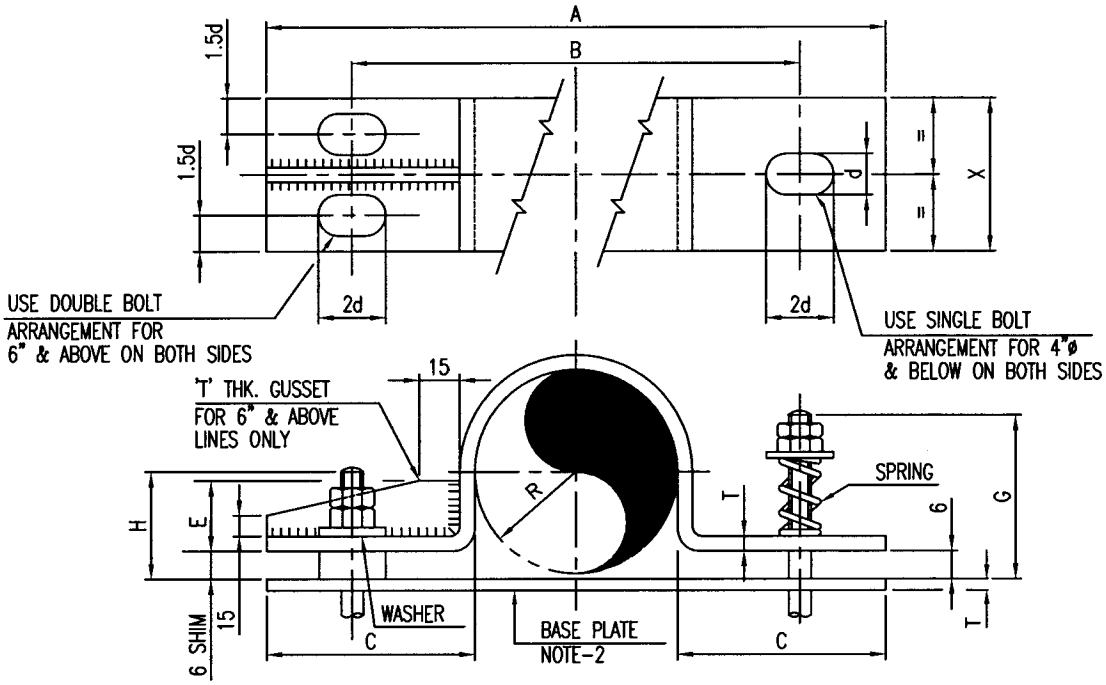


SYMBOL

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
4	15.12.2015	REVISED AND ISSUED AS STANDARD	SH	AK	RN	SC
3	24.01.2011	REVISED AND ISSUED AS STANDARD	SH	RSB	VKB	DM

Approved by

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ALL DIMENSIONS IN MM UNLESS MENTIONED OTHERWISE

PIPE SIZE	X	T	A	B	C	E	R	BOLT	d	G	H	SPRING (NOTE 1 & 3)		
												O.D.	COIL SIZE (INCHES)	FREE LENGTH
1"	65	5	184	124	75	–	17	6	8	60	35	20	5/32 x 3/32	25
1 1/2"	65	5	198	138	75	–	25	6	8	60	35	20	5/32 x 3/32	25
2"	80	6	240	170	90	–	30	10	12	70	40	25	7/32 x 7/64	25
3"	80	6	270	200	90	–	45	10	12	70	40	25	7/32 x 7/64	25
4"	80	6	294	224	90	–	58	10	12	70	40	25	7/32 x 7/64	25
6"	115	10	400	310	115	70	85	12	14	90	50	40	9/32 x 3/32	40
8"	115	10	452	352	115	100	111	12	14	90	50	40	9/32 x 5/32	40
10"	140	10	506	405	115	125	138	20	22	120	65	45	3/8 x 3/16	50
12"	140	12	556	466	115	145	163	20	22	130	70	45	3/8 x 3/16	50
14"	140	12	588	498	115	165	179	20	22	130	70	45	3/8 x 3/16	50
16"	140	12	642	552	115	190	205	20	22	130	70	45	3/8 x 3/16	50
18"	140	12	690	600	115	215	230	20	22	130	70	45	3/8 x 3/16	50
20"	160	12	742	642	115	240	256	24	26	150	100	50	7/16 x 7/32	65
24"	160	12	844	744	115	290	307	24	26	150	100	50	7/16 x 7/32	65

MATERIAL: –

BOLTING: ASTM A193 GR.B7/A194 GR.2H
SPRING: BS–970 EN45,45A,47/50CRV4

C11A - D
TYPE
NOM. PIPE DIA. (INCH)

SYMBOL

NOTES: –

1. SPRING COIL DETAILS ARE ONLY INFORMATIVE. BASED ON AVAILABILITY, EQUIVALENT SPRING COIL MAY BE USED.
2. BASE PLATE NOT REQUIRED FOR INSTALLATION ON STEEL MEMBERS, USE WELDING STUDS WHERE MEMBERS ARE NOT ALLOWED TO BE DRILLED.
3. FIBER STRESS OF SPRING COIL = 6624 KG/SQ.CM (80,000 PSI) AND MODULUS OF ELASTICITY = 0.88 x 10E6 KG/SQ.CM (12.6 x 10E6 PSI).

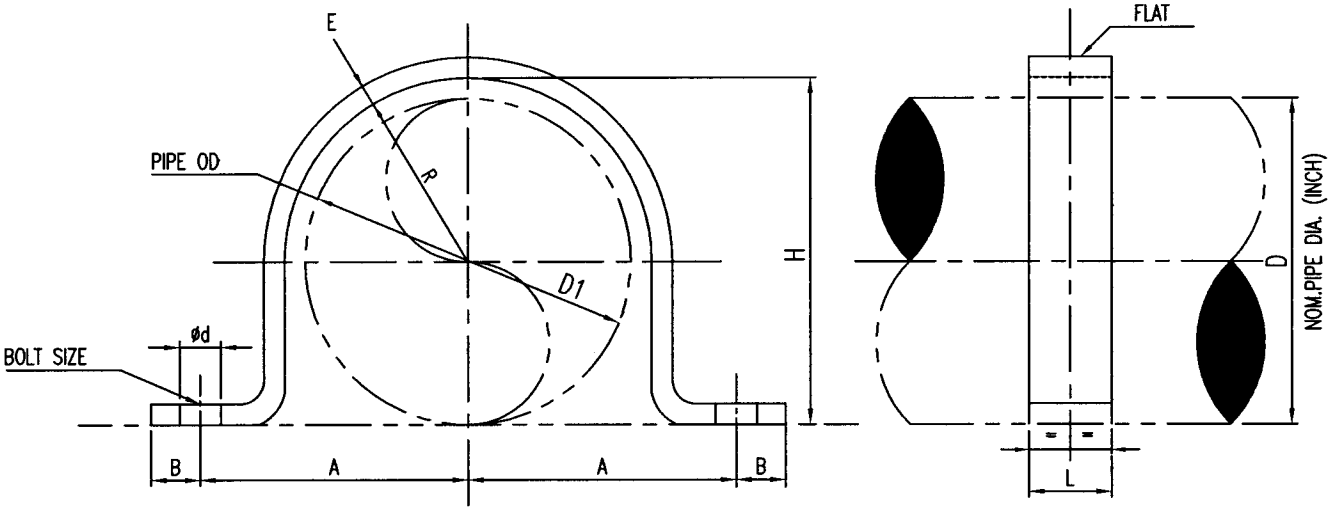
PIPE MATL.	OPERATING TEMPERATURE	CLAMP MATERIAL	CLAMP TYPE
CS	UPTO 232°C	IS–2062	C11A
AS			
SS	UPTO 232°C	SS–316	C11C

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
4	15.12.2015	REVISED AND ISSUED AS STANDARD	SH	AK	RN	SC
3	24.01.2011	REVISED AND ISSUED AS STANDARD	SH	RSB	VKB	DM

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PIPE U-CLAMP FOR BARE CS/AS/SS PIPE SIZE 3/4" THRU 24", TYPE - C15



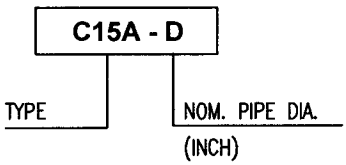
D	DIMENSIONS									ALLOWED LOAD KGS	BOLT SIZE
	D1	R	A	B	H	L	E	dØ	DEV. LENGTH OF FLAT		
3/4"	27	17	35	20	30	30	6	12	160	450	M10 X 45
1"	34	20	43	20	37	30	6	12	190		
1½"	49	28	52	20	52	40	6	14	230		M12 X 50
2"	60	33	58	25	64	50	6	14	260		
3"	89	48	80	30	93	60	6	18	360	850	M16 X 60
4"	115	61	90	30	119	60	6	18	430		
6"	169	88	125	35	173	80	8	22	610	1350	M20 X 70
8"	220	114	160	40	226	80	8	22	750		
10"	274	141	190	40	280	100	10	27	900	1950	M24 X 75
12"	324	166	220	40	330	100	10	27	1030		
14"	356	182	230	50	362	100	10	27	1110		
16"	407	208	270	50	413	120	12	30	1280	2600	M27 X 70
18"	458	233	290	60	464	140	16	33	1410	3800	M30 X 95
20"	508	258	320	60	514	140	16	33	1550		
22"	559	284	340	65	565	140	16	39	1670		M36 X 110
24"	610	309	370	65	616	140	16	39	1810		

PIPE MATL.	OPERATING TEMPERATURE	CLAMP TYPE
CS	UPTO 232°C	C15A
AS		
SS	UPTO 232°C	C15C

CLAMP TYPE	MATERIAL	
	CLAMP	BOLTS AND NUTS
C15A	IS-2062	IS-1367 CLASS 10.9 IS-1367 CLASS 12
C15C	SS-316 PLATE	ASTM A193 GR.B16 ASTM A194 GR.4

NOTES: –

1. WHEREVER THE PIPE CLAMPS ARE SUBJECTED TO VIBRATION AN ADDITIONAL LOCK-NUT SHALL BE USED. M/C-BOLT/STUD-BOLT LENGTH SHALL BE SUITABLY INCREASED TO ACCOMODATE THE LOCK-NUT.
2. FOR CARBON STEEL PIPE, M/C-BOLTS SHALL BE USED, WHEREAS FOR ALLOY STEEL AND STAINLESS STEEL PIPE, STUD-BOLTS SHALL BE USED.

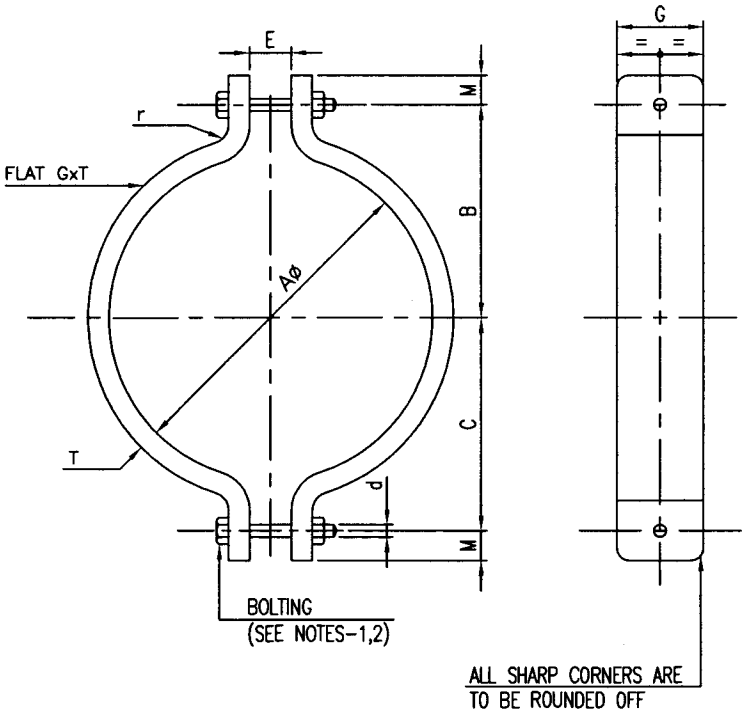


SYMBOL

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
4	15.12.2015	REVISED AND ISSUED AS STANDARD	SH	AK	RN	SC
3	24.01.2011	REVISED AND ISSUED AS STANDARD	SH	RSB	VKB	DM

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HEAVY PIPE CLAMP FOR BARE CS/AS/SS PIPE SIZE 1/2" THRU 24", TYPE - C16



PIPE MATL.	TEMPERATURE	CLAMP TYPE
CS / AS	UPTO 343°C	C16A
	344°C TO 427°C	C16B
	ABOVE 427°C	C16C
SS	ALL TEMP.	C16C

CLAMP TYPE	MATERIAL	
	CLAMP	BOLTS AND NUTS
C16A	IS-2062	IS-1367 CLASS 10.9 IS-1367 CLASS 12
C16B	ASTM A516/A515 (GR.60/65/70)/ IS-2002 GR.2	ASTM A193 GR.B7 ASTM A194 GR.2H
C16C	SS-316 PLATE	ASTM A193 GR.B16 ASTM A194 GR.4

D = NOM. PIPE DIA IN INCHES.

D	DIMENSIONS								BOLT SIZE (REF. NOTE-2)		MAX. ALLOWABLE LOAD (Kg)
	A	B	C	G	M	E	r	T	M/C BOLTS	STUD BOLTS	
1/2"	22	35	35	35	18	15	9	6	M12x55	M12x70	450
3/4"	27	40	40								
1"	35	45	45								
1½"	50	50	50								
2"	62	60	55								
3"	92	80	75	50	25	30	15	10	M16x75	M16x110	800
4"	116	90	85	100	40						
6"	170	125	120				18	12	M24x100	M24x125	1950
8"	222	160	155								
10"	276	190	185	120	45	35	24	16	M27x125	M27x160	2600
12"	327	220	215								
14"	358	230	225								
16"	410	270	265								
18"	460	290	285	140	60				M30x125	M30x160	3000
20"	511	320	315								
24"	613	370	365		65	40	30	20	M36x150	M36x180	4500

NOTES:-

1. WHEREVER THE PIPE CLAMPS ARE SUBJECTED TO VIBRATION AN ADDITIONAL LOCK-NUT SHALL BE USED. M/C-BOLT/STUD-BOLT LENGTH SHALL BE SUITABLY INCREASED TO ACCOMODATE THE LOCK-NUT.
2. FOR CARBON STEEL PIPE, M/C-BOLTS SHALL BE USED, WHEREAS FOR ALLOY STEEL AND STAINLESS STEEL PIPE, STUD-BOLTS SHALL BE USED.

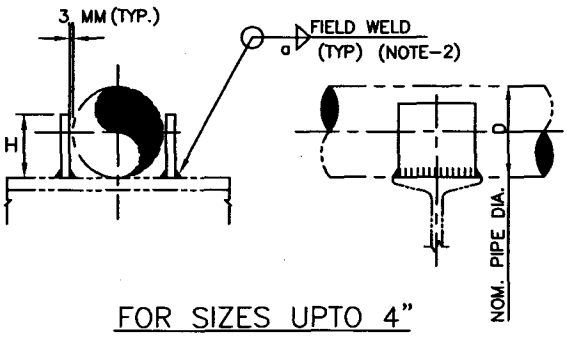
SYMBOL

C16A - D
TYPE
NOM.PIPE DIA. (INCH)

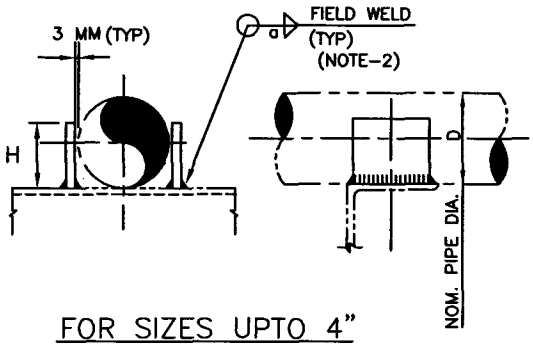
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
4	15.12.2015	REAFFIRMED AND ISSUED AS STANDARD	SH	AK	RN	SC
3	24.01.2011	REVISED AND ISSUED AS STANDARD	SH	RSB	VKB	DM

Approved by

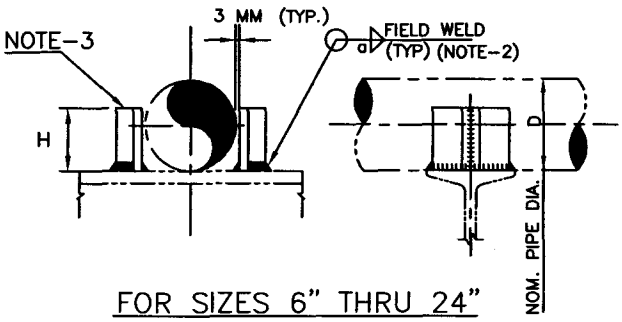
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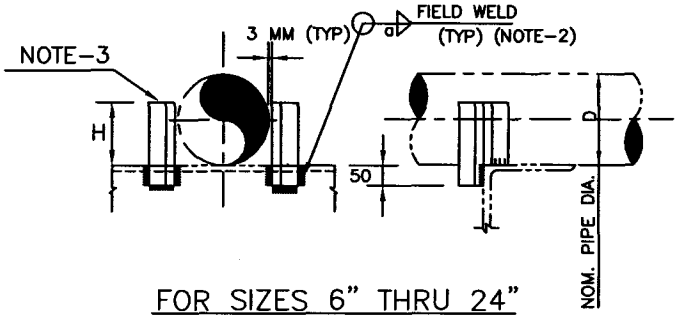
FOR SIZES UPTO 4"
(NOTE-4)



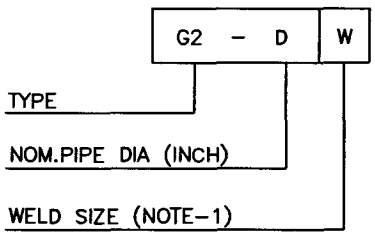
FOR SIZES UPTO 4"
(NOTE-4)



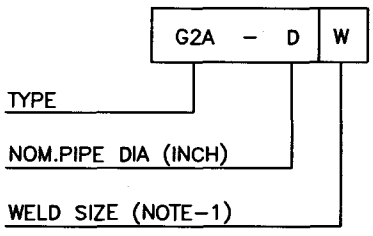
FOR SIZES 6" THRU 24"
(NOTE-4)



FOR SIZES 6" THRU 24"
(NOTE-4)



SYMBOL



SYMBOL

MAXIMUM ALLOWABLE LOAD ON FILLET-WELD OF RESTRAINT (KG/CM)					
WELD SIZE (MM)	TEMPERATURE (IN DEG.C)				
	200	250	300	350	400
6	340	250	220	200	170
8	450	340	300	270	220
10	560	420	370	330	280

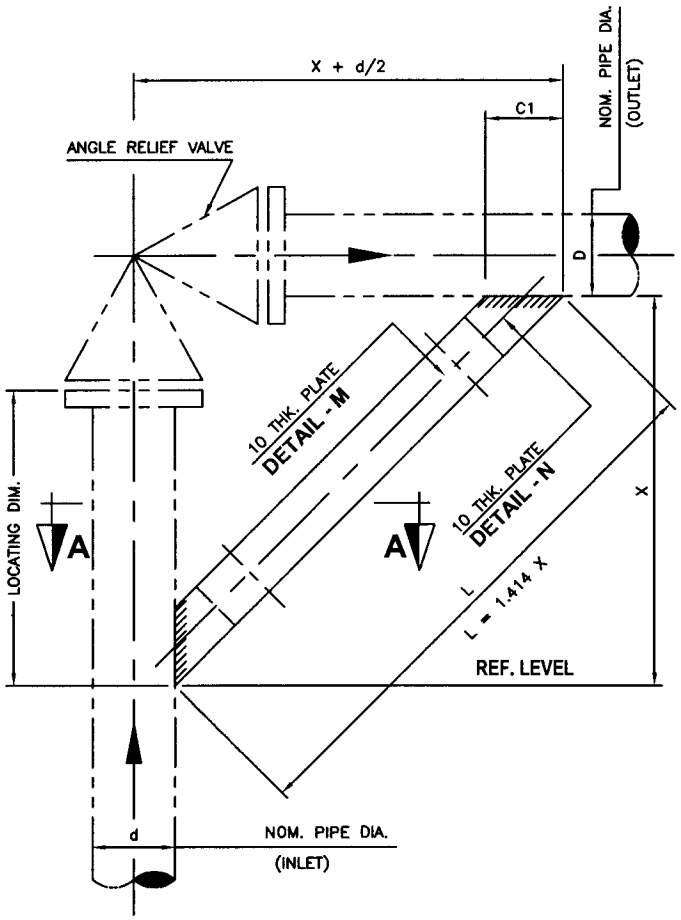
D	H	WELD-SIZE a	MATERIAL
2" & SMALLER	40	6	FLAT 60 X 10 (IS-2062)
3" THRU 4"	70	6	FLAT 75 X 10 (IS-2062)
6" THRU 8"	130	6	2 NOS. ISA 50 X 50 X 6
10" THRU 18"	230	10	2 NOS. ISA 75 X 75 X 10
20" THRU 24"	350	10	2 NOS. ISA 90 X 90 X 10

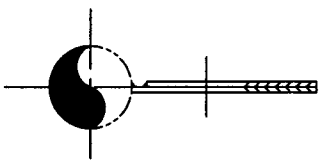
NOTES:-

1. LOADS ON FILLET WELDS OF GUIDE SHALL BE LIMITED TO THE VALUES TABULATED ABOVE AGAINST VARIOUS TEMPERATURES, FOR THE RESPECTIVE WELD-SIZE, FOR RUNNING LENGTH OF WELD. LOADS MAY BE INTERPOLATED FOR INTERMEDIATE TEMPERATURES.
2. GUIDE PLATES/ANGLES SHALL BE WELDED ON BOTH SIDES.
3. GUIDE ANGLES SHALL BE SUITABLY TRIMMED WHEREVER THESE OBSTRUCT ADJACENT GUIDE ANGLES.
4. PROTECTION-SHIELD SHALL BE PROVIDED ON A.S AND S.S LINES 2"NB AND ABOVE, AND ON ALL OTHER LINES 14"NB AND ABOVE. IT SHALL BE CUT FROM LINE-PIPE OR ROLLED FROM PLATE OF MATERIAL EQUIVALENT TO THAT OF PIPE. THICKNESS OF PROTECTION-SHIELD SHALL BE SAME AS THAT OF LINE-PIPE OR 12MM, WHICHEVER IS LESS.

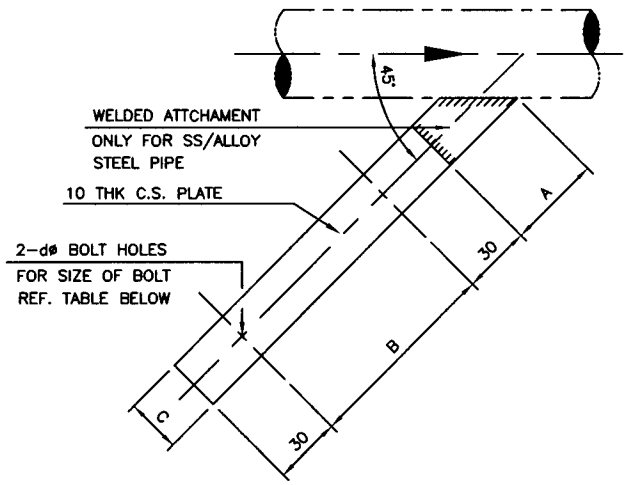
Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
5	22.03.2018	REAFFIRMED AND ISSUED AS STANDARD	PK	SH	MI	RN
4	04.03.2013	REVISED AND ISSUED AS STANDARD	(UK)	(SH)	(RN)	(DM)

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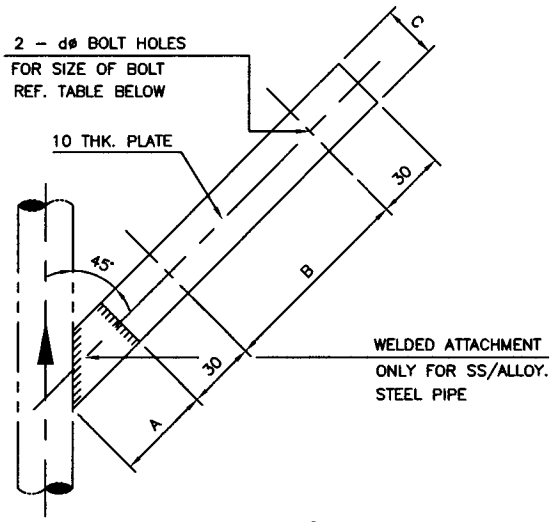




SECTION A-A



DETAIL - N

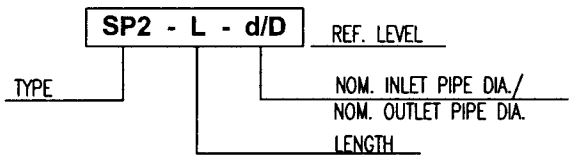


DETAIL - M

D	BOLT SIZE dØ	A	C	B (MIN.)	C1	d1
1" TO 4"	M12 X 50	75	50	150	71	14
6" TO 12"	M16 X 50	100	75	200	106	18

NOTE:-

1. MATERIAL FOR WELDED ATTACHMENT TO BE EQUIVALENT TO PIPE MATERIAL.
2. THIS IS NOT A LOAD TAKING SUPPORT AND IS FOR MAINTENANCE ONLY.



SYMBOL

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
4	15.12.2015	REAFFIRMED AND ISSUED AS STANDARD	SH	KK	RN	SC
3	24.01.2011	REVISED AND ISSUED AS STANDARD	SH	RSB	VKB	DM

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GAIL (India) LIMITED

गांद्यार कम्प्रैसर परियोजना
GANDHAR COMPRESSOR PROJECT

LIST OF APPROVED VENDORS
(PIPELINE ENGINEERING DEPT.)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
1	12.09.2019	REVISED & RE-ISSUED FOR BIDS	SS/TLP	RSB	MSG
0	24.06.2019	ISSUED FOR BIDS	TLP	RSB	MSG

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A. FLANGE - CARBON STEEL (55AA)

Sl. no.	Vendor Name
1.	ANANDMAYEE FORGINGS PVT LTD
2.	ABASI ENGINEERING WORKS
3.	BHARAT FORGE LTD.
4.	BRITEX ENGINEERING WORKS
5.	BRUCK GMBH ENSHEIM
6.	CHW FORGE PVT LTD (FR. CHAUDHRY HAMMER)
7.	CD ENGINEERING CO.
8.	CD INDUSTRIES
9.	ECHJAY INDUSTRIES PVT LTD. (RAJKOT)
10.	ELITE PIPING MANUFACTURE CO. LTD.
11.	FIVEBROS FORGINGS PVT.LTD.
12.	GOOD LUCK ENGINEERING CO.
13.	HILTON METAL FORGING LIMITED
14.	ITM S.R.L.
15.	JAI AUTO PVT LTD.
16.	JAV FORGINGS & ENGINEERINGS PRIVATE LIMITED
17.	KISAAN STEEL (P) LTD
18.	KISAAN DIETECH PVT LTD
19.	KOREA FLANGE CO. LTD.
20.	LAL METAL FORGE LTD
21.	METAL FORGINGS PVT LTD
22.	M.S. FITTINGS MFG. CO PVT LTD
23.	MAASS FLANGE INDIA PVT. LTD
24.	MELESI OFFICINE AMBROGIO MELESI & C.SRL
25.	OFFICINE NICOLA GALPERTI & FIGLIO S.P.A.
26.	OFFICINE SANTAFEDE SRL
27.	PRADEEP METAL LIMITED
28.	PARAMOUNT FORGE (MUMBAI)
29.	PARAMOUNT FORGE (KHOPOLI)
30.	P.K.TUBES & FITTINGS PVT. LTD.
31.	PROMAT BD LTD MIDDLE EAST
32.	R.N.GUPTA & CO. LTD
33.	R D FORGE
34.	SANGHVI FORGINGS & ENGINEERING LTD
35.	TRIVENI REFRACTORIES PVT LTD
36.	UTSAH ENGINEERING PVT LTD (A CD ENGG COMP)
37.	ULMA FORJA S.COOP.
38.	VALVITALIA SPA-TECNOFORGE DIVISION
39.	VILMAR SA

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B. FLANGE – STAINLESS STEEL (55AC)

Sl. no.	Vendor Name
1.	ANANDMAYEE FORGINGS PVT LTD
2.	BHARAT FORGE LTD.
3.	BRUCK GMBH ENSHEIM
4.	CD ENGINEERING CO.
5.	CD INDUSTRIES
6.	CHANDAN STEEL LTD
7.	CHW FORGE PVT LTD (FR. CHAUDHRY HAMMER)
8.	ECHJAY INDUSTRIES PVT LTD. (RAJKOT)
9.	ELITE PIPING MANUFACTURE CO. LTD.
10.	FIVEBROS FORGINGS PVT.LTD.
11.	GOOD LUCK ENGINEERING CO.
12.	HILTON METAL FORGING LIMITED
13.	JAV FORGINGS & ENGINEERINGS PRIVATE LIMITED
14.	KISAAN DIETECH PVT LTD
15.	KISAAN STEEL (P) LTD
16.	KOREA FLANGE CO. LTD.
17.	LAL METAL FORGE LTD
18.	MAASS FLANGE CORPORATION
19.	MAASS FLANGE INDIA PVT. LTD
20.	MELESI OFFICINE AMBROGIO MELESI & C.SRL
21.	METAL FORGINGS PVT LTD
22.	OFFICINE NICOLA GALPERTI & FIGLIO S.P.A.
23.	OFFICINE SANTAFEDE SRL
24.	P.K.TUBES & FITTINGS PVT.LTD.
25.	PARAMOUNT FORGE
26.	PARAMOUNT FORGE (KHOPOLI)
27.	PRADEEP METAL LIMITED
28.	R D FORGE
29.	SANGHVI FORGINGS & ENGINEERING LTD
30.	TRIVENI REFRACTORIES PVT LTD
31.	ULMA FORJA S.COOP.
32.	UTSAH ENGINEERING PVT LTD (A CD ENGG COMP)
33.	VALVITALIA SPA-TECNOFORGE DIVISION
34.	VILMAR SA
35.	VIRAJ PROFILES LIMITED

C. FITTINGS - FOREIGN AGENTS/STOCKIST/TRADERS (70A-)

Sl. no.	Vendor Name
1.	AUSTIN STROUD & CO LTD
2.	AMERICAN PIPING PRODUCTS INC
3.	BUHLMANN ROHR-FITTINGS-STAHLHANDEL GMBH

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4. EDGEN MURRAY FZE
5. HORST KURVERS GMBH
6. INTERNATIONAL INDUSTRIAL EQPT FZCO.
7. MARDALE PIPES PLUS LIMITED
8. OFFSHORE ENGINEERING & MARKETING LTD.
9. PEERAJ GENERAL TRADING CO (LLC)
10. PETROGAS PIPING MIDDLE EAST FZCO
11. SIDECO SPA
12. TECHNICAL PARTS ESTABLISHMENT
13. VAN LEEUWEN BUIZEN

D. FITTINGS FROM SEAMLESS PIPE - CARBON STEEL (72AA)

Sl. no.	Vendor Name
1.	ALLIED INTERNATIONAL S.R.L.
2.	APCO PIPE FITTINGS CO LTD
3.	AWAJI MATERIA (THAILAND) CO. LTD.
4.	CSA FITTINGS
5.	DEE DEVELOPMENT ENGINEERS LIMITED
6.	EBY FASTENERS
7.	ERNE FITTINGS GMBH
8.	EZEFLOW INC.
9.	GUJRAT INFRAPIPES PVT. LIMITED
10.	IBF S P A
11.	ITM SRL
12.	JIANGYIN TIANNING METAL PIPE FITTING CO
13.	K. S. PIPE FITTINGS (P) LTD
14.	LONGSHAN PIPE SOLUTIONS CO LTD
15.	M.S. FITTINGS MFG. CO PVT LTD
16.	MUNRO & MILLER FITTINGS LTD
17.	P.K.TUBES & FITTINGS PVT. LTD.
18.	PETRO CHEM INDUSTRIES
19.	PATTECH FITWELL TUBE COMPONENTS
20.	PIANA S.P.A
21.	RACCORTUBI SPA
22.	S&G ENGINEERS PVT LTD
23.	SAWAN ENGINEERS PVT LTD
24.	SIDHARTH & GAUTAM ENGINEERS
25.	SUNGKWANG BEND CO. LTD
26.	TEEKAY TUBES PVT LTD
27.	TK CORPORATION
28.	TOPAZ PIPING INDUSTRIES
29.	TUBE BEND (CALCUTTA) PVT LTD
30.	TUBE TURN (INDIA) PVT. LTD
31.	VALVITALIA SPA-TECNOFORGE DIVISION
32.	VIRGILIO CENA & FIGLI S.p.A.

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33. WEIFANG HUODA PIPE FITTINGS MANUFACTURE
34. WILH SCHULZ GmbH
35. YINGKOU LIAOHE PIPE FITTINGS CO. LTD

E. FITTINGS FROM SEAMLESS PIPE - STAINLESS STEEL (72AC)

Sl. no.	Vendor Name
1.	ALLIED INTERNATIONAL S.R.L.
2.	CSA FITTINGS
3.	DEE DEVELOPMENT ENGINEERS LIMITED
4.	EBY FASTENERS
5.	ERNE FITTINGS GMBH
6.	EZEFLOW INC.
7.	GUJRAT INFRAPIPES PVT. LIMITED
8.	IBF S P A
9.	JIANGYIN TIANNING METAL PIPE FITTING CO
10.	K. S. PIPE FITTINGS (P) LTD
11.	LONGSHAN PIPE SOLUTIONS CO. LTD.
12.	M.S. FITTINGS MFG. CO PVT LTD
13.	MUNRO & MILLER FITTINGS LTD
14.	P.K.TUBES & FITTINGS PVT. LTD.
15.	PETRO CHEM INDUSTRIES
16.	PIANA S.P.A
17.	RACCORTUBI SPA
18.	SAWAN ENGINEERS PVT LTD
19.	SHANGHAI FEITING PIPE MANUFACTURE CO. LTD
20.	SIDHARTH & GAUTAM ENGINEERS
21.	SUNGKWANG BEND CO. LTD
22.	TEEKAY TUBES PVT LTD
23.	TK CORPORATION
24.	TOPAZ PIPING INDUSTRIES
25.	TOPPER (SHANGHAI) PIPING MATERIALS CO LTD
26.	VALVITALIA SPA-TECNOFORGE DIVISION
27.	VIRGILIO CENA & FIGLI S.p.A.
28.	WILH SCHULZ GmbH
29.	YINGKOU LIAOHE PIPE FITTINGS CO. LTD

F. FITTINGS BLOCK FORGED - CARBON STEEL (71AA)

Sl. no.	Vendor Name
1.	CSA FITTINGS
2.	CHERO PIPING SPA
3.	EBY FASTENERS
4.	FLASH FORGE PVT LTD
5.	FITTINOX SRL
6.	HILTON METAL FORGING LIMITED

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7. ITM S.R.L.
8. KEONSAE HIGH PRESSURE CO.LTD.
9. LEADER VALVES LTD
10. M.S. FITTINGS MFG. CO PVT LTD
11. MUNRO & MILLER FITTINGS LTD
12. M.E.G.A SPA
13. P.K.TUBES & FITTINGS PVT.LTD.
14. PROMAT BD LTD MIDDLE EAST
15. TUBE BEND (CALCUTTA) PVT LTD
16. TK CORPORATION
17. TUBE TURN (INDIA) PVT LTD
18. VAIBHAV FITTING INDIA PVT. LTD.
19. VIJAY CYCLE & STEEL INDUSTRIES
20. WILH SCHULZ GmbH

G. FITTINGS BLOCK FORGED - STAINLESS STEEL (71AC)

Sl. no.	Vendor Name
1.	CSA FITTINGS
2.	CHERO PIPING SPA
3.	EBY FASTENERS
4.	FLASH FORGE PVT LTD
5.	FITTINOX SRL
6.	HILTON METAL FORGING LIMITED
7.	ITM S.R.L.
8.	KEONSAE HIGH PRESSURE CO.LTD.
9.	LEADER VALVES LTD
10.	M.S. FITTINGS MFG. CO PVT LTD
11.	MUNRO & MILLER FITTINGS LTD
12.	M.E.G.A SPA
13.	TK CORPORATION
14.	VAIBHAV FITTING INDIA PVT. LTD.
15.	WILH SCHULZ GmbH

H. WELDOLETS/SOCKOLETS (71AD)

Sl. no.	Vendor Name
1.	CSA FITTINGS
2.	CHERO PIPING SPA
3.	EBY FASTENERS
4.	FLASH FORGE PVT LTD
5.	FITTINOX SRL
6.	KEONSAE HIGH PRESSURE CO.LTD.
7.	M.S. FITTINGS MFG. CO PVT LTD
8.	M.E.G.A SPA
9.	PROMAT BD LTD MIDDLE EAST

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10. TK CORPORATION
11. VAIBHAV FITTING INDIA PVT. LTD.
12. VIAR S.P.A

I. PIPES – FOREIGN AGENTS/STOCKIST/TRADERS (60A-)

Sl. no.	Vendor Name
1.	AMERICAN PIPING PRODUCTS INC [TEXAS]
2.	ARABIAN PIPELINE SUPPLY FZCO [DUBAI-UAE]
3.	ARROW PIPES & FITTING FZCO [DUBAI]
4.	BARTHEL KESSEL ROHRE BOILER TUBES GMBH [NEUSS]
5.	BUHLMANN ROHR-FITTINGS-STAHLHANDEL GMBH
6.	COMMERCIALE TUBI ACCIAIOSPA [TORINO]
7.	EDGEN MURRAY FZE [DUBAI]
8.	GERAB NATIONAL ENTERPRISE L.L.C
9.	HART BV
10.	HORST KURVERS GMBH
11.	INTERNATIONAL INDUSTRIAL EQPT FZCO. [DUBAI]
12.	KIRTANLAL INTERNATIONAL DMCC [DUBAI]
13.	MARDALE PIPES PLUS LIMITED
14.	MEZON STAINLESS STEEL FZE [DUBAI]
15.	OFFSHORE ENGINEERING & MARKETING LTD. [DUBAI]
16.	PETROGAS PIPING MIDDLE EAST FZCO [DUBAI]
17.	PERAJ GENERAL TRADING CO (LLC) [DUBAI]
18.	SIDECO SPA
19.	SUNWEN INDUSTRY WUXI CO LTD [CHINA]
20.	TECHNICAL PARTS ESTABLISHMENT
21.	VAN LEEUWEN BUIZEN

J. PIPES – INDIAN STOCKIST (60B-)

Sl. no.	Vendor Name
1.	CHAMPAK STEEL & ENGINEERING CO.
2.	EVERGREEN SEAMLESS PIPES & TUBES PVT. LTD.
3.	KWALITY TUBES
4.	SHIB DASS AND SONS PRIVATE LIMITED
5.	VINAYAK PIPES AND TUBE PVT LTD

K. PIPE/TUBE - C S (SEAMLESS) TO ASTM STDS (60AH)

Sl. no.	Vendor Name
1.	AVON TUBETECH PVT LTD
2.	ANAND SEAMLESS TUBES PVT. LTD
3.	ARCELORMITTAL TUBULAR PRODUCTS ROMAN SA
4.	BHEL (TRICHY)
5.	BAOSTEEL GROUP CORPORATION
6.	CHANGSHU SEAMLESS STEEL TUBE CO. LTD

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7. HEAVY METALS & TUBES (INDIA) PRIVATE LIMITED (MEHSANA)
8. HUBEI XINYEGANG STEEL CO LTD
9. HENGYANG STEEL TUBE GROUP INTL. TDNG INC
10. JINDAL SAW LTD (NASHIK WORKS)
11. JR SEAMLESS PVT.LTD
12. JFE STEEL CORPORATION
13. JIANGSU CHENGDE STEEL TUBE SHARE CO. LTD
14. KASCO
15. LAL BABA SEAMLESS TUBES PVT. LTD
16. MAHALAXMI SEAMLESS LTD. (RAIGAD)
17. MAHARASHTRA SEAMLESS LTD. (DIST. RAIGAD)
18. MAHARASHTRA SEAMLESS LTD. (RAIGAD)
19. NIPPON STEEL AND SUMITOMO METAL CORPORATION
20. PATELS AIRFLOW LTD.
21. PRODUCTOS TUBULARES S.A.U.
22. PANGANG GROUP CHENGDU STEEL & VANADIUM C
23. RATNADEEP METAL TUBES LTD.
24. SN TUBES PRIVATE LIMITED
25. SAINEST TUBES PVT LTD
26. TUBOS REUNIDOS SA
27. VALLOUREC TUBES FRANCE
28. VALLOUREC TUBES FRANCE (BRAZIL)
29. VALLOUREC TUBES FRANCE (CHANGZHOU JIANGSU PR. CHINA)
30. VALLOUREC TUBES FRANCE (DUSSELDORF-RAT, GERMANY)
31. VALLOUREC TUBES FRANCE (MULHEIM RUHR, GERMANY)
32. VALLOUREC TUBES FRANCE (SOUTH KOREA)
33. VALLOUREC TUBES FRANCE (TIANCHANG CITY CHINA)
34. VALCOVNY TRUB CHOMUTOV
35. WYMAN GORDON FORGINGS
36. YANGZHOU CHENGDE STEEL PIPE CO LTD
37. YANGZHOU LONTRIN STEEL TUBE CO.,LTD.
38. ZHEJIANG GROSS SEAMLESS STEEL TUBE CO LTD

L. PIPE/TUBE - SS (SEAMLESS & WELDED) TO ASTM STDS (60AK)

Sl. no. **Vendor Name**

1. APEX TUBES PVT LTD
2. ARVIND PIPES & FITTINGS IND PVT LTD
3. ASR MET TECH PVT LTD
4. CENTRAVIS PRODUCTION UKRAINE PJSC
5. CHANDAN STEEL LTD
6. CHANGSHU WALSIN SPECIALITY STEEL CO. LTD
7. DEVINE TUBES PVT LTD
8. GIEMINOX TECTUBI RACCORDI SRL
9. HAILONG (ZHANGJIAGANG) INDUSTRY CO., LTD
10. HEAVY METALS & TUBES (INDIA) PRIVATE LIMITED (GANDHINAGAR)

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11. HUADI STEEL GROUP CO., LTD
12. IBF S P A
13. INOX TECH. SPA
14. JIANGSU WUJIN STAINLESS STEEL PIPE GROUP
15. JINDAL QUALITY TUBULAR LIMITED
16. JINDAL SAW LTD (NASHIK WORKS)
17. KRYSTAL STEEL MFG. PVT. LTD.
18. MAXIM TUBES COMPANY PVT LTD
19. MBM TUBES PVT LTD
20. NIPPON STEEL AND SUMITOMO METAL CORPORATION
21. PARAS BHAVANI STEEL PVT LTD
22. PRODUCTOS TUBULARES S.A.U.
23. PATELS AIRFLOW LTD.
24. RATNADEEP METAL TUBES LTD.
25. RATNAMANI METALS AND TUBES LTD
26. REMI EDELSTAHL TUBULARS LTD (FORM RMIL)
27. SALZGITTER MANNESMANN ST DEUTSCHLAND GMBH
28. SANDVIK AB
29. SANDVIK ASIA PVT. LIMITED
30. SANDVIK MATERIALS TECHNOLOGY (CHINA) CO.
31. SCHOELLER-BLECKMANN EDELSTAHLROHR
32. SCODA TUBES LTD
33. SCORDITE STAINLESS (INDIA) PVT. LTD.
34. SEAH STEEL CORPORATION
35. SHALCO INDUSTRIES PVT LTD
36. SHUBHLAXMI METALS AND TUBES PVT. LTD
37. SOSTA GMBH
38. STEAMLINE INDUSTRIES LTD
39. SURAJ LTD
40. TUBACEX PRAKASH INDIA PVT. LTD
41. TUBACEX TUBOS INOXIDABLES SAU
42. WILH SCHULZ GmbH
43. ZHEJIANG JIULI HI-TECH METALS CO. LTD
44. ZHEJIANG TSINGSHAN STEEL PIPE CO. LTD.

M. GASKET METALLIC & SOFT IRON (02AB)

Sl. no.	Vendor Name
1.	ASIAN SEALING PRODUCTS PRIVATE LIMITED
2.	FLEXITALLIC UK LTD
3.	GOODRICH GASKET PVT LTD
4.	IGP ENGINEERS PVT. LIMITED
5.	JAMES WALKER & CO LTD
6.	MICRO PRECISION PRODUCTS PVT LTD
7.	MADRAS INDUSTRIAL PRODUCTS
8.	MOORSIDE MACHINING CO LTD

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9. STARFLEX SEALING INDIA PVT LTD

N. GASKET SPIRAL WOUND (02AD)

Sl. no.	Vendor Name
1.	BOMBAY CHEMICAL EQUIPMENTS
2.	CHAMPION JOINTINGS PVT LTD
3.	DAVE ENGINEERS PVT.LTD
4.	FLEXITALLIC UK LTD
5.	GOODRICH GASKET PVT LTD
6.	HEM ENGINEERING CORPORATION
7.	IGP ENGINEERS PVT. LIMITED
8.	JAMES WALKER INMARCO INDUSTRIES PVT. LTD
9.	JAMES WALKER & CO LTD
10.	MADRAS INDUSTRIAL PRODUCTS
11.	MOORSIDE MACHINING CO LTD
12.	NEOSEAL ENGINEERING PRIVATE LIMITED
13.	STARFLEX SEALING INDIA PVT LTD
14.	TEEKAY FLOWFLEX PVT. LTD.
15.	TEADIT PACKING AND GASKETS PVT LTD
16.	UNI KLINGER LTD

O. FASTENERS (02CA)

Sl. no.	Vendor Name
1.	AEP COMPANY
2.	BEA SRL
3.	DEEPAK FASTENERS LIMITED (DORAHA UNIT)
4.	FASTENERS & ALLIED PRODUCTS PVT LTD.
5.	FIX FIT FASTENERS MFG. PVT. LTD.
6.	HARDWIN FASTENERS PVT LTD.
7.	HEM INDUSTRIES
8.	INDUSTRIAL ENGINEERING CORP.
9.	KUNDAN INDUSTRIES LTD.
10.	KOREA PARTS & FASTENERS (KPF)
11.	LAKSHMI PRECISION SCREWS LTD
12.	MULTI FASTENERS PVT LTD
13.	MEGA ENGINEERING PVT. LTD.
14.	NEXO INDUSTRIES PVT. LTD.
15.	NITIN FASTNERS PVT LTD
16.	OME METALLURGICA ERBESE S.r.l.
17.	PRECISION ENGG. INDUSTRIES
18.	PRECISION AUTO ENGINEERS
19.	PRESIDENT ENGINEERING WORKS
20.	PROCYON TECHNOLOGY
21.	PIONEER NUTS & BOLTS PVT. LTD.

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22. PANKAJ INTERNATIONAL
23. SAVETA ENGINEERING CO. PVT. LTD.
24. SOUVENIR INTERNATIONAL
25. SYNDICATE ENGINEERING INDUSTRIES
26. TECHNICAL METAL EST.
27. TRIPLE FAST MIDDLE EAST LTD
28. UDEHRA FASTNERS LTD
29. UDEHRA MECHANICAL WORKS

P. STRAINERS (02E-)

Sl. no.	Vendor Name
1.	FORIAN S.R.L.
2.	FUJI FILTER MFG CO LTD
3.	JFC CORPORATION
4.	NEWARK WIRE CLOTH CO
5.	SPIRAX SALCO INTERNATIONAL INC
6.	VEE BEE LIMITED

Q. STRAINERS (FAB/CAST/FORGED) (02EA)

Sl. no.	Vendor Name
1.	BOMBAY CHEMICAL EQUIPMENTS
2.	DOUGLAS CHERO SPA
3.	ESCO STEAMCON PVT. LTD.
4.	FORBES MARSHALL PVT. LTD.
5.	GRAND PRIX ENGINEERING PVT. LTD
6.	GUJARAT OTOFILT
7.	LEADER VALVES LTD
8.	MULTITEX FILTRATION ENGINEERS LTD.
9.	PENNANT ENGINEERING PVT LTD
10.	RAKDIN ENGINEERS
11.	SUNGOV ENGINEERING PVT LTD
12.	VERMEER PROCESS TECHNOLOGY B.V

R. VALVE BALL PIPELINE (API6D/METAL SEAT) (30PFA)

Sl. no.	Vendor Name
1.	CAMERON ITALY SRL
2.	EMERSON PROCESS MANAGEMENT (INDIA) PRIVATE LIMITED
3.	FRANZ SCHUCK GMBH
4.	KITAMURA VALVE MANUFACTURING CO LTD
5.	KMC KOREA
6.	L & T VALVES LIMITED
7.	MICROFINISH VALVES PVT LIMITED
8.	MSA A.S.
9.	OMS SALERI

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10. OSWAL INDUSTRIES LTD
11. PCC BALL VALVES SRL
12. PERAR S.P.A (ENQ TO T.R.P. SRL)
13. PETROL VALVES SRL
14. PIBIVIESSE S. R. L.
15. PTPA JSC
16. PETRO VALVES PVT LTD
17. VALVART SRL
18. VALVITALIA SPA
19. ZA. VE. RO. SRL

S. VALVE BALL PIPELINE (API6D/SOFT SEAT) FS (30PFE)

Sl. no.	Vendor Name
1.	CHENGDU HOLY VALVE & COMPLETE EQPMT CO L
2.	DEMBLA VALVES LIMITED
3.	EMERSON PROCESS MANAGEMENT (INDIA) PRIVATE LIMITED
4.	GALPERTI ENGINEERING AND FLOW CONTROL SPA
5.	HAWA VALVES INDIA PVT. LTD.
6.	MICROFINISH VALVES PVT LIMITED
7.	MIR VALVE SDN.BHD.
8.	MNF VALVES PVT. LTD.
9.	NEWAY VALVE (SUZHOU) CO LTD
10.	NSSL ITALIA
11.	PERAR S.P.A (ENQ TO T.R.P. SRL)
12.	RMT VALVOMECCANICA SRL
13.	STEELSTRONG VALVES INDIA PVT LTD
14.	VALVITALIA SPA
15.	ZA. VE. RO. SRL

T. VALVE BALL FIRE SAFE-CSS (50DF)

Sl. no.	Vendor Name
1.	AMPO, S.COOP (POYAM VALVES) (GIPUZSKOA)
2.	BELGAUM AQUA VALVES PVT. LTD.
3.	BOTELI VALVE GROUP CO.
4.	DEMBLA VALVES LIMITED
5.	EMERSON PROCESS MANAGEMENT (INDIA) PRIVATE LIMITED
6.	FLOW CHEM INDUSTRIES
7.	GALPERTI ENGINEERING AND FLOW CONTROL SPA
8.	GM ENGINEERING PVT. LTD.
9.	INTERVALVE POONAWALLA LIMITED
10.	JC FABRICA DE VALVULAS SA
11.	JIANGSU JIULONG VALVE MANUFACTURE CO. LTD
12.	KUMKANG VALVE MFG. CO.LTD.

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13.	L & T VALVES LIMITED
14.	LEADER VALVES LTD
15.	MICON ENGINEERS (HUBLI) PVT LTD
16.	NEWAY VALVE (SUZHOU) CO LTD
17.	NITON VALVE INDUSTRIES PRIVATE LTD.
18.	NSSL ITALIA
19.	REYNOLD VALVES LTD
20.	SHENJIANG VALVE CO LTD
21.	SUZHOU VIZA VALVE CO. LTD
22.	VALBART SRL
23.	VALVITALIA SPA
24.	VALVOSPAIN INDUSTRIAL S.P.U.
25.	WEIR BDK VALVES-A UNIT OF WEIR INDIA PVT
26.	ZA. VE. RO. SRL

U. VALVE BALL - FIRE SAFE (FORGED) (50DL)

Sl. no.	Vendor Name
1.	BELGAUM AQUA VALVES PVT. LTD.
2.	FLOW CHEM INDUSTRIES
3.	GALPERTI ENGINEERING AND FLOW CONTROL SPA
4.	HAWA VALVES INDIA PVT. LTD.
5.	INTERVALVE POONAWALLA LIMITED
6.	MICON ENGINEERS (HUBLI) PVT LTD
7.	NITON VALVE INDUSTRIES PRIVATE LTD.
8.	RMEBS CONTROLS PRIVATE LIMITED
9.	STEEL STRONG VALVES INDIA PVT LTD (SANAND)
10.	VALVULAS FEVISA SAU
11.	WEIR BDK VALVES-A UNIT OF WEIR INDIA PVT

V. VALVE GLOBE FORGED (50BD)

Sl. no.	Vendor Name
1.	ASSOCIATED TOOLINGS INDIA PVT LTD
2.	AUTOCAP INDUSTRIES
3.	AV VALVES LIMITED
4.	BFE SRL
5.	BHEL (TRICHY)
6.	BOTELI VALVE GROUP CO.
7.	DEMBLA VALVES LIMITED
8.	DOUGLAS CHERO SPA
9.	FLOWSERVE PTE
10.	FLUIDLINE VALVES CO.PVT LTD
11.	GM VALVE PVT LIMITED
12.	HAWA ENGINEERS LIMITED

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13. INTERVALVE POONAWALLA LIMITED
14. JC FABRICA DE VALVULAS SA
15. JIANGSU JIULONG VALVE MANUFACTURE CO. LTD
16. JMD ENGINEERING
17. KSB PUMPS LTD
18. L & T VALVES LIMITED
19. LEADER VALVES LTD
20. LVF SPA
21. MH VALVES PVT. LTD.
22. MICON ENGINEERS (HUBLI) PVT LTD
23. NITON VALVE INDUSTRIES PRIVATE LTD.
24. OMB VALVES
25. OSWAL INDUSTRIES LTD
26. PANCHVATI VALVES & FLANGES PVT LTD
27. PEE INDUSTRIAL VALVES PVT. LTD.
28. SEMPELL VALVES PVT LTD
29. SHALIMAR VALVES PVT. LTD.
30. STEEL STRONG VALVES INDIA PVT LTD (SANAND)
31. STEEL STRONG VALVES INDIA PVT LTD (RABALE)
32. VEE TECH VALVES PRIVATE LIMITED
33. VELAN VALVES INDIA PVT. LTD.
34. WEIR BDK VALVES-A UNIT OF WEIR INDIA PVT

NOTES:

1. Bidder may procure material from any of approved vendors listed above. However, **current validity and range of approval as per enlistment letter, workload, stability and solvency need to be verified by the Vendor before placement of order.The finally selected vendor(s) for items shall be informed to the Company. Confirmation shall be taken from the Company regarding the current status (Holiday/Blacklist etc.) of the Vendor before placing the orders on the vendor(s)**.

2. For equipment/components other than the above, vendor shall submit past track record for the proposed sub-vendors and obtain written approval from Owner / EIL before placing order.

3. The sub-vendors list shall be approved by owner/EIL prior to placement of order by vendor. Vendor shall list down the proposed suppliers/vendors for such items and submit the same for owner review/approval along with necessary documents/PTR. Non-acceptance of a particular proposed vendor due to any reasons whatsoever shall not be a cause of schedule and cost implication. If equipment are sourced from outside India, vendor shall obtain prior approval for make of equipment before placement of order.

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JOB SPECIFICATION FOR FIRE SUPPRESSION SYSTEM

(GAS TURBINE ENCLOSURES)

MR No : B240-910-KA-MR-5010

PROJECT : Installation of New GT driven Centrifugal Compressor at GAIL Gandhar, Gujarat

OWNER : Gas Authority of India Limited

PMC : Engineers India Limited

JOB NO. : B240

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
A	24.04.19	ISSUED WITH MR	PPC	PPC	SKN

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1.0 SCOPE

This specification describes the minimum requirements for design, supply and supervision for installation and commissioning of fire suppression system required for Gas Turbine Enclosure for Gas Turbine driven centrifugal compressor package at GAIL, Gandhar, Gujarat.

2.0 TECHNICAL REQUIREMENTS

2.1 The Fire suppression system shall be as per NFPA requirements.

2.2 The Fire Suppression System shall consist of an automatic release of "CO_2" (as per NFPA-12) extinguishing agent. Fire water deluge system shall not be provided for the gas turbine enclosure.

2.3 CO_2 Fire suppression system for the turbine enclosure shall be designed so that it can be activated automatically by receiving a signal from any of the two different type of fire detection instruments located in that area. i.e. UV detectors and thermal detectors. The fire suppression system shall also be manually activated by an operator, in the event of a signal from any of the devices.

2.4 Area protected by CO_2 system shall have adequate primary source and 100% back-up supply manifold together. The extinguishing system shall provide high speed release of CO_2 based on the concept of local flooding.

2.5 A suitable time delay sound and flashing red light alarm shall be provided before the release of CO_2, to facilitate escape of the personnel.

2.6 The fire and gas detection system (vendor's scope of supply) shall have self integrity check modules of gas/ thermal detection system, input/ output fuse status, display for fault in self checking facilities, CO_2 pressure/ weight monitoring, CO_2 primary/ secondary selection facilities etc.

2.7 For the requirements concerning Fire and Gas detection system, Instrumentation specifications enclosed with the inquiry documents, shall be referred.

3.0 VENDOR DATA AND DRAWING

Vendor shall furnish all the necessary drawings and instructions required for installation, operation and maintenance of the fire suppression system.

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4.0 INSTALLATION WORK AT SITE

The vendor shall provide his services for supervision of the installation & commissioning of the fire suppression system supplied along with the Gas Turbine.

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ऐक्सीयल तथा सेन्ट्रीफ्यूगल कम्प्रेसरों तथा एक्सपेन्डर-कम्प्रेसरों के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR AXIAL AND CENTRIFUGAL COMPRESSORS AND EXPANDER-COMPRESSORS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	21.01.2014	Revised and Issued as Standard Specification	JSD	TK	DB/AKN	SC
1	21.03.2011	Re-affirmed and Reissued	SPS	SM	AKN	DM
0	07/06/2005	Issued as Standard Specification	DB	KDS	RK	VJN

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Abbreviations:

API	:	American Petroleum Institute
ASME	:	The American Society of Mechanical Engineers
EQC	:	Equipment Qualification Criteria
PDF	:	Portable Document Format
P&ID	:	Piping and Instrumentation Diagram
PTC	:	Power Test Codes
PTR	:	Proven Track Record
VDR	:	Vendor Data Requirements
QA	:	Quality Assurance
DCIM	:	Document Control Index Module
EDMS	:	Electronic Document Management System

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Chapter 1

General Requirements

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1.0 SCOPE

(i) This specification together with the attendant data sheets and other specifications/ attachments to inquiry/ order defines the minimum requirements for axial compressors, single-shaft and integrally-geared process centrifugal compressors, and expander-compressors for all types of services [except for packaged, integrally-geared centrifugal plant & instrument air compressors, fans or blowers that develop less than 0.35 kgf/cm^2 (34 kPa) pressure rise above atmospheric pressure and hot gas expanders over 300°C], including their drivers and drive mechanisms, reducing gears, if any, lubricating/sealing systems, controls, safety devices and instrumentation, and other auxiliary equipment.

(ii) Vendor shall make all possible efforts to comply strictly with the requirements of this specification and other specifications/attachments to inquiry/order. In case deviations are considered essential by the vendor (after exhausting all possible efforts) these shall be separately listed in the vendor's proposal under separate section titled as "List of deviations/exceptions to the inquiry document". Deviation shall be listed separately for each document with cross reference to Page No./Section/Clause No./Para etc. of the respective document supported with proper reasons for the deviation for purchaser's consideration. Any deviation not listed under the above section, even if reflected in any other portion of the proposal shall not be considered applicable. No deviation or exception shall be permitted without the written approval of the purchaser.

(iii) Compliance with this specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories/auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions. In case the vendor considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, he shall recommend the same along with reasons in a separate section along with his proposal and include the same in his scope of supply.

(iv) Except as modified herein, the main equipment and their auxiliaries shall be designed, manufactured, tested and supplied strictly in accordance with the **API Standard 617, Seventh Edition, July 2002, "Axial and Centrifugal Compressors and Expander-compressors for Petroleum, Chemical and Gas Industry Services."**

(v) Except for new paragraphs, the number and title of the paragraphs in the following Modifications to **API Standard - 617** correspond to the respective sections and paragraphs of the above standard. Paragraphs not addressed in this specification shall be strictly in accordance to **API Standard 617, Seventh Edition July 2002** requirements.

The word in parenthesis following the number or title of a paragraph indicates the following:

(Addition)	:	An addition to a part, section or paragraph referred to.
(Modification)	:	An amplification or rewording has been made to a part of the corresponding section or paragraph but not a substitution replacing the entire section or paragraph.
(Substitution)	:	A substitution has been made for the corresponding section or paragraph of the standard in its totality.
(New)	:	A new section or paragraph having no corresponding section or paragraph in the Standard.
(Delete)	:	This paragraph is deleted.

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SECTION 1 - GENERAL

1.1 **SCOPE** (Substitution)
The entire paragraph excepting Paragraph 1.1.1 and 'NOTE' is substituted by paragraph 1.0 above

1.2 **ALTERNATIVE DESIGNS** (Delete)

1.3 **CONFLICTING REQUIREMENTS** (Substitution)
In case of conflict between this specification and the attendant data sheets, job specifications (if any) and other attached specifications the following order of precedence shall govern:

1. Equipment Data Sheets.
2. Job Specifications (if any)
3. P&ID's (if any)
4. This specification
5. Other specifications
6. Other referred codes and standards

1.5 **DEFINITION OF TERMS**

1.5.45 **Standard Volume Flow** (Modification)

Nm^3/hr is an abbreviation for capacity in normal cubic meters per hour referred to 1.033 kg/cm^2a pressure, 0°C temperature with a compressibility factor of 1.0 and 0% relative humidity.

Sm^3/hr is an abbreviation for capacity in standard cubic meters per hour referred to 1.033 kg/cm^2a pressure, 15°C temperature with a compressibility factor of 1.0 and 0% relative humidity.

1.6 **NORMATIVE REFERENCES**

1.6.4 (Modification)
The editions of referenced publications that are in effect at the time of inquiry or at a date specified in the inquiry document shall be applicable.

1.6.5 (Modification)
Equipment supplied shall comply with applicable US Standards. However ISO Standards ISO-1940 & ISO-8821 will also be applicable.

1.8 **UNIT RESPONSIBILITY** (Addition)
Unless otherwise specified, vendor having unit responsibility shall be as defined in Clause# 1.3 of Chapter-2 (Centrifugal & Axial Compressor), Clause# 1.3 of Chapter-3 (Integrally Geared Compressors) & Clause# 1.3 of Chapter-4 (Expander-Compressors).

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SECTION 2 - BASIC DESIGN

2.1 GENERAL

2.1.1 Performance

2.1.1.3 (Modification)
Unless otherwise specified the compressor shall be designed to deliver the rated head and rated capacity without negative tolerance.
The BKW at the above condition shall be guaranteed with zero positive tolerance.

2.1.5.1 (Modification)
Unless otherwise specified, cooling water system (jackets, diaphragms, internal coolers, and so forth) shall be designed for the following condition:

Velocity over heat exchanger surface	:	1.5 - 2.5 m/sec.
Maximum Allowable Working Pressure	:	8.0 kg/cm^{2}g
Test Pressure (1.5 X MAWP)	:	12.0 kg/cm^{2}g
Maximum Pressure Drop	:	1.0 kg/cm^2
Maximum Inlet Temperature	:	33°C
Maximum Outlet Temperature	:	45°C
Maximum Temperature Rise	:	12°C
Minimum Temperature Rise	:	6°C
Fouling Factor on Water Side	:	0.0004 m^2 hr °C/kcal
Shell Side Corrosion allowance	:	3.2 mm

2.1.9 (Modification)
Unless otherwise specified, the maximum permissible sound pressure level of the compressor-driver train shall not exceed 88 dBA measured at 1 meter from the equipment surface for the recommended range of operation.

2.1.14 (Substitution)
All electrical components and installations shall be suitable for the hazardous area classification and gas group specified in the inquiry/order documents.

2.2 MATERIALS

2.2.1.2 (Modification)
Add to this clause: Equivalent materials in accordance with other internationally recognised standards are acceptable.

2.2.1.15.3 (Modification)
Unless otherwise specified, minimum design metal temperature shall be the minimum surrounding ambient temperature or minimum temperature of compressed gas, whichever is lower.

2.2.4.1 (Modification)
Add to this clause: Welders qualified with other internationally recognised standards are acceptable.

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2.3 CASINGS

2.3.1 Pressure containing Casings

2.3.1.11.6 (New)
Unless specified otherwise, 100% radiography inspection shall be done in the case of connections welded to pressure castings. In addition cast compressor casings shall be radiographed in critical areas (critical areas are generally defined as those areas where there is a major change in section thickness or direction).

2.3.2 Pressure Casing Connections

2.3.2.1 General

2.3.2.1.6 (Addition)
All casing drain connections shall be valved and brought to a common header terminating with a valve so that the Purchaser has to make a single connection. This common header valve shall be brought to the skid edge and supported.

2.3.2.2 Main Process Connections

2.3.2.2.7 The words 'when specified' stand deleted.

2.6 DYNAMICS

2.6.7 Torsional Analysis

2.6.7.1 (Modification)
Unless specified otherwise, the compressor vendor shall perform a composite torsional vibration analysis of the complete coupled train and shall be responsible for the satisfactory mechanical performance of the train. Other manufacturers providing components for the system shall provide the necessary data to the compressor manufacturer, who shall submit to the Purchaser a complete torsional analysis report.

2.6.8 Vibration and Balancing

2.6.8.2 (Addition)
The final balancing of the rotor assembly shall be carried out along with the coupling half.

2.6.8.2.1.1 (Modification)
The words 'when specified' stand deleted.

2.6.8.3 (Modification)
When the vendor's standard balance method is by operating speed balancing in lieu of sequential low speed balancing, the same is also acceptable.

2.6.8.7 (Modification)
The words: "when specified" stands deleted.
For rotors that are high speed balanced, a low speed residual unbalance check shall be performed in a low speed balance machine. This is done to provide a reference of residual unbalance and phase for future use in a low speed balance machine.

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2.8 SHAFT END SEALS

2.8.1 General

2.8.1.1 (Modification)
Where settling out pressure is not specified by the purchaser, settling out pressure shall be taken as equal to the rated discharge pressure of the compressor.

2.8.3 Oil Seals

2.8.3.4 (Modification)
Mechanical contact type seals shall incorporate a suitable design feature to prevent process gas leakage when the compressor is pressurized and not running and the seal oil system is shut down.

2.8.4 Self Acting Dry Gas Seal

2.8.4.1 (Modification): Unless otherwise specified, Tandem DGS with intermediate labyrinths (Fig. 1.C-9) shall be used for toxic or flammable gases.

2.8.4.5 (New): The lift off speed of seal faces shall always be below the compressor train minimum operating speed including the shop speed for performance test.

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SECTION 3 - ACCESSORIES

3.1 DRIVERS

3.1.4 (Modification)
Steam turbine driver shall be capable of continuously developing 110% of the maximum power required for the specified conditions while operating at the corresponding speed under specified steam conditions (minimum inlet steam condition and maximum steam outlet condition, unless specified otherwise).

3.1.7 (Modification)
The base continuous rating of the gas turbine driver at rated site conditions of temperature, altitude, humidity, intake/exhaust pressure losses, shall be as a minimum 110% of the greatest power required by the compressor under any of the specified operating conditions including gearbox and all transmission losses.

3.2 COUPLINGS AND GUARDS

3.2.2 (Modification)
Unless otherwise specified, coupling shall be of non-lubricated diaphragm/stainless steel flexible membrane type, as per **API Standard 671**.

3.3 MOUNTING PLATES

3.3.1 **General**

3.3.1.2.6 (Substitution)
Unless otherwise specified, anchor bolts will be furnished by the vendor.

3.3.2 **Baseplates**

3.3.2.1 (Modification)
Unless otherwise specified, the complete compressor unit, including gear and driver, shall be mounted on a single lift base plate of structural steel. There shall be no limits to the size of the base plate other than those derived from transportation, installation (lifting constraints), and/or plant lay-out considerations.

3.3.2.4 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

3.3.2.6 (Modification)
The words 'when specified' stand deleted.

3.4 CONTROLS & INSTRUMENTATION

3.4.1 **General**

3.4.1.1 (Substitution)
Minimum instrumentation and process controls as desired by the Purchaser, shall be as specified in the data sheets/job specifications/drawings/general specifications and other documents referenced in the inquiry or order and shall be supplied by the vendor. The vendor shall specify and provide any additional instrumentation and controls as deemed necessary for the smooth and safe operation of the unit under all specified operating conditions. The vendor shall review Purchaser's overall compressor control system for compatibility with the vendor furnished controls/instrumentation.

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3.4.2 **Control Systems**

3.4.2.2 (Modification)
Unless specified otherwise, anti-surge system for compressor shall be furnished by the vendor. The anti-surge system furnished shall enable stable compressor operation at any point on the right side (high flow side) of surge control line.

3.5 PIPING AND APPURTENANCES

3.5.1 **General**

3.5.1.5 (New)
The vendor shall also supply interconnecting piping between equipment groupings and off-base facilities.

All piping for utilities (cooling water, steam, exhaust gas, purge gas, buffer gas etc.) shall be furnished by the vendor and terminated at the vendor's battery limit (unless otherwise specified, the vendor's battery limit shall be treated as the compressor house battery limit) with single inlet and single outlet flanged connections per service for purchaser's interface.

All vent pipes shall be supplied by the vendor and terminated outside the compressor shelter above the shelter roof level.

To the extent possible all drains shall be manifolded and terminated at the grade level for purchaser's interface. Where manifolding is not feasible/advisable, the individual drains shall be terminated at the grade level. All drains shall be terminated with a flanged valve.

All flare lines required for the package shall be piped by the vendor upto the purchaser's flare header and shall be free draining towards the flare header.

SECTION 4 - INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

4.1 GENERAL

4.1.8 (New)
Rejections made by Purchaser's inspector, based on inspection or tests shall be final. Acceptance by the inspector shall in no way release the vendor from guarantees as to materials, workman-ship, and performance of the equipment inspected.

4.2 INSPECTION

4.2.1 **General**

4.2.1.5 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

4.3 TESTING

4.3.1 **General**

4.3.1.2 (Substitution)
At least 12 weeks before the first scheduled test vendor shall submit to the purchaser detailed test procedures for all running tests for his approval.
The test procedure shall as a minimum include the following:

- Test Objectives and Acceptance criteria

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- Test Set up (layout) showing the arrangement of equipment & piping system along with location and number of measuring instruments.
- Operating conditions during the test.
- Sequence of various activities during the test starting from preparation for start of test till the final termination of test.
- Sample test log sheets and calculations.

4.3.1.3 (Substitution)
The vendor shall notify the purchaser not less than 4 weeks before the date of scheduled testing and reconfirm the same at least one week before the firm test date.

4.3.6 **Mechanical Running Test**

4.3.6.1.2 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

4.3.6.1.3 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

4.3.6.1.5 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

4.3.8 **Optional Tests**

4.3.8.1 **Performance Test** (Addition)

Unless otherwise specified, all equipment shall be subjected to performance testing in manufacturer's facility.

4.3.8.2 **Helium Test** (Addition)
Casings for compressors handling gas containing 30 mole percent or higher of hydrogen shall be subject to a helium leak test, as defined above.

4.4 PREPARATION FOR SHIPMENT

4.4.1 (Modification)
The words "6 months" shall be replaced with the words "8 months".

SECTION 5 - VENDOR'S DATA

5.1 GENERAL

5.1.2 (Substitution)
Refer Clause# 5.3.1.2.

5.2 PROPOSALS

5.2.1 **General** (Substitution)
In addition to data specified in clauses 5.2.2 to 5.2.4, the vendor's proposals shall, as a minimum, include the following:

a. All data sheets, drawings and documents listed under "WITH BID" in the Vendor Data Requirement Form enclosed with the inquiry.
b. List of recommended commissioning spares included in the offer.
c. List of insurance spares (where specified by the purchaser) included in the offer.
d. List of Spare Parts for Two Years Normal Operation
This list shall be made separately for each item including auxiliaries and drivers in the

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form of a table & shall show

i) Part name, description and number.
ii) Quantity installed in one unit.
iii) Quantity recommended per unit for 2 years normal operation.
iv) Quantity recommended for number of units of an item as specified in the inquiry.
v) Quantity recommended as insurance for the number of units of an item specified in the inquiry.

e. An itemised list of special tools included in the offer.
f. Any start-up, shutdown or operating restrictions required to protect the integrity of the equipment.
g. Any limitations of vendor's test-facility to carryout the specified tests.
h. A specific compliance statement that the scope of supply, the offered equipment/systems and all its components are in strict accordance with the data sheets, job specifications, this specifications and all other attachments, except for specific deviations as listed in the proposal.

Unless a specific deviation/exception is taken by the vendor at the time of submitting the proposal, it will be understood that final equipment/system shall be designed, fabricated tested and supplied strictly in accordance with Purchaser's specified requirements as covered in the inquiry or order.

5.2.2 **Drawings**

5.2.2.1 (Addition)
The drawings indicated in the Vendor Data Requirement under "WITH BID" shall also be included in the proposal.

5.2.3 **Technical Data**

5.2.3 (i) (Addition)
Vendor shall also furnish a consolidated list of all consumables which need to be replaced/replenished periodically (like lube oil, seal gas , greases, any cleaning agent etc.), indicating the total quantity required for the period of commissioning/start-up and one year continuous operation of the unit.

5.2.3 (l) (Substitution)
A list of installations, prepared in a manner so as to give explicit evidence that the offered equipment amply meets the specified design, manufacturing and experience requirements.

5.2.3 (n) (Delete)

5.2.5 Quality Assurance Procedures (Substitution)
Vendor shall furnish his standard QA procedures, duly modified as per requirements of inquiry for the offered equipment.

5.3 CONTRACT DATA

5.3.1 **General** (Substitution)

5.3.1.1 Drawings and data as required after purchase order has been specified in Vendor Data Requirement. Vendor to note that the drawing/document descriptions/titles as given in the Vendor Data Requirement are generic in nature. It is possible that against one drawing/document specified, there are several drawings to be furnished by the vendor or vice versa. Vendor shall complete & forward a document titled as "Vendor Drawing Schedule", Document Control Index (DCI) to the purchaser (Destination & contact person as per order). This document shall list out in consolidated form all drawings and documents

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required by purchaser (As specified in Data Sheets, Specifications and Vendor Data Requirement forms enclosed with the order). Against each drawing/document vendor shall indicate the vendor's drawing number, title, Rev. No., category (whether for information or approval) and schedule of submission.

This shall be the first document to be submitted by vendor within two weeks of order. **No drawing shall be taken up for review till DCI for the inquiry/order is finalized by vendor.**

5.3.1.2 All transmittal letters (covers), drawings and data shall have a title block (in addition to vendor's standard title block) which shall as a minimum contain the following contract information:

i) Purchaser's and Consultant's Corporate Name
ii) Project Name.
iii) Equipment Name and Item No.
iv) Purchase Order No.
v) Purchase Requisition No.

Title Block on drawings shall be placed on the lower right hand corner.

5.3.1.3 All vendor data/drawings/documents shall be in English Language and in Metric Systems.

5.3.1.4 Data specified in the VDR is the minimum requirements of Purchaser. Any additional document/data required or requested by Purchaser for engineering or construction shall also be made available by the vendor.

5.3.1.5 Whether or not specified the vendor shall furnish the following, before shipment:

- As built running clearances and when applicable; thrust bearing, radial bearing and seal running clearances.
- A supplementary list of spare parts other than those included in his original proposal. The supplementary list shall include recommended spare parts, cross-sectional or assembly type drawings, parts numbers, materials, prices and delivery period. The vendor shall forward this supplementary list to the purchaser promptly after receipt of the reviewed drawings and in time to permit order and delivery of parts before field start-up.
- A parts list for all equipment supplied. This list shall include pattern, stock, or production drawing numbers and materials of construction. The list shall completely identify each part so that the purchaser may determine the interchangeability of the parts with other equipment furnished by the same manufacturer. Standard purchased items shall be identified by the original manufacturer's name and part number.
- At least 8 weeks before shipment, the vendor shall submit equipment preservation, packaging and shipping procedures to the purchaser for review.

5.3.2 **Drawings and Technical Data** (Addition)

The number of prints required and the times within which these are to be submitted by vendor are specified in Purchaser's inquiry/order.

The purchaser's review of the vendor's drawings shall not constitute permission to deviate from any requirements in the purchase order/specifications unless specifically agreed upon in writing. After the drawings have been reviewed, the vendor shall furnish certified copies in the quantity specified. All drawings must be clearly legible and shall be folded to 216 mm x 279 mm size.

Drawings/documents with following titles shall contain as a minimum the following information:

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a) **General Arrangement Drawing**

A general arrangement drawing shall indicate:

- Outline dimensions (minimum three views) (All principal dimensions).
- Allowable forces and moments on suction and discharge nozzles.
- Location (in all three planes), size, type, rating and identification of all purchaser's interface connections including those of vents, drains lubricating oil, sealing fluid, cooling water, steam & Electrical/Instrumentation.
- Direction of rotation, viewing from the driving end.
- Weight of each assembly/component.
- The weight & location of center of gravity of the heaviest assembly/components that must be handled for erection.
- Identification, weight and dimensions of the heaviest equipment assembly / subassembly / component required to be handled for maintenance.
- Maintenance clearances and dismantling clearances.
- Speeds of Driven Equipment and Driver with Driver rating. Location of driver terminal box (in case of Electric motor Driver).
- Layout of auxiliary equipment and operating platform.
- Make, Type and Size of couplings and the location of guards and their coverage.
- A list of reference drawings if any.
- A list of any special weather-protection and climatic features.
- Equipment furnished (loose) by the vendor for mounting by the purchaser.

b) **Foundation Drawings**

A foundation drawing shall indicate complete information required for foundation design by purchaser including the following:

- Foundation bolt sizes, pipe sleeve details, pocket sizes and locations.
- Grouting thickness and other necessary technical details.
- Static weight of each skid/independently grouted item and location of center of gravity of each of such skid/items in all three planes.
- Weight distribution for each bolt/subsole plate location and total static weight.
- Dynamic loading caused due to various items grouted independently.
- The direction and magnitude of unbalance forces and moments generated by each such item at the worst operating condition and short circuit moments of motor drivers
- GD^2 value of each item resolved to driver speed.
- Maximum permissible amplitude of vibration on the foundation at base level.
- Total mass of rotating parts.
- Suggested dynamic factor and ratio of foundation weight to weight of skid/equipment as per vendor experience.

c) **Layout Drawing (For multi-skid packages)**

This drawing shall include atleast the following:

- Layout of all skid/equipment and their auxiliaries, vessels, control panels, exchangers etc. Vendor shall furnish an optimised layout (considering the space allocated, site wind conditions, area classification, the type of equipment located in the vicinity etc.) indicating elevation and dimension of skids/equipment.
- Minimum spacing required between the various skids/equipment and between the skids and the walls/columns/roof for an easy accessibility and maintenance.
- Layout for water piping, trenches for water piping, cable tray/trenches layout.
- Piping arrangement and piping support arrangement/location for piping in vendor's scope.
- Layout for auxiliary equipment and operating platform details.
- Specification for crane/mono rail (including suggested crane/mono rail layout) recommended for maintenance and height of the lifting hook from the centerline of equipment.

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d) **Field Alignment Diagram**
The diagram shall indicate the relative displacement to be kept between the centerlines of various equipments at the time of installation, so that under normal running conditions the equipments get fully aligned. This relative displacement should be decided on the basis of centerline temperature rise data of driver, gear box/transmission system, driven equipment.

e) **Heat Exchanger Drawings**
Heat exchanger drawing and data shall include heat and mass balance data, details of provisions for separating and withdrawing the condensate, construction details, cross sections & general arrangement drawings of heat exchangers, vendors recommendations regarding provision for support and piping expansion.

f) **P&I Diagrams (with Bill of Materials)**
Vendor shall supply P&I Diagrams along with Bill of Materials of each system in the vendor's scope of supply or specified in the order. P&I Diagram shall indicate the system details, location of various auxiliaries, instruments, controls and safety devices as required. Line sizes, piping class, valve sizes and class shall be clearly marked on the P&ID. Vendor's scope and purchaser's scope shall be clearly demarcated. Each item shall be identified by an item No./item tag no., which shall correspond to the item no. shown on the bill of materials. The bill of materials shall include items number, normal value, set value, range, quantity per unit, make and other specifications as applicable. Legends adopted shall be indicated either at the bottom of drawing or on a separate drawing. The legends shall be as per ISA.

g) **Cross-sectional Drawing with Bill of Materials**
The vendor shall supply cross-sectional or assembly type drawings for all equipment furnished showing all parts, design assembly and running clearances, and balancing data required for erection and maintenance. Each part shall be numbered which shall correspond to the part number on the bill of materials. The bill of materials shall include the part no., name of component, materials quantity installed per unit & sizes where applicable (say for bolts, nuts, rings, gaskets etc.). All bought-out items shall also be indicated with make and brief specifications.
A separate cross-sectional drawing showing installation and setting dimensions for the seals shall be furnished.

5.3.5 **Installation, Operation, Maintenance and Technical Data Manuals.**

5.3.5.3 (Substitution)
Refer Clause# 5.3.5.4

5.3.5.4 **Technical Data Manual/Mechanical Catalogue** (Substitution)

5.3.5.4.1 Technical Data Manual is a compilation of "As Built" drawings and data, manufacturing and test records, installation, operating and maintenance instructions.

5.3.5.4.2 Not later than two weeks after successful completion of all specified tests, the vendor shall furnish the required number of Technical Data Manuals for the equipment, any auxiliaries and instruments that the vendor is providing. The Technical Data Manual shall include the following documents as a minimum:

(i) All drawings and data as listed in the vendor data index & schedule. (For drawings, where purchaser's approval is required, the final certified drawings shall be attached.) Sections shall be organised in a manner that data & drawings related to one subject is grouped together such as Mechanical, Electrical, Instrumentation etc.

(ii) All manufacturing, inspection and test data and records.

(iii) Installation Manual
The vendor shall provide sufficient written instructions, including a cross-reference list of all drawings, to enable the purchaser to correctly install the equipment and prepare the equipment for start-up. It shall include any special information required

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for proper installation that is not on the drawings, special alignment or grouting procedures, utility specifications (including quantity) and all installation data. It shall also contain the following information:

a) Instructions for erecting, piping, aligning (including the expected thermally induced shaft centerline shift between normal site ambient temperature position and that at normal equipment operating temperature).
b) A description of rigging procedures, including the lifting of the assembled equipment, and methods of disassembly, repair, adjustment, inspection and reassembly of the equipment and auxiliaries.
c) Pre-commissioning / commissioning / functional test procedures and acceptance criterion.
d) Lube and Seal oil, Seal Gas/Purge Gas recommendations.

(iv) Operation and Maintenance Manual

This manual shall provide sufficient written instructions and data to enable purchaser to correctly operate and maintain the equipment ordered. It shall include a section to cover special instructions for operation at extreme environmental and/or extreme operating conditions. The following shall be included in this manual:

a) Instructions covering start-up, normal shutdown, emergency shutdown, operating limits and routine operational procedures.
b) A description of equipment construction features and the functioning of component parts or systems (such as control, lubrication, sealing systems etc.).
c) Outline and sectional drawings, schematics and illustrative sketches in sufficient details to identify all parts and clearly show the operation of all equipment and components and the methods of inspection and repair. Standardised sectional drawings are acceptable only if they represent the actual construction of the equipment.
d) The following maintenance information:
   - Maximum and minimum bearing, labyrinth and seal clearances including any other clearance between moving and stationary parts of the equipment affecting proper running and maintenance of the equipment.
   - Instructions for measuring and adjusting cold clearances, shaft runout, concentricity etc.
   - Rotor float allowance.
   - Interference fits on parts that are required to be removed or replaced for maintenance of normally consumable spares.
   - Balancing tolerances.
   - Lubricating schedules indicating recommended grades of oil, their properties, replacement period etc.
   - Normal maintenance procedure including disassembly procedures.
   - Preventive maintenance schedules and criterion for replacement of parts.
   - Trouble - shooting procedures.
e) The following reassembly information:
   - Bolting sequence and torque values for all bolts affecting equipment performance/integrity/safety.
   - Reassembly sequences together with required inspection checks.
   - Adjustment procedures to achieve required positions, clearances, float and so forth.
   - Detailed procedures for pre-operational checks, including settings and adjustments.
   - Seals and coupling installation procedures.
   - Parts list indicating cross-sectional drawings of various assemblies and sub-assemblies, part numbers, materials of construction (ASTM grades) etc.to facilitate identification of parts and for procurement of spares.

(v) Following information shall also be included in the Technical Data Manual:

a) Storage instructions for storing and preserving the equipment (including driver and all the auxiliary units) at the plant site before installation of the same.

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b) Instructions for preserving the equipment after it has been installed. This is particularly required in cases where a long time gap is expected between equipment installation and commissioning.
c) Field performance test procedures and acceptance criterion.

5.3.5.4.3 Technical Data Manual shall be in Hard board folder(s) of size 265 mm x 315 mm and shall not be more than 90 mm thick; it may be of several volumes and each volume shall have a volume number, index of volumes & index of contents of that particular volume.

5.3.5.4.4 Title sheet (Top sheet) of each volume of Technical Data Manual shall contain the contract information as defined under clause 5.3.1.2 besides the volume number.

5.3.5.4.5 In case order contains more than one item, separate dedicated Technical Data Manuals shall be submitted for each item.

5.3.5.4.6 Final drawings & documents shall also be submitted as Electronic Files (preferably in portable document format i.e. PDF) on CD/DVD's.

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Chapter 2

Centrifugal and Axial Compressors

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SECTION 1 - GENERAL

1.3 EQUIPMENT QUALIFICATION CRITERIA (New)

1.3.1 Unless otherwise specified elsewhere, the Equipment Qualification Criteria (EQC) specified vide para 1.3.2 to 1.3.6 of this specification shall be applied for acceptance of the offered compressor model and its manufacturer.

1.3.2 The vendor for the complete unit shall be an established manufacturer of the type of Compressors required and he shall also be the manufacturer of the proposed compressors having adequate design, engineering, manufacturing & testing facilities for the same.

1.3.3 The vendor shall have designed, engineered, packaged, tested and supplied in the last TEN (10) years, from the proposed manufacturing plant, at least ONE (1) same type of Compressors which is from the same model series with same type of driver having similar driver power as offered.
As a minimum, this package shall have completed ONE year of satisfactory operation at site, as on the bid due date.

1.3.4 The vendor besides satisfying the requirements of clause 1.3.2 & 1.3.3 above shall also be the packager of the complete system proposed and shall have the SINGLE POINT RESPONSIBILITY for the entire package.

1.3.5 The compressor model offered shall be from the existing compressor model series and shall be from the regular manufacturing range of the vendor.
The offered compressor model shall meet the following minimum service and manufacturing experience requirements as specified below:
Compressors shall be identical in Model No./frame size and similar in terms of Power rating, Inlet and discharge pressures, Inlet temperatures, Actual Inlet flow, Process Gas, Induction/Extraction Side streams, Speed, Number & Type of Impellers/blades(for axial compressors), Type of Sealing System, Rotor dynamics, Mechanical Design, Materials, Bearing span etc. as compared to at least ONE (1) unit designed, manufactured, tested and supplied from the proposed manufacturing plant in the last TEN (10) years and the reference unit shall have completed ONE year of satisfactory operation at site, as on the bid due date.

In case all the above parameters are not available from single past reference, more than one reference can be cited / considered to satisfy the above qualification requirement.

As an alternative vendor may show to the satisfaction to the purchaser, that the equipment offered comprises of components each of which individually satisfies the requirements specified above.

1.3.6 In case the vendor is a licensee and does not meet on his own the above criteria as per 1.3.5, he can substitute the references of his Collaborator (licensor) provided the following conditions are met by him:

1.3.6.1 The vendor shall be a regular & established manufacturer of specified type of compressor and shall have supplied smaller & larger frame sizes of compressors from the proposed manufacturing plant and proves to the satisfaction of the purchaser that he does possess the manufacturing & testing facilities for the offered compressor.

1.3.6.2 His Collaborator (licensor) meets the criteria as per 1.3.5.

1.3.6.3 His license agreement is valid & continues to be valid till atleast TWO years after the delivery of the compressors. Necessary documents to establish the same shall be furnished

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in proposal.

1.3.6.4 The vendor imports the following critical components from his Collaborator (licensor)/Collaborator's sub-vendors.
- Impellers and Diffusers, as applicable.
- Complete rotor
- Stationary blades in case of axial compressors
- Casing, rough machined. Casing includes all pressure containing parts.
- Bearings

1.3.6.5 His Collaborator (licensor) furnishes the detailed design & drawings for critical sections such as
- Housings, supply & return arrangements & partitioning arrangements between lube & seal chamber along with buffer gas induction system.
- Mixing chambers for side stream induction/extraction
- Thrust balance system

1.3.6.6 His Collaborator (licensor) furnishes a written back up guarantee regarding design, mechanical integrity and performance of the machine equivalent to as if the machines were manufactured & supplied by the Collaborator (licensor).

1.3.7 Proven Track Record (PTR)
The vendor shall complete the Experience Record Proformas as enclosed in the inquiry specification to amply prove that the Equipments offered meet the EQC for technical acceptance. Vendor may furnish additional information to justify that the EQC is being met. In addition, manufacturer's catalogue and general reference list for all the above equipments shall also be furnished alongwith the proposal.

SECTION 2 - BASIC DESIGN

2.5 ROTATING ELEMENTS

2.5.3.2 (Modification)
Modular rotors shall not be provided for centrifugal compressors.

2.5.4.3 (Modification)
The words 'when specified' stand deleted.

2.7 BEARINGS AND BEARING HOUSING

2.7.1.1.1 (Modification)
Directed lubricated bearings can also be offered based on compressor manufacturer's proven experience on similar type and size of bearing that have been used on similar sizes of machines, bearing spans, and operating speeds.

2.11 NAMEPLATES AND ROTATION ARROWS

2.11.2 (Modification)
Replace the last sentence by "MKS Units shall be used".

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SECTION 3 - ACCESSORIES

3.4 CONTROLS & INSTRUMENTATION

3.4.2 **Control Systems**

3.4.2.2 (Modification)
Unless otherwise specified, control valve shall be in vendor's scope of supply.

3.4.7 **Vibration, Position, and Bearing Temperature Detectors**

3.4.7.2 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

3.4.7.4 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

SECTION 4 - INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

4.3 TESTING

4.3.1 **Mechanical Running Test**

4.3.1.2.1 (Modification)
In case mechanical run test is performed with shop motor. The compressor is to be operated at speeds from 30% to MCS in 10% increments and run at the MCS until bearing lube oil temperature & shaft vibrations have stabilized.

4.3.1.3.5 (Modification)
Replace the words "spare rotor" with "spare rotor/cartridge"

4.3.3 **Optional Tests** (Modification)
Performance test shall be performed on each compressor.

4.3.3.1 **Performance Test**

4.3.3.1.1 (Addition)

(a) The compressor shall be performance tested in accordance with ASME PTC-10, Type 1, wherever feasible. The test procedure containing following information shall be made available at least 12 weeks prior to test for Purchaser's approval.
   1. Interpretation of performance specifications and a detailed statement of the test objectives.
   2. Identification of the type of test (type-1 or type-2) required to meet objectives and selection of operating conditions to satisfy the limitations outlined in ASME PTC-10.
   3. The nature of the test gas, if the design or specified gas cannot be used, and the means for establishing its physical and thermodynamic properties.
   4. Piping arrangement and location of instrumentation.
   5. Deviations from Code rules to be applied.
   6. Procedure to be used for adjusting test results to specified operating conditions with respect to test type-1 or type-2.
   7. Estimates of possible error in the measurements and methods selected.
   8. Test acceptance criteria.

(b) Within two weeks after successful completion of the test, a test report shall be submitted by the vendor in accordance with section 6 of ASME PTC-10. Performance data for 75%, 80%, 85%, 90%, 95%, 100% and 105% of the speed, as

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established on the basis of test results shall form part of the test report.
The test report shall end with a discussion about the test results and final conclusion.

4.3.3.1.2 (Substitution)
Unless otherwise specified, the rated point shall be the guarantee point. Head and capacity shall have zero negative tolerance at the guaranteed point and the horsepower at this point shall be guaranteed with zero positive tolerance including instrument and measuring tolerances. Surge shall comply with provisions of clause 2.1.1.1.

4.3.3.1.3 (Substitution)
For variable-speed compressors, a speed other than the vendor's originally estimated speed may be used to achieve the guaranteed performance and performance tolerance provided that:

1. This adjusted speed meets the criteria specified in Chapter 1, 2.6.
2. The adjusted speed does not exceed the 100% speed of the compressor i.e. the adjusted speed does not encroach on the margin of 5% between 100% speed and maximum continuous speed, and therefore does not affect in any way the requirements of impeller overspeed as per clause 4.3.3 of Chapter 1.

4.3.3.1.4 (Substitution)
For constant speed compressors, the guaranteed capacity shall have zero negative tolerance. The head shall be within the range of 100% to 102% of the guaranteed head. Beyond 102% head and up-to 105% head, at purchaser's option, the impellers shall be trimmed, but the test need not be repeated. Beyond 105% head, the impellers shall be trimmed and the complete test shall be repeated. The horsepower based on measured head at guaranteed capacity shall not exceed the value as given by

$BKW_{Test} \leq BKW_{Guaranteed}$ x [Measured Head / Guaranteed Head]

4.3.3.1.6 (Substitution)
For multi compressor trains and for compressors with intermediate process stream pressures, the additional tolerance on individual sectional pressures shall be specified in the data sheets. But not withstanding the individual sectional tolerance, the overall tolerances as in clauses 4.3.3.1.2 to 4.3.3.1.4 shall govern.

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Chapter 3

Integrally Geared Compressors

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SECTION 1 - GENERAL

1.3 EQUIPMENT QUALIFICATION CRITERIA (New)

1.3.1 Unless otherwise specified elsewhere, the Equipment Qualification Criteria (EQC) specified vide para 1.3.2 to 1.3.5 of this specification shall be applied for acceptance of the offered compressor model and its manufacturer.

1.3.2 The vendor for the complete unit shall be an established manufacturer of Integrally Geared Centrifugal Compressors (Process Air/Gas) and he shall also be the manufacturer of the proposed compressors having adequate design, engineering, manufacturing & testing facilities for the same.

1.3.3 The vendor shall have designed, engineered, packaged, tested and supplied in the last TEN (10) years, from the proposed manufacturing plant, at least ONE (1) Integrally Geared Centrifugal Compressor which is from the same model series with same type of driver having similar driver power as offered.
As a minimum, this package shall have completed ONE year of satisfactory operation at site, as on the bid due date.

1.3.4 The vendor besides satisfying the requirements of clause 1.3.2 & 1.3.3 above shall also be the packager of the complete system proposed and shall have the SINGLE POINT RESPONSIBILITY for the entire package.

1.3.5 The compressor model offered shall be from the existing compressor model series and shall be from the regular manufacturing range of the vendor.
The offered compressor model shall meet the following minimum service and manufacturing experience requirements as specified below:
Compressors shall be identical in Model No./frame size and similar in terms of Power rating, Inlet and discharge pressures, Inlet temperatures, Actual Inlet flow, Process Gas, Bull Gear / Pinion Speeds, Number of stages, Type of Impellers, Type of Sealing System, Rotor dynamics, Mechanical Design, Materials etc. as compared to at least ONE (1) unit designed, manufactured, tested and supplied from the proposed manufacturing plant in the last TEN (10) years and the reference unit shall have completed ONE year of satisfactory operation at site, as on the bid due date.

In case all the above parameters are not available from single past reference, more than one reference can be cited / considered to satisfy the above qualification requirement.

As an alternative vendor may show to the satisfaction to the purchaser, that the equipment offered comprises of components each of which individually satisfies the requirements specified above.

1.3.6 Proven Track Record (PTR)
The vendor shall complete the Experience Record Proformas as enclosed in the inquiry specification to amply prove that the Equipments offered meet the EQC for technical acceptance. Vendor may furnish additional information to justify that the EQC is being met. In addition, manufacturer's catalogue and general reference list for all the above equipments shall also be furnished alongwith the proposal.

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SECTION 2 - BASIC DESIGN

2.3 CASINGS

2.3.1 **Pressure Casings**

2.3.1.2 (Modification)
Unless otherwise specified, vendor will furnish system protection.

2.11 NAMEPLATE AND ROTATION ARROWS

2.11.2 (Modification)
Replace the last sentence by "MKS Units shall be used".

SECTION 3 - ACCESSORIES

3.4 CONTROLS & INSTRUMENTATION

3.4.2 **Control Systems**

3.4.2.1 (Modification)
Unless otherwise specified, control valve shall be in vendor's scope of supply.

3.4.7 **Vibration, Position, and Bearing Temperature**

3.4.7.2 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

3.4.7.3 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

3.4.7.5 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

3.5 PIPING AND APPURTENANCES

3.5.2.1 (Modification)
The vendor shall also supply interconnecting piping between equipment groupings and off-base facilities.

SECTION 4 - INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

4.3 TESTING

4.3.3 **Optional Tests (Modification)**
Performance test shall be carried out on each compressor.

4.3.3.1 **Performance Test**

4.3.3.1.1 (Addition)

(a) The compressor shall be performance tested in accordance with ASME PTC-10, Type 1, wherever feasible. The test procedure containing following information shall be made available at least 12 weeks prior to test for Purchaser's approval.

1. Interpretation of performance specifications and a detailed statement of the test

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objectives.

2. Identification of the Type of test (type-1 or type-2) required to meet objectives and selection of operating conditions to satisfy the limitations outlined in ASME PTC-10.
3. The nature of the test gas, if the design or specified gas cannot be used, and the means for establishing its physical and thermodynamic properties.
4. Piping arrangement and location of instrumentation.
5. Deviations from Code rules to be applied.
6. Procedure to be used for adjusting test results to specified operating conditions with respect to test type-1 or type-2.
7. Estimates of possible error in the measurements and methods selected.
8. Test acceptance criteria.

(b) Within two weeks after successful completion of the test, a test report shall be submitted by the vendor in accordance with section 6 of ASME PTC-10. Performance data for 75%, 80%, 85%, 90%, 95%, 100% and 105% of the speed for variable speed and at 100% speed for constant speed, as established on the basis of test results shall form part of the test report.
The test report shall end with a discussion about the test results and final conclusion.

4.3.3.1.2 (Substitution)
Unless otherwise specified, the rated point shall be the guarantee point. Head and capacity shall have zero negative tolerance at the guaranteed point and the horsepower at this point shall be guaranteed with zero positive tolerance including instrument and measuring tolerances. Surge shall comply with provisions of clause 2.1.1.1.

For variable-speed compressors, a speed other than the vendor's originally estimated speed may be used to achieve the guaranteed performance and performance tolerance provided that:

1. This adjusted speed meets the criteria specified in clause 2.6, chapter 1.
2. The adjusted speed does not exceed the 100% speed of the compressor i.e. the adjusted speed does not encroach on the margin of 5% between 100% speed and maximum continuous speed, and therefore does not affect in any way the requirements of impeller overspeed as per clause 4.3.3, chapter 1.

4.3.3.1.3 (Substitution)
For constant speed compressors, the guaranteed capacity shall have zero negative tolerance. The head shall be within the range of 100% to 102% of the guaranteed head. Beyond 102% head and upto 105% head, at purchaser's option, the impellers shall be trimmed, but the test need not be repeated. Beyond 105% head, the impellers shall be trimmed and the complete test shall be repeated. The horsepower based on measured head at guaranteed capacity shall not exceed the value as given by
$BKW_{Test} \leq BKW_{Guaranteed}$ x [Measured Head / Guaranteed Head]

4.3.3.1.5 (Substitution)
For compressors with intermediate process stream pressures, the additional tolerance on individual sectional pressures shall be specified in the data sheets. But not withstanding the individual sectional tolerance, the overall tolerances as in clauses 4.3.3.1.2 and 4.3.3.1.3 shall govern.

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Chapter 4

Expander-Compressors

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SECTION 1 - GENERAL

1.3 EQUIPMENT QUALIFICATION CRITERIA (New)

1.3.1 Unless otherwise specified elsewhere, the Equipment Qualification Criteria (EQC) specified vide para 1.3.2 to 1.3.5 of this specification shall be applied for acceptance of the offered expander-compressor model and its manufacturer.

1.3.2 The vendor for the complete unit shall be an established manufacturer of Expander-Compressors and he shall also be the manufacturer of the proposed expander- compressors having adequate design, engineering, manufacturing & testing facilities for the same.

1.3.3 The vendor shall have designed, engineered, packaged, tested and supplied in the last TEN (10) years, from the proposed manufacturing plant, at least ONE (1) Expander - Compressor which is from the same model series having similar driver power as offered. As a minimum, this package shall have completed ONE year of satisfactory operation at site, as on the bid due date.

1.3.4 The vendor besides satisfying the requirements of clause 1.3.2 & 1.3.3 above shall also be the packager of the complete system proposed and shall have the SINGLE POINT RESPONSIBILITY for the entire package.

1.3.5 The expander-compressor model offered shall be from the existing expander-compressor model series and shall be from the regular manufacturing range of the vendor.
The offered expander-compressor model shall meet the following minimum service and manufacturing experience requirements as specified below:
Expander Compressors shall be identical in Model no./frame size and similar in terms of Power rating, Inlet and discharge pressures, Inlet temperatures, Expander outlet temperature, Actual Inlet flow, Process Gas, Rotor Speeds(Tip speeds), Number of stages, Type of Impellers, Type of Sealing System, Rotor dynamics, Mechanical Design, Materials etc. as compared to at least ONE (1) unit designed, manufactured, tested and supplied from the proposed manufacturing plant in the last TEN (10) years and the reference unit shall have completed ONE year of satisfactory operation at site, as on the bid due date.

In case all the above parameters are not available from single past reference, more than one reference can be cited / considered to satisfy the above qualification requirement.

As an alternative vendor may show to the satisfaction to the purchaser, that the equipment offered comprises of components each of which individually satisfies the requirements specified above.

1.3.6 Proven Track Record (PTR)
The vendor shall complete the Experience Record Proformas as enclosed in the inquiry specification to amply prove that the Equipments offered meet the EQC for technical acceptance. Vendor may furnish additional information to justify that the EQC is being met. In addition, manufacturer's catalogue and general reference list for all the above equipments shall also be furnished alongwith the proposal.

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SECTION 2 - BASIC DESIGN

2.1 GENERAL

2.1.1 **Performance**

2.1.1.1 (Substitution)
The compressor shall be guaranteed for head and capacity at normal operating point & at other operating points, if specifically asked for in the inquiry. The expander-compressor shall give satisfactory performance at all the specified operating points. In addition, the BKW at normal operating point shall be guaranteed for both the expander (-0% tolerance) and the compressor (+0% tolerance).

2.1.2 (New)
Unless otherwise specified, vendor shall supply with each expander-compressor stage a spare centre-section assembly consisting of the assembled rotor with its bearings, seals and their housing along with metal container for vertical storage. Where two or more assemblies are identical, only one common spare assembly shall be supplied.

2.3 CASINGS

2.3.1 **Pressure Casings**

2.3.1.1.2 (Modification)
Unless otherwise specified, vendor will furnish system protection.

2.11 NAMEPLATE AND ROTATION ARROWS

2.11.2 (Addition)
MKS Units shall be used.

SECTION 3 - ACCESSORIES

3.4 CONTROLS & INSTRUMENTATION

3.4.2 **Vibration, Position, and Bearing Temperature Detectors**

3.4.2.3 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

3.4.2.5 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

3.4.2.7 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

3.4.3 **Overspeed Shutdown System**

3.4.3.1.2 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

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3.4.3.4 **Permanent Strainer**

3.4.3.4.1 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

3.4.3.4.2 (Modification)
The words "when specified" shall be read as "Unless otherwise specified".

3.5 PIPING AND APPURTENANCES

3.5.1 **General**

3.5.1.1 (Modification)
The vendor shall also supply interconnecting piping between equipment groupings and off-base facilities.

SECTION 4 - INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

4.3 TESTING

4.3.5 **Optional Tests** (Modification)
The words "when specified" and "/or" stand deleted.

4.3.5.1 **Performance Test**

4.3.5.1.1 (Modification)
Performance test shall be carried out on each expander.
Vendor shall furnish his standard test procedure for purchaser's approval at least 12 weeks prior to test:
Expander efficiency at the normal point shall be guaranteed with zero negative tolerance including instrument, measuring & test tolerances.

4.3.5.1.2 (Modification)

(a) Performance test shall be carried out on each compressor.
(b) Unless otherwise specified, the compressor shall be performance tested in accordance with ASME PTC-10, Type 1, wherever feasible.
(c) Head and capacity shall have zero percent negative tolerance at normal operating point and the compressor BKW shall be guaranteed at the normal operating point with zero percent positive tolerance including instrument, measuring & test tolerances. Surge shall comply with provisions of clause 2.1.1.2.

4.3.5.1.3 (Delete)

4.3.5.1.5 (New)
The test procedure containing following information shall be made available at least 12 weeks prior to test for Purchaser's approval.

1. Interpretation of performance specifications and a detailed statement of the test objectives.
2. Identification of the type of test (Type-1 or Type-2) required to meet objectives and selection of operating conditions to satisfy the limitations outlined in ASME PTC-10.
3. The nature of the test gas, if the design or specified gas cannot be used, and the means for establishing its physical and thermodynamic properties.
4. Piping arrangement and location of instrumentation.
5. Deviations from Code rules to be applied.
6. Procedure to be used for adjusting test results to specified operating conditions with

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respect to test type-1 or type-2.

7. Estimates of possible error in the measurements and methods selected.
8. Test acceptance criteria.

Within two weeks after successful completion of the test, a test report shall be submitted by the vendor in accordance with section 6 of ASME PTC-10. Performance data for 75%, 80%, 85%, 90%, 95%, 100% and 105% of the speed, as established on the basis of test results shall form part of the test report.

The test report shall end with a discussion about the test results and final conclusion.

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गैस टर्बाइन के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR GAS TURBINES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	31.03.15	Revised & issued as standard specification	JSD	NK	DB / AKN	SC
1	13.05.08	Reaffirmed & issued as standard specification	JSD	NK	VKM	VC
0	24.07.03	Issued as standard specification (superseding eil spec. 6-41-0041 rev.2)	NK	KDS	RK	SKG

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Abbreviations:

AC	:	Alternating Current
ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
DC	:	Direct Current
EGHP	:	Expected Gas Horse Power
EQC	:	Equipment Qualification Criteria
GG	:	Gas Generator
IGHP	:	Indicated Gas Horse Power
ISO	:	International Organization for Standardization
NFPA	:	National Fire Protection Association
P&ID	:	Piping and Instrumentation Diagram
PT	:	Power Turbine
PTR	:	Proven Track Record
QA	:	Quality Assurance
SS	:	Stainless Steel
VDR	:	Vendor Data Requirement

Rotating Equipment Standards Committee

Convenor: Mr Dinesh Bhatia

Members: Mr Nalin Kumar
Mr Tarun Kumar
Mr Anukul Mandal
Mr. J.S. Duggal
Mr K.V.K. Naidu (Projects)

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1 SCOPE

i. This specification together with the attendant data sheets and other specifications/attachments to inquiry/order covers the minimum requirements for open, simple and regenerative-cycle combustion gas turbine units for use in process plants, utility and pipeline services as mechanical drive, generator drive or process gas generation. All auxiliary equipment required for operating, starting and controlling gas turbine units and for turbine protection is either discussed directly in this specification or referred to in this specification through references to other publications. Specifically, gas turbine units that are capable of continuous service firing gas or liquid fuel or both are covered by this standard.

ii. Vendor shall make all possible efforts to comply strictly to the requirements of this specification and other specifications/attachments to inquiry/order. In case deviations are considered essential by the vendor (after exhausting all possible efforts) these shall be separately listed in the vendor's proposal under separate section titled as "List of deviations/exceptions to the inquiry document". Deviations shall be listed separately for each document with cross reference to page no./section/clause no./para etc. of the respective document supported with proper reasons for the deviation for purchaser's consideration. Any deviation not listed under the above section, even if reflected in any other portion of the proposal shall not be considered applicable. No deviation or exception shall be permitted without the written approval of the purchaser.

iii. Compliance with this specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories/auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions. In case the vendor considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, he shall recommend the same along with reasons in a separate section along with his proposal and include the same in his scope of supply.

iv. Except as modified here in, the gas turbines and their auxiliaries shall be designed, manufactured, tested and supplied strictly in accordance with **API Standard 616 - Gas Turbines for the Petroleum, Chemical and Gas Industry Services, Fifth Edition, January 2011.**

v. Except for new paragraphs, the number and title of the paragraphs in the following Modifications to API Standard-616 correspond to the respective sections and paragraphs of the above standard. Paragraphs not addressed in this specification shall be strictly in accordance to **API Standard 616, Fifth Edition, January 2011** requirements.
The word in parenthesis following the number or title of a paragraph indicates the following:

(Addition)	:	An addition to a part or paragraph referred to
(Modification)	:	Amplification or rewording has been made to a part of the corresponding paragraph but not a substitution replacing the entire paragraph.
(Substitution)	:	A substitution has been made for the corresponding paragraph of the standard in its totality.
(New)	:	A new paragraph having no corresponding paragraph in the Standard.
(Delete)	:	This paragraph is deleted.

The entire paragraph 1 of API-616 regarding SCOPE (except Note) is substituted by paragraph 1 above.

1.2 ALTERNATIVE DESIGNS (Deleted)

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1.3 CONFLICTS (Substitution)

In case of conflict between this specification and the attendant data sheets, job specifications (if any) and other attached specifications, the following order of precedence shall govern:

1. Equipment Technical Data Sheets.
2. Job specifications (if any)
3. P&ID's (if any)
4. This specification
5. Other Specifications
6. Other referred codes and standards

1.4 EQUIPMENT QUALIFICATION CRITERIA (New)

1.4.1 Unless otherwise specified elsewhere, the Equipment Qualification Criteria (EQC) specified vide para 1.3.2 to 1.3.4 of this specification shall be applied for acceptance of the offered gas turbine model.

1.4.2 Vendor shall be an established gas turbine manufacturer having adequate design engineering, manufacturing and testing facilities.

1.4.3 The gas turbine model offered shall be from the existing regular production range of the vendor, and the rating offered shall be based on internationally published rating.

1.4.4 Gas Turbine offered shall be identical in construction (i.e. no. of shafts, no. of stages in each compressor section, no. of stages in each turbine section, mechanical design, material of construction of Blades, Nozzles, Discs and Combustors; Cooling of blades, nozzles & discs; Combustion system ; Starting system), Type of Turbine Temperature Control and in performance at ISO conditions in terms of Power Rating for the type of fuel specified (liquid and/or gas fuel), heat rate, firing/cycle temperature, power turbine inlet temperature, exhaust temperature, overall pressure ratio, air flow and speed of each shaft as compared to at least ONE (1) unit designed, manufactured, tested and supplied from the proposed manufacturing plant in the last TEN (10) years which has completed ONE (1) year of satisfactory operation at site as on bid due date.

In case all the above parameters are not available from single past reference, more than one reference may be cited to satisfy the above qualification requirement.

In case certain improvements have been done the same can be considered provided the vendor is having field proven experience for the same. Vendor to clearly highlight such improvements and shall furnish information of experience as per Experience Record Proforma enclosed in the enquiry specification to amply prove that the equipment meet the EQC.

As an alternative, vendor may show to the satisfaction of purchaser, that the equipment offered is comprised of modules such as compressor, turbine, etc. each of which individually satisfies the requirements specified above.

1.4.5 **Proven Track Record (PTR)**

Gas Turbine vendor shall complete the Experience Record Proformas as enclosed in the inquiry specification to amply prove that the Equipment offered meet the EQC for technical acceptance.

Turbine vendor may furnish additional information to justify that the EQC is being met. In addition, manufacturer's catalogue and general reference list for all the above equipment shall also be furnished along with the proposal.

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2 REFERENCES

2.1 **REFERENCED STANDARDS** (Addition)

Following publications shall also form a part of Referenced Standards listed under 2.1 of API – 616:

ANSI B17.1 Keys and key seats
NFPA 37 Stationary Combustion Engines and Gas Turbines.
NFPA 850 Electrical Generating Plants

2.2 COMPLIANCE (Substitution)

Vendor shall take measures to comply with governmental codes, regulations, ordinances or rules that are specified in the inquiry document or applicable to the equipment at the proposed location.

4 BASIC DESIGN

4.1 GENERAL

4.1.3.1 (Substitution)

The gas turbine vendor shall provide turbine full load power (with no negative tolerance) at certified point / specified guarantee point as shown on the datasheet with no positive tolerance on the heat rate (lower heating value for specified fuel).

4.1.3.2 (Deletion)

This clause stands deleted.

4.1.8 (Addition)

The emission suppression system shall be capable of limiting the emissions to the specified levels at all levels of power output from minimum load to full load for all specified fuels. The vendor shall provide a project specific flow diagram, complete with bill of material and a written technical description of the emission suppression system with the proposal.

4.1.10 (Substitution)

Unless otherwise specified, the maximum sound pressure level of the unit when measured at a distance of 1 meter from the skid edge shall not exceed 88 dBA. The vendor shall indicate in the proposal the noise emission data for the unit both in terms of dBA as well as octave band analysis.

4.1.11 (Substitution)

Unless otherwise specified, cooling water system shall be designed for the following conditions:

Velocity over heat exchanger surface	:	1.5 - 2.5 m/sec.
Maximum Allowable Working Pressure (MAWP)	:	$\geq$ 8.0 kg/cm^{2}g
Test Pressure (Hydrostatic)	:	= 1.5 x MAWP
Maximum Pressure Drop	:	1.0 kg/cm^2
Maximum Inlet Temperature	:	33°C
Maximum Outlet Temperature	:	45°C
Maximum Temperature Rise	:	12°C
Fouling Factor on Water Side	:	0.0004 m^2 hr°C/kcal
Shell Side Corrosion allowance	:	3.2 mm

Provision shall be made for complete venting and draining of the system.

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4.1.13 (Substitution)
The arrangement of the equipment, including piping, ducting, coolers, pumps, controls and other auxiliaries shall be developed by the vendor. The arrangement shall provide adequate clearance areas and safe access for operation and maintenance. Clearance areas and suggested maintenance areas shall be marked in the layout drawing .

4.1.16 (Addition)
The vendor shall furnish, in the proposal, a list of all components of gas turbine and auxiliaries which require regular periodical inspection and maintenance. Procedure for inspection and handling the equipment components (including Gas Turbine Modules) for maintenance shall be fully described. Weight and dimensions of components which need to be dismantled and transported for the purpose of inspection/maintenance shall be indicated in the proposal. Vendor shall make recommendations as to the handling and maintenance facilities to be provided by the purchaser.

4.1.18 (Addition)
Vendor shall carryout the activity mentioned under sl. No. "a" of this paragraph and where their supervision is specified during erection / commissioning, vendor shall carryout checks mentioned under sl. No. b, c and d of this paragraph.

4.1.21 (Addition)
Flat rating of gas turbines is not permitted.

4.7 DYNAMICS

4.7.2.15 (Modification)
Gas turbines with a new, modified bearing and rotor configuration or Prototype gas turbine designs shall not be offered, hence this section is not applicable.

4.7.4 Vibration and Balancing

4.7.4.3.4 (Modification)
The words 'if specified' stand deleted.

4.9 LUBRICATION

4.9.7 (Substitution)
Oil system shall comply with the requirements of Chapter 1 & 2 of API - 614, 4th edition.

4.9.8 (Modification)
The word "Purchaser" to be substituted by, "the Vendor having responsibility of the complete unit".

4.9.9 (New)
Lube oil system shall be provided with AC or DC Electric motor driven emergency oil pump to supply lube oil gas turbine during coast down & cool - off. The dedicated emergency power supply system (i.e. battery bank for DC motors or battery bank + inverter for AC motor) shall also be supplied by vendor for above pumps.
Turbine control system shall have provisions to

(i) Monitor emergency oil pump performance at every turbine start, and periodically thereafter (once in 12 hrs).

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(ii) Continuously monitor emergency power supply system circuit for their availability during turbine operation.

Unsatisfactory pump performance or emergency power supply circuit condition shall be annunciated and shall trip the turbine.

4.10 MATERIALS

4.10.4.6.2 (Modification)
The words 'if specified' stand deleted.

4.10.4.7.1 (Substitution)
The vendor shall specify the type of non-destructive testing such as radiography, ultra-sonic testing, magnetic particle inspection or dye-penetrant inspection carried out by the vendor on welds as per the vendor's standard QA plan.

5 ACCESSORIES

5.1 STARTING AND HELPER DRIVER

5.1.1 General

5.1.1.1 (Addition)
All starter and helper driver shall be suitable for satisfactory operation with the specified electrical power characteristics, inlet and exhaust steam/air/gas pressure and temperatures, the specified fuel in case of internal combustion engines or micro gas turbines, as applicable. The power output of starter and helper driver shall not be considered while declaring the gas turbine power output.

5.1.1.10 (Addition)
The gas for the starter shall not be extracted from the fuel system. The Vendor shall furnish a separate connection and piping system from the starter to his battery limit as defined in the enquiry/contract.

Exhaust from a gas expansion starter shall not be connected to any common vent system.

Lubrication systems for the gas starter shall not require any operater's attention on the lubricant oil levels.

5.1.3 Turning Equipment

5.1.3.1 (Substitution)
A turning gear or ratchet device shall be furnished, if required, to avoid rotor deformation after a tripout or during prolonged periods of shutdown. For single-shaft turbine, the turning gear shall be sized to turn the entire train. Engagement on shutdown before the rotor has come to stop shall be positively prevented if this could damage the turning device or the turbine. Disengagement shall be automatic when the rotor accelerates during start-up. Vendor shall describe the complete turning gear equipment along with its operation, speed, duration of use etc.

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5.2 GEARS, COUPLINGS AND GUARDS

5.2.1 Gears

5.2.1.3 (Substitution)
The Load gears shall have rating (gear rated power) as a minimum equal to the potential maximum power of the gas turbine. For power generation service the load gear shall be capable of withstanding the worst case of alternator fault conditions.

5.2.2 Couplings and Guards

5.2.2.3 (Addition)
For power generation service, the generator load coupling shall be capable of withstanding the worst case of generator fault conditions.

5.2.2.6 (New)
Coupling spacer length shall allow removal and replacement of bearings and seals without disturbing main equipment casings, first piece of load equipment or load gear.

5.2.2.7 (New)
Coupling shall be balanced as per method 2 of **API Standard 671**.

5.3 MOUNTING PLATES

5.3.1 General

5.3.1.1 (Substitution)
The gas turbine unit, as well as its starting equipment, lubrication system and other auxiliaries shall be furnished with baseplates.

5.3.1.2.5 (Addition)
Mounting surfaces that are not to be grouted shall be coated with a rust preventive immediately after machining.

5.3.1.2.9 (Substitution)
Anchor bolts and foundation bolts shall be furnished by the vendor.

5.3.2 Base Plate

5.3.2.3 (Modification)
The words "if specified" shall be read as "Unless otherwise specified".

5.3.2.10 (New)
Baseplate(s) shall be provided with drip containment and low point drains

5.3.2.11 (New)
Unless otherwise specified lifting frames/spreader bar alongwith slings and shackles shall be supplied by the vendor to permit single point lift capability.

5.4 CONTROLS AND INSTRUMENTATION

5.4.2 Control Systems

5.4.2.1 (Substitution)
The starting and loading control system for the turbine - driven equipment package may be semi automatic (two push button start) or fully automatic (single push button start), as specified. The starting cycle of the turbine shall be automatic.

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The commissioning of accessories, auxiliaries and driven equipment; starting and loading sequence of turbine - driven equipment package shall be as follows:

(a) Semiautomatic start (Two push Button Start), if specified shall require only two actions by the operator. On pressing the first switch, the system shall sequentially commission the accessories & auxiliaries (including that of driven equipment), prepare the driven equipment for start-up. Completion of these activities will be signalled by "Train ready to start" indication / message on the panel. Pressing the second switch will commit the turbine to the complete starting and speed / load control sequence.

(b) Automatic (Single Push Button) start shall require only a single action by the operator to sequentially commission accessories & auxiliaries, prepare the driven equipment for start and to initiate the complete starting and loading sequence.

5.4.6 **Electrical Systems**

5.4.6.6 (Modification)
Electrical materials shall be given the treatments as specified in 5.4.6.6.1 and 5.4.6.6.2.

5.4.7 **Instrumentation**

5.4.7.8 **Vibration and Position Detectors**

5.4.7.8.2 (Modification)
The words 'if specified' stand deleted.

5.4.7.8.3 (Modification)
The words "if specified" stands deleted.

5.4.7.8.4 (Modification)
The words "if specified" stands deleted.

5.4.7.8.6 (Modification)
The words "if specified" stands deleted.

5.6 INLET AND EXHAUST SYSTEMS

5.6.1 **General**

5.6.1.15 (Substitution)
Corrosion protection of the filter housing and elements, ducting and silencer is required. Unless otherwise specified all metallic air path components shall be of Type 304 stainless steel.

5.6.2 **INLET SYSTEMS**

5.6.2.1 **Inlet Filters**

5.6.2.1.6 (Addition)
Vendor shall also furnish in the proposal filter performance data such as design flow rate, pressure drop in clean condition and pressure drop at which filter cleaning/change out is recommended for each stage of filtration as well as for overall filter.

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5.6.2.1.7d (Addition)
High overall differential pressure transmitter for trip (2 no's. with unit shutdown on activation by either of the transmitter).

5.6.2.1.9 (Addition)
Unless otherwise specified, supporting steel work and facilities for access and maintenance is to be supplied by the Vendor.

5.6.2.5 **Inlet Silencers**

5.6.2.5.2 (Addition)
Silencers shall be flanged and sufficiently rigid to be supported only by the end flanges when mounted in a horizontal or vertical duct system.

5.6.2.6 **Inlet Coolers**

5.6.2.6.1 **Evaporative Coolers**

5.6.2.6.1.1 (Addition)
Unless otherwise specified evaporative coolers shall not be used in air inlet to gas turbine.

5.6.2.6.1 **Inlet Air Cooler Heat Exchanger**

5.6.2.6.1.1 (Addition)
Unless otherwise specified Inlet Air Cooler Heat Exchanger shall not be used in air inlet to gas turbine.

5.7 INSULATION, WEATHER PROOFING, FIRE PROTECTION AND ACOUSTICAL TREATMENT

5.7.4 **Acoustical Treatment**

5.7.4.1 (Substitution)
Vendor shall furnish acoustical treatment to meet the requirements of Clause 4.1.10 of this specification

5.7.5 **Enclosures**

5.7.5.1 (Modification)
The words "if specified" shall be read as "Unless otherwise specified"

5.7.5.3 (Addition)
Enclosures should have facilities (like mono-rail, chain-pulley blocks and accessories etc.) for removal of Gas Generator and Power Turbine either as one unit or individually.

5.7.5.3.2 (Addition)
Access ways shall be lockable

5.7.5.6 (Substitution)

(i) Each enclosure shall be fitted with two no. (one working + one standby) fans driven by explosion proof electric motors, to preclude build up of a hazardous atmosphere and to maintain the air temp inside the enclosure less than 60^0 C in the most severe climatic and load conditions. Ventilation system shall include air filtration and silencing equipment. Ventilation air shall be taken from safe area and shall be discharged in a safe area. Ventilation filters shall be provided with differential pressure indication and high differential pressure alarm. Fans shall be arranged in parallel configuration to facilitate

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isolation and removal of a fan without interruption in turbine operation.

Note :-
Purchaser may consider higher temperature in certain zones of the enclosure, provided the vendor proves to the satisfaction of the purchaser that the design/constructional features are such that these hot zones are physically isolated by partitions from other areas of the enclosure and that the equipment, electrical systems, instruments and instrumentation systems (including cabling, wiring, piping/tubing) and the fluid lines in these zones are suitable for the vendor's stated higher temperature (including the temperature settlement during emergency shutdown of the turbine and simultaneous shutdown of ventilation system). Vendor shall also have adequate proven track record to establish the provenness of such claims.
Vendor shall also detail out the safety features incorporated in the system to prevent injury to operators, in case the doors of these partitions are opened either for routine monitoring/investigating or accidentally.

(ii) Each fan shall be sized for atleast 125% of design flow rate required to keep enclosure temperature below 60°C.

(iii) Unless otherwise specified, enclosures of Gas Turbines driving electric generators installed in safe area shall be maintained at a negative pressure of atleast 5 mm of water column (with only one fan operating) and of Gas turbines for mechanical drive application installed in a hazardous area shall be maintained at a positive pressure of atleast 5 mm of water column (with only one fan operating). Vendor shall furnish calculations for heat rejection by turbine and equipments inside the enclosure, heat transfer to ventilation air, expected pressure drops in the entire ventilation path, fan sizing etc for purchaser's review.

(iv) Enclosure shall be furnished with enclosure air temperatures indicators, differential pressure indicators, and alarm & trip transmitters for high enclosure air temperature and abnormal enclosure pressure.

(v) Ventilation/purging flow shall enter/leave the enclosure via flanged port(s). Ventilation inlet and exhaust ports shall be provided with fire suppression medium dampers and the required back draft/balance dampers.

(vi) If a cool down ventilation is required to prevent damage to the gas turbine, auxiliary systems or instrumentation within the enclosure; a separate DC back-up fan or emergency AC back-up power for normal ventilation fans shall be provided. The dedicated emergency power supply system (i.e. battery bank for DC back-up fan or battery bank + inverter for normal fan) shall also be supplied by vendor. Vendor shall also supply charging arrangement for battery banks. Performance of the back-up fan, if provided, shall be checked at every turbine start and at regular intervals during turbine operation. Back-up power system health shall be continuously monitored. Any malfunction of back-up fan or back-up power system shall shutdown the turbine.

5.8 FUEL SYSTEM

5.8.1 General

5.8.1.2 **Fuel Gas System** (Addition)
Fuel gas system shall consist of the following:

1. Gas Turbine Fuel Gas System
   Gas turbine fuel gas system shall be gas turbine vendor's standard proven system suitable for the fuel gas properties specified. This shall include necessary pressure and temperature monitors/gauges, low fuel pressure transmitteres, a manifold and nozzles, fuel shut off valve (and vent valve) for actuation by emergency devices, a

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fuel governor valve for normal control purposes, fuel gas pressure regulator & safety valve, and necessary instrumentations, control & safety devices. This system shall be totally skid mounted inside the gas turbine enclosure. Fuel gas pressure regulator & safety valve may also be a part of Fuel gas treatment skid, if the same is recommended by the vendor as per their standard safety norms.

2. Fuel Gas Treatment System

(i) Fuel gas treatment system shall be console type and shall be mounted off skid.

(ii) This system shall be designed for ISO rating of the gas turbine or maximum potential power of gas turbine or to meet the turbine starting and acceleration requirements whichever is highest.

(iii) Irrespective of the fuel supply conditions as stated in the enquiry document, vendor shall design the fuel treatment skid considering the supply gas to be 100% saturated with hydrocarbons and water vapours at the specified supply pressure-temperature conditions.

(iv) The fuel gas treatment system shall be designed to deliver clean, dry gas to the turbine fuel system with the degree of superheat as recommended for the subject turbine/gas generator. However, as a minimum the super heat considered shall be 20^0C above the water and or hydrocarbon dew point.

(v) Fuel gas treatment system shall have the following minimum features. Any additional feature recommended by the vendor for safe operation of the system and the turbine shall be included in the vendor's scope:

(a) Twin knockout pots with demister pads. Each knockout pot shall have level controller, automatic drain valves with manual bypass, level gauges, low level & high level transmitters with alarms, safety valves and continuous flow transfer valves.

(b) Twin filters (2 micron) with differential pressure indicators and high differential pressure alarms, and continuous flow transfer valves.

(c) Fuel gas super heater to provide the required degree of super heat considering the gas inlet as fully saturated. The super-heater shall be controlled by thyrister panel with energy controller to control the heater output from 0 to 100 per cent in step-less control. The super heater shall be of SS-300 series material and design temperature of heater shall be greater than 150°C.

(d) Transfer valves shall have carbon steel body with stainless steel plug, and if applicable a plug jacking device.

(e) Complete fuel gas system downstream of filters shall be in stainless steel construction including piping.

(f) All pressure vessels in fuel gas system and in other auxiliary system of the gas turbine shall be designed as per section VIII, Division 1 of the ASME code.

(g) All the shut-off/ isolation valves in main line and in vent line shall be tight shut-off (TSO) type with leakage class VI.

(vi) The following controls and safety shall be provided for the fuel gas treatment skid:

(a) The skid shall be provided with automatic shut down valves at inlet & outlet of the skid and a vent valve connected to flare.

(b) For all gas turbine shut downs:

- Fuel gas supply to the turbine shall be shut off and the trapped gas within the treatment skid as well as in the piping between the skid and turbine shall be vented out.
- Thyrister panel output shall be zero.
- Heater electric supply shall be cut off.

(c) High/High-High fuel gas temperature alarms shall be provided along with heater supply cut off at high-high fuel gas temperature alarm.

(d) Heater skin temperature high alarm shall be provided.

(e) Contactors shall be heavy duty. (AC-3 duty or higher)

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3. Bypass & Vent valve: A fuel bypass valve and vent valve for purging the fuel gas line prior to light off shall be provided

4. Fuel gas booster system: If the fuel gas pressure required by the vendor is higher than that available, fuel gas booster (i.e. compression) system will be furnished by the vendor. Vendor's proposal shall include complete details of such compression system. The reliability and availability of fuel gas compressor system shall be equal or higher than that of the Gas Turbine. Fuel gas booster compressor offered shall be either centrifugal compressor as per API standard 617 or rotary compressor as per API standard 619 or reciprocating compressors as per API standard 618. In case reciprocating compressor is being offered as fuel gas booster, 2 nos. (1working + 1standby) compressor each sized for 100% capacity shall be supplied. The fuel gas booster compressor shall normally be driven by Electric motor.
[Note: In case of oil lubricated reciprocating/ oil flooded rotary compressor, the allowable oil contamination in the discharge fuel gas shall be as gas turbine vendor standard.]

5.8.2.2.3 (Modification)
The words "if specified" shall be read as "if required by vendor".

5.8.2.5.1 (Addition)
The "Fuel Gas Treatment System" shall be supplied by the vendor.

5.8.3.14 (Modification)
Words "by the Purchaser" are replaced by "by the Vendor"

6 INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

6.1 GENERAL

6.1.5 (Addition)
The vendor shall notify the purchaser not less than 4 weeks before the date the equipment will be ready for test. The date shall be reconfirmed by the vendor at least one week before the scheduled date of test.

6.3 TESTING

6.3.1.2 (Modification)
Detailed procedures for all running tests shall be submitted atleast 12 weeks before the first scheduled test.

6.3.1.3 (Modification)
For witnessed or observed test vendor shall give advance notice to purchaser as per clause 6.1.5 above.

6.3.2 **Hydrostatic Test**

6.3.2.1 (Substitution)
All Pressure containing parts (including that of auxiliaries), exclusive of gas turbine casing and combustors, shall be tested hydrostatically.

6.3.4 **Mechanical Running Test**

6.3.4.1 (Substitution)
The requirements of 6.3.3.1.1 through 6.3.3.1.12 shall be met before the mechanical running test of the gas turbine (combined Gas generator & power turbine) is performed.

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6.3.4.1.6 (Modification)
The words 'if specified' stand deleted.

6.3.4.4.2 (Modification)
The words 'if specified' stand deleted.

6.3.4.5 **Gas Generator Test** (New)
Each gas generator shall be subjected to a mechanical running and performance test in accordance with the manufacturer's standard.

Gas generator shall be operated at speeds from idle to maximum continuous speed in speed increments allowing the unit to stabilise at each point and necessary mechanical and performance data shall be recorded. Gas generator shall be run for 15 minutes at a speed 1% below the trip speed. The test shall establish the mechanical integrity and EGHP / IGHP (Expected / Indicated Gas Horse Power) capability of the unit.

6.3.5.1 **Performance test**
(Modification)
The first sentence of this clause stands revised to: "Unless otherwise specified, the machine shall be tested in accordance with ASME Performance Test Codes 1 and 22."

7 VENDOR'S DATA

7.1 GENERAL

7.1.1 (Modification)
The information to be furnished by the vendor is specified in 7.2, 7.3 and purchaser's Vendor Data Requirements as included in the inquiry document.

Vendor shall complete and forward the document 'Vendor Data Index & Schedule/ Document Control Index (DCI)' to the purchaser. (Destination & Contact persons as per order).

7.2 PROPOSALS

7.2.1 **General** (Substitution)
In addition to data specified in 7.2.2 through 7.2.4, the vendor's proposal shall as a minimum include the following:

a) All data sheets, drawings and documents listed under "PRINTS WITH QUOTE" in the Vendor Data Requirement Form enclosed in the inquiry.
b) Vendor's confirmation/comments on post-order Vendor Data Requirements (Type of Documents, no. of prints and date needed) indicated in Vendor Data Requirement forms data sheets and specs.
c) List of recommended commissioning spares included in the offer.
d) List of mandatory spares (where specified by the purchaser) included in the offer.
e) List Of Spare Parts For Two Years Normal Operation
This list shall be made separately for each item including auxiliaries and drivers in the form of a table & shall show
   i) Part name, description and number.
   ii) Quantity installed in one unit.
   iii) Quantity recommended per unit for 2 years normal operation.
   iv) Quantity recommended for number of units of an item as specified in the inquiry.
   v) Quantity recommended as insurance for the number of units of an item

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specified in the inquiry.

f) An itemised list of special tools included in the offer.

g) Any start-up, shutdown or operating restrictions required to protect the integrity of the equipment.

h) Any limitations of vendor's test-facility to carryout the specified tests.

i) A specific compliance statement that the scope of supply, the offered equipment/systems and all its components are in strict accordance with the data sheets, job specifications, this specifications and all other attachments, except for specific deviation as listed in the proposal.

Unless a specific deviation/exception is taken by the vendor in the proposal, it will be understood that final equipment/system shall be designed, fabricated, tested and supplied in accordance with Purchaser's specified requirements as covered in the inquiry or order.

7.2.3 **Technical Data**

7.2.3(i) (Addition)

Vendor shall also furnish a consolidated list of all consumables which are required or need to be replaced/replenished periodically (like lube oil, seal oil, greases, chemicals, any cleaning agent, additives etc.) indicating the total quantity required for the period of commissioning/startup and one year continuous operation of the unit.

7.2.3(m) (Substitution)

A list of installations, prepared in a manner so as to give explicit evidence that the equipment offered meets the specified minimum manufacturing and experience requirements.

7.2.3 (y) (New)

Expected noise levels in dBA for each individual component as well as for overall train when measured at any point one meter away from the machine(s)/enclosures.

7.2.5 Deleted.

7.3 CONTRACT DATA

7.3.1 **General** (Substitution)

7.3.1.1 Drawings and data as required after purchase order has been specified in Vendor Data Requirement (VDR). Vendor to note that the drawing/document descriptions/titles as given in the Vendor Data Requirement are generic in nature. It is possible that against one drawing/document specified there are several drawings to be furnished by the vendor or vice versa.

Vendor to note that, the submission of all post order drawing & documents shall be done through EIL Electronic Document Management System (eDMS) portal. Vendor shall complete & forward the Document Control Index (DCI) to the purchaser (Destination & contact person as per order) through above eDMS portal.

This document shall list out in consolidated form all drawings and documents required by purchaser vide VDR as included in the purchase requisition. Any other data, drawing/ document as specified in Data Sheets and Specifications shall also be included by the vendor in the DCI. Against each drawing/document, vendor shall populate their list of document indicating the vendor's drawing numbers, titles, Rev. No. and schedule of submission.

This shall be the first document to be submitted by vendor within two weeks of order.
No drawing shall be taken up for review till DCI for the inquiry/order is finalized by vendor.

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7.3.1.2 All transmittal letters (covers), drawings and data shall have a title block (in addition to vendor's standard title block) which shall as a minimum contain the following contract information:

i) Purchaser's and Consultant's Corporate Name
ii) Project Name.
iii) Equipment Name and Item No.
iv) Purchase Order No.
v) Purchase Requisition No.

Title Block on drawings shall be placed on the lower right hand corner.

7.3.1.3 Data specified in the VDR is minimum requirements of Purchaser. Any additional document/data required or requested by Purchaser for engineering or construction shall also be made available by the vendor.

7.3.1.4 Whether or not specified the vendor shall furnish the following, before shipment:

- As built running clearances and when applicable; thrust bearing, radial bearing and seal running clearances.
- A supplementary list of spare parts other than those included in his original proposal. The supplementary list shall include recommended spare parts, cross-sectional or assembly type drawings, parts numbers, materials, prices and delivery period. The vendor shall forward this supplementary list to the purchaser promptly after receipt of the reviewed drawings and in time to permit order and delivery of parts before field start-up.
- A parts list for all equipment supplied. The list shall include pattern, stock, or production drawing numbers and materials of construction. The list shall completely identify each part so that the purchaser may determine the interchangeability of the parts with other equipment furnished by the same manufacturer. Standard purchased items shall be identified by the original manufacturer's name and part number.
- At least 8 weeks before shipment, the vendor shall submit his preservation, packaging and shipping procedures to the purchaser's for his review.

7.3.2 **Drawings** (Substitution)

7.3.2.1 The time-frame within which the drawings are to be submitted by vendor are specified in Purchaser's inquiry/order.

7.3.2.2 The purchaser's review of the vendor's drawings shall not constitute permission to deviate from any requirements in the purchase order/specifications unless specifically agreed upon in writing. After the drawings have been reviewed, certified copies shall be submitted by vendor as a part of final documents (Technical Data Manual/Mechanical catalogues) in the specified quantity. All drawings must be clearly legible and shall be submitted A4 or A3 paper sizes (except overall layout/ Foundation/ GA drawings which shall be submitted in A2 paper sizes). Documents in higher paper size shall be submitted in exceptional circumstances or as indicated in the enquiry/ contract document(s).

7.3.2.3 **General Arrangement Drawing**

A general arrangement drawing shall contain as a minimum the following information:

i) Outline dimensions (minimum three views) (all principal dimensions).
ii) Allowable forces and moments on suction and discharge nozzles.
iii) Location (in all three planes), size, type, rating and identification of all purchaser's interface connections including those of vents, drains lubricating oil, sealing fluid, cooling water, steam & Electrical/Instrumentation.
iv) Direction of rotation viewing from the driving end.
v) Weight of each assembly/component.
vi) The weight & location of center of gravity of the heaviest assembly/components that must be handled for erection.
vii) Identification, Weight and dimensions of the heaviest assembly/subassembly/ component required to be handled for maintenance.

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viii) Maintenance clearances and dismantling clearances.
ix) Speeds of Driven Equipment and driver and driver rating.
x) Layout of auxiliary equipment and operating platform.
xi) Make, Type and size of couplings and the location of guards and their coverage.
xii) A list of reference drawings if any.
xiii) A list of any special weather-protection and climatic features.

7.3.2.4 **Foundation Drawings**

A foundation drawing shall indicate complete information required for foundation design by purchaser including the following:

i) Foundation bolt sizes, pipe sleeve details, pocket sizes and locations.
ii) Type of grout material, its recommended make & grade.
iii) Static weight of each skid/independently grouted item and location of center of gravity of each of such skid/items in all three planes.
iv) Weight distribution for each bolt/subsole plate location and total static weight.
v) Dynamic loading caused due to various items grouted independently.
vi) The direction and magnitude of unbalance forces and moments generated by each such item at the worst operating condition and short circuit moments of motor drivers/generators.
vii) GD^2 value of each item resolved to driver speed.
viii) Maximum permissible amplitude of vibration on the foundation at base level.
ix) Total mass of rotating parts.
x) Suggested dynamic factor and ratio of foundation weight to weight of skid/equipment as per vendor experience.

7.3.2.5 **Layout Drawing (For multi-skid packages)**

This drawing shall contain as a minimum the following information:

i) Layout of all skid/equipment and their auxiliaries, vessels, control panels, exchangers etc. Vendor shall furnish an optimised layout (considering the space allocated, site wind conditions, area classification, the type of equipment located in the vicinity etc.) indicating elevation and dimension of skids/equipment.
ii) Minimum spacing required between the various skids/equipment and between the skids and the walls/columns/roof for an easy accessibility and maintenance.
iii) Layout for water piping, trenches for water piping, cable tray/trenches layout.
iv) Piping arrangement and piping support arrangement/location for piping in vendor's scope.
v) Layout for auxiliary equipment and operating platform details.
vi) Specification for crane/mono rail (including suggested mono rail layout) recommended for maintenance and height of the lifting hook from the centreline of equipment.

7.3.2.6 **Field Alignment Diagram**

The diagram shall indicate the relative displacement to be kept between the centrelines of various equipment, at the time of installation, so that under normal running conditions the equipments get fully aligned. This relative displacement should be decided on the basis of centreline temperature rise data of driver, gear box/transmission system, driven equipment.

7.3.2.7 **Heat Exchanger Drawings**

Heat exchanger drawing and data shall include heat and mass balance data, details of provisions for separating and withdrawing the condensate, construction details, cross sections & general arrangement drawings of heat exchangers, vendor's recommendations regarding provision for support and piping expansion.

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7.3.2.8 **P&I Diagrams (with Bill of Materials)**

Vendor shall supply P&I Diagrams along with Bill of Materials of each system in the vendor's scope of supply or specified in the order. P&I Diagram shall indicate the system details, location of various auxiliaries, instruments, controls and safety devices as required. Line sizes, piping class, valve sizes and class shall be clearly marked on the P&ID. Vendor's scope and purchaser's scope shall be clearly demarcated. Each item shall be identified by an item No./item tag no., which shall correspond to the item no. shown on the bill of materials. The bill of materials shall include item number, normal value, set value, range, quantity per unit, make and other specifications as applicable. Legends adopted shall be indicated either at the bottom of drawing or on a separate drawing. The legends shall be as per ISA.

7.3.2.9 **Cross-sectional Drawing with Bill of Materials**

The vendor shall supply cross-sectional or assembly type drawings for all equipment furnished showing all parts, design assembly and running clearances, and balancing data required for erection and maintenance. Each part shall be numbered which shall correspond to the part number on the bill of materials. The bill of materials shall include the part no., name of component, materials quantity installed per unit & sizes where applicable (say for bolts, nuts, rings, gaskets etc.). All boughtout items shall also be indicated with make and brief specifications. A separate cross-sectional drawing showing installation and setting dimensions for the seals shall be furnished.

7.3.6 **Technical Data Manual/Mechanical Catalogues** (Substitution)

7.3.6.1 Technical Data Manual/Mechanical Catalogue is a compilation of "as built" drawings and data, manufacturing and test records, installation, operating and maintenance instructions.

7.3.6.2 Not later than two weeks after successful completion of all specified tests, the vendor shall furnish the required number of Technical Data Manual/Mechanical Catalogues for the equipment, any auxiliaries and instruments that the vendor is providing. The Technical Data Manual/Mechanical Catalogue shall include the following documents as a minimum:

i) All drawings and data as listed in the vendor data index & schedule. (For drawings, where purchaser's approval is required, the final certified drawings shall be attached.) Sections shall be organised in a manner that data & drawings related to one subject is grouped together such as Mechanical, Electrical, Instrumentation etc.

ii) All manufacturing, inspection and test data and records.

iii) Installation and Instruction Manual

The vendor shall provide sufficient written instructions, including a cross-reference list of all drawings, to enable the purchaser to correctly install the equipment and prepare the equipment for start-up. It shall include any special information required for proper installation that is not on the drawings, special alignment or grouting procedures, utility specifications (including quantity) and all installation data. It shall also contain the following information:

a) Instructions for erecting, piping, aligning (including the expected thermally induced shaft centreline shift between normal site ambient temperature position and that at normal equipment operating temperature).

b) A description of rigging procedures, including the lifting of the assembled equipment, and methods of disassembly, repair, adjustment, inspection and reassembly of the equipment and auxiliaries.

c) Pre-commissioning/commissioning/functional test procedures and acceptance criterion.

iv) Operation and Maintenance Manual

This manual shall provide sufficient written instructions and data to enable purchaser to correctly operate and maintain the equipment ordered. It shall include a section to cover special instructions for operation at extreme environmental and/or extreme operating conditions. The following shall be included in this manual:

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a) Instructions covering start-up, normal shutdown, emergency shutdown, operating limits and routine operational procedures.

b) A description of equipment construction features and the functioning of component parts or systems (such as control, lubrication, sealing systems etc.).

c) Outline and sectional drawings, schematics and illustrative sketches in sufficient details to identify all parts and clearly show the operation of all equipment and components and the methods of inspection and repair. Standardised sectional drawings are acceptable only if they represent the actual construction of the equipment.

d) The following maintenance information:

1. Maximum and minimum bearing, labyrinth and seal clearances including any other clearance between moving and stationary parts of the equipment affecting proper running and maintenance of the equipment.
2. Instructions for measuring and adjusting cold clearances, shaft runout, concentricity etc.
3. Rotor float allowance.
4. Interference fits on parts that are required to be removed or replaced for maintenance of normally consumable spares.
5. Information for Rotor Balancing.
6. Lubricating schedules indicating recommended grades of oil, their properties, replacement period etc.
7. Normal maintenance procedure.
8. Preventive maintenance schedules and criterion for replacement of parts.
9. Trouble-shooting procedures.

e) The following reassembly information:

1. Bolting sequence and torque values for all bolts affecting equipment performance/integrity/safety.
2. Reassembly Sequences together with required inspection checks.
3. Adjustment procedures to achieve required positions, clearances, float and so forth.
4. Detailed procedures for pre-operational checks, including settings and adjustments.
5. Seals and coupling installation procedures.
6. Parts list indicating cross-sectional drawings of various assemblies and sub-assemblies, part numbers, materials of construction (ASTM) etc. to facilitate identification of parts and for procurement of spares.

v) Following information shall also be included in the Technical Data Manual/Mechanical Catalogue:

a) Storage instructions for storing and preserving the equipment (including driver and all the auxiliary units) at the plant site before installation of the same.

b) Instructions for preserving the equipment after it has been installed. This is particularly required in cases where a long time gap is expected between equipment installation and commissioning.

c) Field performance test procedures and acceptance criterion.

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7.3.6.3 Technical Data Manual/Mechanical Catalogue shall be in Hard board folder(s) of size 265 mm x 315 mm and shall not be more than 90 mm thickness; it may be of several volumes and each volume shall have a volume number, index of volumes & index of contents of that particular volume.

7.3.6.4 Title sheet (Top sheet) of each volume of Technical Data Manual/Mechanical Catalogue shall contain the contract information as defined under 7.3.1.2 besides the volume number.

7.3.6.5 In case order contains more than one item, separate dedicated Technical Data Manual/Mechanical Catalogues shall be submitted for each item.

7.3.4.6 Two (2) sets of Final / "As-Built" drawings / documents shall also be submitted as electronic files on secondary storage media (CD-ROM / DVD-ROM disks).

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अग्निरोधक नियंत्रण स्टेशन के लिए विनिर्देश

SPECIFICATION FOR FLAMEPROOF CONTROL STATIONS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	24.02.16	REVISED AND ISSUED AS STANDARD SPECIFICATION	NNB/AK	ANPS	BRB	SC
4	11.04.11	REVISED AND ISSUED AS STANDARD SPECIFICATION	PS	ANPS	UAP	DM
3	24.08.07	REVISED AND ISSUED AS STANDARD SPECIFICATION	ANPS	UAP	JMS	VC
2	30.01.02	REVISED AND ISSUED AS STANDARD SPECIFICATION	UAP	AAN	VPS	GRR
1	19.08.96	REVISED AND ISSUED AS STANDARD SPECIFICATION	AP	VPS	SG	AS

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Abbreviations:

AC	Alternating Current
BIS	Bureau of Indian Standards
BS	British Standards
CEA	Central Electricity Authority
CIMFR	Central Institute of Mines and Fuel Research (formerly CMRI)
CT	Current Transformer
DGMS	Directorate General of Mines Safety
ERTL	Electronics Regional Test Laboratory
FM	Factory Mutual Research Corporation
GI	Galvanised Iron
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	Ingress Protection
IS	Indian Standards
LCIE	Laboratoire Central des Industries Electriques
LED	Light Emitting Diodes
NEMA	National Electrical Manufacturers Association
PESO	Petroleum and Explosives Safety Organisation
PVC	Poly Vinyl Chloride
SWG	Standard Wire Gauge
VDE	Verband Der Electrotechnik, Elecktronik und Information Stechnik
UL	Underwriters Laboratory

Electrical Standards Committee

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1.0 SCOPE

This specification covers the requirements of design, manufacture, testing, packing and supply of flameproof control stations and accessories suitable for installation in locations handling flammable liquids and gases / vapours.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of the following standards issued by BIS:

IS-5	: Colours for ready mixed paints and enamels.
IS-1248	: Direct acting indicating analogue measuring instruments and their accessories.
IS / IEC 60079-0	: Electrical apparatus for explosive gas atmospheres (General Requirements).
IS / IEC 60079-1	: Electrical apparatus for explosive gas atmospheres (Equipment Protection by Flameproof Enclosures "d").
IS / IEC 60079-7	: Electrical apparatus for explosive gas atmospheres (Equipment Protection by Increased Safety "e").
IS / IEC 60529	: Degree of protection provided by enclosures (IP Code).
IS / IEC 60947	: LV switchgear and control gear.

2.2 In case of imported equipment, standards followed in the country of origin shall be applicable, if these standards are equivalent or more stringent than the applicable Indian Standards.

2.3 The equipment shall also confirm to the provisions of CEA Regulations with latest amendments and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

2.5 In case of any conflict between requirements specified in various applicable documents for the project, the most stringent requirement shall govern. However, Owner's/EIL's decision in this regard will be final and binding.

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of art technology and having proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

4.0 SITE CONDITIONS

The equipment shall be suitable for installation and satisfactory operation in classified hazardous locations in tropical, humid and corrosive atmosphere as prevalent in refineries, petrochemical and fertilizer plants. Unless otherwise specified, a design ambient temperature of 40° C and an altitude not exceeding 1000 m above mean sea level shall be considered.

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5.0 CERTIFICATION

The equipment shall have test certificates issued by recognised independent test house (CIMFR/ ERTL/ Baseefa/ LCIE/ UL/ FM or equivalent). All equipment (indigenous & imported) shall also have valid statutory approvals as applicable for the specified location. All indigenous flameproof equipment shall have valid BIS license and marking as required by statutory authorities.

6.0 TECHNICAL REQUIREMENTS

6.1 Construction

6.1.1 The enclosures of the control stations shall be made of cast light metal alloy.

6.1.2 The control stations shall be suitable for use in outdoor open locations and shall have IP-55 degree of protection. They shall preferably be provided with integral canopy. However, where the enclosure has been certified without integral canopy, a separate canopy can be accepted. The separate canopy shall be made of at least 14 SWG (2mm) galvanised sheet steel. The canopy shall be suitable for providing protection against rain from top and two sides.

6.1.3 The control stations shall be provided with gaskets made of non-inflammable and self-extinguishing material.

6.1.4 All metal surfaces shall undergo manufacturer's standard cleaning/ painting cycle. After preparation of under surface, the equipment shall be painted with two coats of epoxy based final paint with colour shade as below:

- Flame proof (Gas group IIA/ IIB) : Dark admiralty grey shade 632 of IS-5/ RAL 7031
- Flame proof (Gas group IIC) : Light yellow shade 355 of IS-5/ RAL-1012

All unpainted steel parts shall be suitably treated to prevent rust formation. If these parts are moving elements then these shall be greased.

6.1.5 A warning inscription "DO NOT OPEN WHEN ENERGIZED" shall be provided on each enclosure. The warning inscription shall be embossed on the enclosure or a separate warning plate with above inscription shall be fixed to the enclosure with screws. The warning plate shall be of nickel plated brass or stainless steel.

6.1.6 All accessories like nuts, bolts, washers etc. and operating shaft of pushbuttons, switches etc. shall be made of stainless steel SS-304.

6.1.7 The control stations shall be provided with two earthing studs with lugs on the external surface of the enclosures suitable for termination of 8 SWG GI wire.

6.1.8 The control station shall be provided with bottom cable entries. Required number of flameproof double compression nickel plated brass cable glands and flameproof nickel plated brass sealing plugs shall be provided.

6.1.9 The control stations shall have external fixing lugs for mounting on wall or column. The holes provided on these lugs shall be of oblong type.

6.1.10 A nameplate indicating Tag Number shall be provided on each control station. Separate nameplate shall also be provided to indicate the details of testing agency (CIMFR or equivalent), test certificate reference, statutory approval agency (PESO / DGMS) and reference, BIS license number, applicable gas group etc. The nameplates shall be engraved type and permanently fixed on the equipment. In case the standard details given above are embossed on the enclosures, the same need not be repeated on the name plate.

6.1.11 All flameproof control station shall be suitable for 240V AC as well as 110V/220V DC control supply.

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6.2 Component Specification

6.2.1 Push buttons for START and STOP shall be of GREEN and RED colour respectively. Each push button shall have two NO and two NC contacts. The STOP push button shall be mushroom type with stay put feature and lockable in pressed position.

6.2.2 All control switches shall be provided with a pistol grip handle. Circuit breaker control switch, wherever specified, shall have three positions (START - NEUTRAL - STOP) with spring return to neutral from START position and stay put in STOP position. All control/ selector switches shall have minimum two poles for each position. Each position of switch shall be indelibly marked on the control station. Exact configuration of selector switch (LOCAL-OFF-REMOTE or AUTO-OFF-MANUAL) shall be as per datasheet / MR requirement.

6.2.3 All ammeters shall be of moving iron type having an accuracy class of 3 and suitable for 1 Ampere CT secondary. Minimum size of ammeter shall be either 72mm x 72 mm or 65 mm diameter. 80% of the scale length shall cover 100% of the CT primary current uniformly and the balance 20% of the scale shall cover 100-800% of the CT primary. A red mark corresponding to the full load current of the motor shall be provided on the ammeter dial. The ammeter front glass shall be toughened.

6.2.4 Indicating lamp(s) wherever provided shall be clustered LED type (with minimum 3 numbers LEDs, preferably connected in parallel), mounted inside an enclosure of minimum diameter of 15mm.

6.3 Terminals & Wiring

6.3.1 The control stations shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. Each terminal for external cable connection shall be suitable for termination of 2.5 mm^2 solid copper conductor. Tinned copper lugs shall be provided for cable termination wherever applicable.

6.3.2 All internal wiring shall employ 1.5 mm^2, 660V grade, FR type, PVC insulated copper conductor wires.

6.3.3 For flameproof equipments, terminal box can be provided in 'Exe' or 'Exd' execution.

7.0 INSPECTION, TESTING AND ACCEPTANCE

7.1 During fabrication, the equipment shall be subjected to inspection by EIL/ Owner or by an agency authorized by the Owner, if specified/ agreed in Inspection Test Plan. Manufacturer shall furnish all necessary information concerning the supply to EIL/ Owner's inspector. All routine/acceptance tests shall be carried out at manufacturer's works under his care & expense.

7.2 Type test certificates from CIMFR or equivalent test house, applicable PESO/DGMS approval certificates, BIS license and original drawings referred in type test certificates shall be shown to the inspection agency on demand during inspection. The certificates and BIS license must be valid at the time of despatch.

7.3 Test certificates of bought out components shall be shown to the inspection agency on demand during inspection.

7.4 All equipments shall be subjected to various routine / acceptance tests as per Inspection & Test plan no. 6-81-1006.

8.0 PACKING AND DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for the selected mode of transportation, i.e. by ship/ rail or trailer, and shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. The crates/ cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Center of gravity',

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'Weight', 'Owner's particulars', 'PO no.' etc., shall be clearly marked on the packages together with other details as per purchase order.

The equipment may be stored outdoors for long periods before installation. The packing should be suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance manuals and a set of final drawing shall be enclosed in a waterproof cover along with the shipment.

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मध्यम वोल्टेज स्वीचबोर्ड के लिए विनिर्देश

SPECIFICATION FOR MEDIUM VOLTAGE SWITCHBOARD

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	21.12.2016	REVISED AND ISSUED AS STANDARD SPECIFICATION	CA/RKS	SA	BRB	RN
4	23.03.2011	REVISED AND ISSUED AS STANDARD SPECIFICATION	DA	SG	UAP	DM
3	01.03.2005	REVISED AND ISSUED AS STANDARD SPECIFICATION	SSM	RR	AAN	SKG
2	19.11.2001	REVISED AND ISSUED AS STANDARD SPECIFICATION	SSM	AAN	VPS	GRR
1	26.12.1996	REVISED AMD ISSUED AS STANDARD SPECIFICATION	AAN	VPS	SG	AS

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Abbreviations:

A	:	Ampere	kVA	:	kilo Volt Ampere
AC	:	Alternating Current	kW	:	kilo Watt
ACB	:	Air Circuit Breaker	LV	:	Low Voltage
ASB	:	Auxiliary Service Board	LED	:	Light Emitting Diode
BIS	:	Bureau of Indian Standard	LDB	:	Lighting Distribution board
BS	:	British Standard	LOTO	:	Lock-Out Tag-Out
CEA	:	Central Electricity Authority	mA	:	milli Ampere
CFL	:	Compact Fluorescent Lamp	MCC	:	Motor Control Center
CT	:	Current Transformer	MCB	:	Miniature Circuit Breaker
CPRI	:	Central Power Research Institute	MCCB	:	Moulded Case Circuit Breaker
			NO	:	Normally Open
CRCA	:	Cold Rolled Cold Annealed	NC	:	Normally Closed
DC	:	Direct Current	NEMA	:	National Electrical Manufacturer Association
EIL	:	Engineers India Limited			
EPDM	:	Ethylene Propylene Diene Monomer	PCC	:	Power Control Center
			PMCC	:	Power cum Motor Control Center
FRLS	:	Flame Retardant Low Smoke	PT	:	Potential Transformer
HDPE		High-density polyethylene	PVC	:	Poly Vinyl Chloride
HRC	:	High Rupture Capacity	R-C	:	Resistor-Capacitor
IEC	:	International Electrotechnical Commission	SWG	:	Standard Wire Gauge
			V	:	Volt
IEEE	:	The Institute of Electrical and Electronics Engineers	VA	:	Volt Ampere
			VDE	:	Verband Deutscher Elektrotechniker
IP	:	Ingress Protection			
IS	:	Indian Standard	XLPE	:	Cross-Linked Polyethylene
kA	:	kilo Amperes			

Electrical Standards Committee

Convenor: Mr. B.R. Bhogal

Members: Ms. S. Anand
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1.0 SCOPE

1.1 This specification covers the requirements of design, manufacture, testing, packing and supply of fixed and draw out type medium voltage switchboards.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of the latest revision of the following standards issued by BIS unless otherwise specified.

IS : 1248	:	Direct Acting Indicating Analogue Electrical Measuring Instruments and their Accessories
IS : 2705	:	Current transformers
IS : 2824	:	Method for determining the proof and the comparative tracking indices of solid insulating materials.
IS : 3156	:	Voltage transformers
IS : 3231	:	Electrical relays for power systems protection.
IS : 3618	:	Phosphate treatment of iron and steel for protection against corrosion.
IS : 5082	:	Wrought aluminum and aluminum alloy bars, rods, tubes and sections for electrical purposes.
IS : 5578	:	Guide for marking of insulated conductor.
IS: 8623	:	Low voltage switchgear and control gear assemblies. Particular requirement for bus bar trunking system.
IS : 11353	:	Guide for uniform system marking and identification of conductors and apparatus terminals.
IS : 13703	:	Low voltage fuses for voltages not exceeding 1000V AC or 1500V DC.
IS/ IEC: 60529	:	Degree of protection provided by enclosures (IP Code).
IS/ IEC: 60947	:	LV Switchgear and control gear.
IEC-61439	:	Low voltage switchgear and controlgear assemblies
IEC-61641	:	Enclosed low-voltage switchgear and controlgear assemblies - Guide for testing under conditions of arcing due to internal fault.

2.2 In case of imported equipments, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

2.3 The equipment shall also conform to the provisions of CEA Regulations with latest amendments and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC/BS / VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

2.5 In case of any contradiction between various referred standards/specifications/data sheet and statutory regulations, the most stringent requirement shall govern and decision of owner/EIL in this regard shall be final & binding.

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment at least for 10 years from the date of supply.

3.3 Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/spares to enable the end user for placement of order for spares and services.

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4.0 SITE CONDITIONS

4.1 The switchboards shall be suitable for installation and satisfactory operation in an air-conditioned/pressurised substation or in a covered shed/enclosed electrical room (e-room) or in a substation with restricted natural air ventilation in a tropical, humid and corrosive atmosphere.

4.2 The switchboards shall be designed to operate under specified site conditions. If not specifically mentioned, a design ambient temperature of 40° C and altitude not exceeding 1000 metres above mean sea level shall be considered.

4.3 All the equipment described in this specification shall be suitable for continuous duty with the specified ratings under the mentioned ambient conditions unless indicated otherwise.

5.0 DESIGN AND FABRICATION REQUIREMENTS

5.1 Medium voltage switchboard shall be metal enclosed fully draw out or fixed, as specified in datasheet/ job specification, free standing, floor mounting, compartmentalised, modular type suitable for indoor installation with form of internal separation "Form-4b" as per IEC-61439 (except for fixed type switchboards), unless otherwise specified elsewhere. The switchboard shall be a type tested assembly (TTA) as per IEC-61439.

5.2 The switchboard enclosure shall be dust and vermin proof and shall provide a degree of protection not less than IP-41.

5.3 The switchboard shall be assembled out of vertical panels of uniform height, not exceeding 2450mm in a single line up.

5.4 It shall be possible to extend the switchboard, in either direction at a later date. End of bus bars shall be suitably drilled for this purpose. Panels at extreme end shall have openings, which shall be covered with plates screwed to the panel.

5.5 The switchboard shall be designed to ensure maximum safety during operation, inspection, connection of cables, relocation of outgoing circuits and maintenance, with the bus bar system energised and without taking any special precautions.

5.6 Adequate means shall be provided to prevent shorting of power and / or control terminals due to accidental dropping of maintenance tools etc. inside the switchboard. Checking and removal of components shall be possible without disturbing adjacent equipment/modules/feeders.

5.7 All identical equipments and corresponding parts shall be fully interchangeable.

5.8 The frame, of individual vertical panels shall be fabricated using pressed and cold rolled sheet steel. The sheet steel used for panel shall be of minimum 2mm (14SWG) CRCA except the doors and covers that may be made of 1.6mm (16SWG) CRCA. Wherever required, stiffeners shall be provided to increase mechanical strength of large size doors and covers.

As an alternative to CRCA, Aluzinc/pre-galvanised sheet steel can also be provided for internal inter-panel partitions only as per vendor's standard manufacturing practices. However, all external surfaces shall be of CRCA with specified paint shade.

5.9 The switchboard shall be provided with integral base frame for each vertical panel. The switchboard integral base frame shall be suitable for tack welding.

5.10 All openings, covers and doors shall be provided with gaskets of Neoprene/HDPE/EPDM or equivalent around the perimeter to make the switchboard dust and vermin proof.

5.11 All hardware shall be corrosion resistant. All joints and connections of the panel members shall be made of galvanized or zinc passivated or cadmium plated high quality steel bolts, nuts and washers, secured against loosening.

5.12 Suitable removable type eyebolts/ lifting hooks shall be provided for lifting of the panel/shipping section. These eyebolts/ lifting hooks, when removed shall not leave any opening in the panels.

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5.13 Non-magnetic cable gland plates (min. 3mm thick) shall be provided for termination of single core cables.

5.14 The switchboard shall be formed using distinct vertical panels each comprising of the following compartments.

5.14.1 A metal enclosed horizontal bus bar compartment running at the top or rear, unless otherwise specified.

5.14.2 Individual feeder modules in multitier mode.

5.14.3 Vertical bus bars serving all feeder modules in the vertical panel.

5.14.4 Cable termination compartment.

5.14.5 Perforated sheet steel / insulating material enclosed, horizontal auxiliary bus bars for control, interlock, indication and metering running horizontally.

5.15 Metal sheets shall be provided between two adjacent vertical panels running upto the full useful height of the switchboard.

5.16 MCC/MCC part of PMCC shall be of single/double front execution as specified in data sheet/job specification. However circuit breaker panels and fixed type switchboard shall be in single front execution only.

5.17 Motor starter and MCCB/switch fuse modules shall not be accommodated at front and rear of ACB Incomer and bus coupler panels.

5.18 The MCC/ASB/LDB switchboards shall be provided with castle-key interlock between incomers and bus-coupler for manual changeover of supplies unless otherwise specified elsewhere.

5.19 All metering and protection equipment associated with a particular circuit, as specified in data sheet, shall be housed in separate and independent compartment earmarked for that particular circuit and in the fixed portion of the vertical panel in case of breaker panels.

5.20 All auxiliary devices for control, reset, indication, measurement and protection such as push buttons, control and selector switches, indicating lamps, measuring instruments and protective relays shall be mounted on the front side of the respective compartment. The design shall be such that all power ON/OFF or START / STOP and relay reset operations shall be performed without opening the panel door.

5.21 Unless otherwise specified elsewhere, the switchboard assembly and components shall be suitable for use in pollution degree 3 environment as per IS/IEC.

5.22 In open doors condition of compartment, all live parts or terminals of all door-mounted, internal components and bus contact openings shall be IP-2X protected.

5.23 LOTO arrangement

5.23.1 Pad locking arrangement shall be provided for rack in operation of breaker as well as for the panel door meeting LOTO requirements.

5.23.2 LOTO arrangement shall be provided be provided for each module of draw-out switchboard PCC/PMCC/MCC etc and shall include provision for the following:

a) Provision for hooking lockout devices by multiple lock arrangement to prevent opening of panel door and racking-in of circuit breaker.

b) Provision for attaching tag-out device for warning against energisation and to provide information regarding date of isolation, agency working on the equipment, etc.

c) Provision for Hasp such that the same shall be put-in and closed in the locking arrangement of the breaker/switch and panel door.

5.24 Unless otherwise specified elsewhere, the switchboard shall be designed and tested to meet the requirements of IEC-61641 for arcing due to an internal fault of full short circuit current for

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duration of 0.1 sec such that the arc is confined in the section where it occurs and adjacent sections are not affected.

5.25 Space Heaters & Panel Illumination

The switchboard panels shall be provided with space heaters to prevent moisture condensation. The space heater shall be located in the bottom part of each panel and shall be supplied from 240 V AC auxiliary buses for space heater. The space heater shall be provided with a switch, fuse or double pole MCB and thermostat having adjustable setting range of 30-70° C. Further, one number 240V AC, 6/ 16A, 5 Pin socket for owner's use shall be provided inside panels. The panels shall be provided with suitable illuminating lamp/CFL or LED with switch and fuse or MCB.

5.26 Auxiliary Bus Bars

5.26.1 Auxiliary bus bars (solid – rectangular or circular), each of minimum size 18-mm^2 copper, shall be provided for the following applications.

a) Panel space heater supply and motor space heater supply.

b) AC Control supply.

c) DC Control supply.

d) AC PT supply for energy meters, voltage operated relays etc.

5.26.2 Tee-off connectors shall be used for distributing auxiliary supply to each vertical panel. Rubber grommets shall be used for all wire entries to make the entries dust and vermin proof.

5.26.3 Provision for hook up of external AC space heater/ DC control supply to be provided either in bus PT panel or bus coupler panel.

5.27 Bus Bar

5.27.1 Bus bars shall be of high conductivity electrolytic aluminium or copper supported on insulators made of non-hygroscopic, non-inflammable material with tracking index equal to or more than that defined in Indian standards.

5.27.2 The main bus bars shall have uniform current ratings throughout their length as specified in data sheet/job specification. The current rating of the neutral shall be half that of the phase bus bars. Removable neutral links shall be provided on feeders to permit isolation of the neutral bus bar.

5.27.3 Both horizontal and vertical bus bars, bus joints and supports shall be capable of withstanding dynamic and thermal stresses of the specified short circuit currents.

5.27.4 Only zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers shall be used for all bus bar joints and supports.

5.27.5 The hot spot temperature of bus bars, including joints, at design ambient temperature shall not exceed 95^0 C under normal operating conditions. However, for silver plated joints, the allowable maximum temperature shall be 115°C.

5.27.6 The current rating as defined for switchboard and components in data sheet/enquiry document are for design ambient temperature at site conditions and for being inside the cubicle at fully loaded condition. The vendor shall suitably derate the nominal rating to suit the above condition.

5.27.7 All bus bars shall be insulated with heat shrunk PVC sleeves of 1100 V grade. Red, yellow and blue colour shall be used for phase bus bars and black colour shall be used for neutral bus bars. Alternatively, colour bands at suitable intervals along PVC sleeved bus bars may be provided. Removable type shrouds shall be provided for joints & tap off points.

5.27.8 Minimum clearance between live parts, between live parts/neutral to earth shall be 19 mm. However clearances between terminals at components shall be as per applicable individual standards for respective components.

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5.27.9 Vertical bus bars for circuit breaker panels shall be sized depending upon the rating and number of breakers per vertical panel. However vertical bus bars of all other panels shall be of uniform cross section.

5.28 Wiring and Terminals

5.28.1 Inside the switchboards, the wiring for power, control, signalling protection and instrument circuits shall be done with BIS approved FRLS, PVC/XLPE insulated copper conductor wires having 660/1100 V grade insulation. The wiring shall preferably be enclosed in flame retardant plastic channels or neatly bunched together.

5.28.2 PVC insulated copper conductor of cross section 1.5 mm^2 may normally be used provided the control fuse rating is 10 A or less. For higher fuse ratings minimum 2.5 mm^2 copper conductor shall be used. Each wire shall be terminated at a separate terminal. CT circuit wiring shall be done with 2.5mm^2 copper conductor.

5.28.3 Shorting links/suitable arrangement for shorting CT secondary shall be provided.

5.28.4 Each wire shall be identified at both ends by PVC ferrules.

5.28.5 Inter panel wiring within each shipping section shall be switchboard vendor's responsibility. For wiring between shipping sections, vendor shall provide terminal blocks on adjoining shipping sections and supply suitable jumpering wires. Inter-panel wiring shall be taken thorough PVC sleeves or rubber grommets.

5.28.6 A minimum of 10% spare terminals shall be provided on each terminal block.

5.28.7 Required number of single compression nickel plated brass cable glands and tinned copper compression type lugs (for bolted terminals) for all power and control cables shall be included in the vendor's scope of supply, if specified in the datasheet. Sufficient terminals shall be provided on each terminal block to ensure that not more than one outgoing wire is connected per terminal.

5.28.8 Terminal strips shall preferably be separated from power circuits by metal barriers or enclosures. All spare input and output contacts of numerical relays, auxiliary relays, contactors, timers, etc shall be wired up to the terminal strips/block (ensuring that two terminals are provided for each contact).

5.29 Earthing

5.29.1 All panels shall be connected to a tinned copper earth bus bar running throughout the length of the switchboard at the bottom of the panels.

5.29.2 The minimum earth bus size shall be 30x6 mm^2 copper for fault level up to 31.5kA and 50x6 mm^2 copper for fault level above 31.5kA.

5.29.3 All doors and movable parts shall be earthed, using flexible copper connections, to the fixed frame of the switchboard. Provision shall be made at the end panels of each switchboard to connect the earthing bus bar to the plant-earthing grid at two ends.

5.29.4 All non-current carrying metallic parts of the mounted equipment shall be earthed. Minimum 4 nos, 10 mm diameter bolts with nuts shall be provided on the earth bus for termination of fourth core of cable per vertical panel.

5.30 Nameplate

5.30.1 A nameplate with the switchboard designation shall be fixed at the top of the central panel. A separate nameplate giving details for each feeder compartment of all panels shall be provided. Danger nameplate shall be provided at the front and rear of each panel.

5.30.2 The nameplates for feeder compartments shall be in two parts. One part shall have necessary details pertaining to the compartments number of vertical panel of the switchboards. The other parts shall be removable and shall contain all details regarding the feeder number for drives/equipment controlled by the particular module as per approved single line diagram.

5.30.3 Blank nameplates shall be provided for all spare and vacant modules.

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5.30.4 Nameplate or polyester adhesive stickers shall be provided for each equipment mounted inside the switchboard. Special warning plates shall be provided on removable covers or doors giving access to cable terminals and bus bars.

5.30.5 Special warning labels shall be provided inside the switchboards also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.

5.30.6 Engraved nameplates shall preferably be of 3- ply (Black-White- Black) lamicoid sheets or anodised aluminium. However back engraved perspex sheet nameplates may also be acceptable. Nameplates shall be fastened by screws and not by adhesives.

5.31 Painting

5.31.1 After preparation of the under surface, the panel shall be spray painted with two coats of epoxy based final paint or shall be powder coated. The colour shade of final paint shall be as RAL-7032, unless specified otherwise. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint, etc.

5.31.2 All unpainted steel parts shall be zinc passivated, cadmium plated or suitably treated to prevent rust and corrosion. If these parts are moving elements, then these shall be greased.

6.0 SPECIFIC REQUIREMENTS OF AIR CIRCUIT BREAKER PANELS

6.1 The breaker panels shall have distinct bus bar, breaker and cable compartments.

6.2 The design of each compartment shall be such as to prevent movement of vermin from a particular compartment to any other compartment of the panel when the breaker is withdrawn and compartment door is closed.

6.3 In order to minimise accidental access and avoid accidents due to falling tools, all the outgoing links shall be shrouded.

6.4 Outgoing air circuit breaker can be mounted in a maximum of two-tier execution while the incoming/bus coupler air circuit breaker shall be in single tier execution only.

6.5 Cable Compartment

6.5.1 Separate compartment, totally enclosed from all sides, shall be provided for cable termination, on the rear side. Access to cables shall be from the rear side after opening the cabling compartment cover.

6.5.2 The incoming / outgoing cable termination shall be staggered for each circuit and barriers of sheet steel or insulating material shall be provided between terminations of two circuits such that maintenance on one circuit could be carried out while the other circuit is live. Suitable clamping arrangements shall be provided for cables and cable termination. Terminal blocks shall not be used for supporting the cables.

6.5.3 The incoming supply for PCC/ PMCC panels shall be through top entry bus ducts or through bottom entry cables unless specified otherwise. The outgoing cables shall have bottom entry unless specified otherwise.

6.5.4 The cable terminations shall be suitably sized for receiving specified number of cables per termination and provision shall be made for terminating each outgoing cable with a separate bolted connection. In case the total number of cables entering a particular panel cannot be accommodated in the cabling compartment of the panel, an extension panel of full height shall be added to the cabling compartment for accommodating extra cables. Alternatively, in view of extra cables, provision for back to back connections of cables may be offered.

6.6 Circuit Breaker Compartment

6.7.1 The circuit breaker compartment shall be fully draw-out. Suitable guides shall be provided to facilitate easy withdrawal of the circuit breaker.

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6.7.2 The current transformers for the ammeter/protection circuits shall be mounted on the fixed portion of the compartment. However, current transformers associated with built-in releases may be mounted on the breaker trolley.

6.7.3 All terminals except wiping/sliding type control terminals shall be shrouded with plastic covers to prevent accidental contact. For direct termination, clip-on shrouded type terminals shall be provided.

6.7.4 There shall be three positions for the draw out trolley viz:

- "Service" position - In this position both power and control circuits shall be connected. This shall be the normal operating position of the circuit breaker.
- "Test" position - The power contacts shall be disconnected in this position but the control connections shall not be disturbed, testing provision for the entire control circuitry shall be available in test mode including close and trip of breakers.
- "Drawout" Position - both power and control circuits shall be disconnected in this position and breaker removed from the cubicle.

6.7.5 The circuit breaker shall be lockable in "service" and "test" positions. Safety shutters shall be provided when the breaker is in withdrawn/drawout position.

6.7.6 The earth connection must remain connected in "Test" position; Earthing of the unit shall be done with a "pin" or with scrapping earth connections.

6.7.7 The earth connection shall make before the main power / control contacts make and break after the power /control contacts are disconnected. Earthing connection through a plug and socket connection shall not be acceptable

6.7 Interlocks

Following interlocks shall be provided:

6.7.1 Compartment doors shall be interlocked against opening when breaker is in closed condition. However, it shall be possible to defeat this interlock for inspection purposes.

6.7.2 It shall not be possible to push "in " a drawn out circuit breaker in closed condition or withdraw a circuit breaker in closed condition.

6.7.3 It shall be possible to operate a circuit breaker only in the defined "Full in" or "service" and "test' position inside the panel. It shall not be possible to operate the breaker in intermediate positions while inserting or withdrawing circuit breaker.

6.8 Any unused circuit breaker compartment shall be fully equipped and provided with compartment door, vertical busbars and control terminals/ wiring etc. such that the same could be used for housing outgoing breakers in future without any modifications to the panel.

7.0 SPECIFIC REQUIREMENTS OF FEEDERS OTHER THAN ACB FEEDERS

7.1 The design of drawout feeder modules shall not change for single front or double front execution. Separate vertical bus bars shall be provided for each front side modules.

7.2 All identical feeder modules shall be interchangeable.

7.3 Each vertical panel shall have a separate cable alley. The width of this cable alley shall be sufficient to accommodate all the cables and shall have free access for cable terminations and in any case shall not be less than 200mm minimum. Cable alleys shall be provided with suitable doors.

7.4 Sheet steel barrier shall be provided between individual compartments and cable alley. This barrier shall be provided with opening for power and control connections and it shall be possible to safely carryout maintenance work on cable connections to any one circuit in the cable alley with the busbars and the adjacent circuits live.

7.5 Maintenance and connection of cables to any modules shall be possible without having to take out the modules from its position from the panel.

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7.6 The outgoing feeder trolleys for drawout type switchboard shall be fully drawout and shall have the following features.

7.6.1 It shall be possible to withdraw the trolley without having to unbolt or unscrew any power and control connections to the equipment mounted on the withdrawable trolley.

7.6.2 Both power and control connections shall be drawout type. All line and bus PTs shall be in drawout execution only. However, outgoing modules having size more than half of the useful vertical height of the panel may be in mixed combination of drawout /fixed type.

7.6.3 Control supply transformer modules may be provided in fixed execution.

7.6.4 The trolley withdrawal shall be by means of crank and screw arrangement. Alternatively movement on guided rollers or swivelling guide levers for self guided movement may also be acceptable. Plug in operation shall be independent of manual force. An insulating handle for racking in/ out modules shall be provided, as required.

7.6.5 For drawout type feeders of size equal to or greater than half the useful vertical height of panel, positive clamping arrangement shall be provided on the top portion of the trolley in addition to clamping arrangement at the bottom, to ensure all round positive pressure on the power drawout contacts once the trolley is plugged in. Alternatively, fixed execution may be acceptable for feeder with higher rating, equal to or greater than 400A.

7.6.6 Power drawout contacts shall preferably be located towards the bottom portion of each trolley. The trolley shall be lockable in fully plugged in position and devices shall be provided to ensure positive plugging in. In test position, power contacts shall be totally isolated and a device shall be provided for indication of test position. In test position, testing provision for the entire control circuitry shall be available.

7.7 The incomer and bus tie feeders with load break switches rated 800A and above may be in fixed execution

7.8 Various compartment sizes in a vertical panel shall be multiples of a basic dimension. However the minimum module size for switch fuse/MCCB feeder and motor startor/contactor feeder shall not be less than that defined in data sheet/job specification. Vertical bus bars shall be pre-drilled at regular intervals for complete flexibility for changes in size of modules.

7.9 All switch drives other than rotary control switches, shall be lockable in 'OFF' position.

7.10 The switches/Moulded case circuit breakers /MCB shall be interlocked with the compartment door to prevent opening of the door when the switch/ moulded case circuit breaker is in 'ON' position and to prevent switching on when the door is open. A defeat mechanism for this interlock shall also be provided.

7.11 The maximum height of the operating handle and switches shall not exceed 1900 mm and the minimum height shall not be below 300 mm.

7.12 Unused modules in the panel shall be fully equipped with hinged door & vertical busbars and shall be suitable for mounting power and control terminals for starter modules and cradle for future use.

7.13 For all the contactor controlled starter/feeder modules of MCC/PMCC, R-C circuit across the power contactor shall be provided. Further, low burden auxiliary contactors shall be provided in each contactor controlled motor starter modules for receiving start and stop command from remote.

8.0 SWITCHGEAR MODULES

8.1 Switchboard shall be completely lined up in one straight row with the type and quantities of feeders as defined in switchboard data sheet. Generally the feeders of three main categories are identified as circuit breaker, motor starters and MCCB or switch fuse.

8.2 Starter modules required for motor control shall be of the following types and internal control wiring of all starter modules of each type shall be identical for all ratings.

8.2.1 FVNR Full Voltage Non -Reversing starter with minimum 18 control terminals.

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8.2.2 FVR Full Voltage Reversing starter with minimum 24 control terminals.

8.2.3 FVNR - HD Full Voltage Non -Reversing Heavy Duty starter with long starting time such as for compressors and fans etc. with minimum 18 control terminals.

8.3 Switch fuse/MCCB /contactor feeder modules shall be of following types and internal control wiring of all modules of each type shall be identical for all ratings.

8.3.1 SFU/MCCB Switch Fuse Unit or MCCB modules with no control terminals.

8.3.2 SFC/MCCB+C Switch Fuse Contactor or MCCB with contactor modules with 18 control terminals.

8.4 Control transformer shall be provided for each FVR/FVNR/SFC starter/MCCB+C starter/feeder modules or bus section of the PMCC/MCC switchboard having contactor control feeders as specified in the datasheet/job specification or elsewhere. Each control transformer of starter/feeder module shall be sized for taking control supply load of all components of starter module. In case control transformer is provided in bus section, same shall be sized for control supply load of entire switchboard. Switchboard having two bus sections and coupled by bus tie shall have manual changeover switch for the control transformers. The control transformer shall have at least 10% spare capacity. The control transformer secondary shall be earthed at one end.

8.5 To facilitate site modification due to changes in motor KW ratings and to minimise spares inventory, overload relays and power fuse links shall meet the following requirements.

8.5.1 All bimetal overload relays shall be separately mounted type with connecting links rated for the maximum rating of the contactor in a starter module.

8.5.2 Bimetal overload relays of various current ranges required for motors likely to be connected to a contactor must be identical in dimension for inter-changeability. In case offered relays are with different dimension for any particular starter module, special mounting plate suitable for mounting different relays shall be provided in all the modules of that size.

8.6 Heavy duty starters shall be provided with saturable type, current transformer operated; overload relays only, which shall be suitable for motor starting time of 15-60 seconds.

8.7 All contactor controlled starter feeders shall meet the requirements of type-2 co-ordination as per IS/IEC: 60947. However, contactor controlled motor feeders shall meet the requirements of type-2 co-ordination as per IS/IEC: 60947 considering energy efficient motors of IE-2 type, unless otherwise specified elsewhere.

9.0 SWITCHBOARD COMPONENTS

9.1 Circuit Breakers

9.1.1 Circuit breakers shall be air break, draw-out type and 3/4 poles as specified in the datasheet/job specifications. However, all ACBs of PCC/PMCC incomers and bus-coupler(s) shall be with 4 poles unless specified elsewhere.

9.1.2 The circuit breakers shall be provided with mechanically operated emergency tripping device. This device shall be available on the front of the panel. Mechanically operated 'closing' device shall be provided for all breakers. However mechanical closing shall be inhibited for all breakers in service position.

9.1.3 The circuit breakers shall be provided with minimum 4 NO + 4 NC contacts, wired and available for owner's use. In case contacts are directly not available in breaker, auxiliary latching type relays shall be used to multiply the auxiliary contacts of the breakers.

9.1.4 Circuit breaker's Open and closed positions; Service and test locations and spring charged condition shall also be indicated mechanically in addition to electrical indications.

9.1.5 Unless otherwise specified, all circuit breakers in the switchboard shall be provided with electrical power operating mechanism. Wherever circuit breakers are provided in place of Isolators, Breaker can be manually operated type.

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9.1.6 **Operating Mechanism**

a) Electric power operating mechanism shall be motor wound spring charged stored energy type. However, manual-operating mechanism may be of the spring charging stored energy type or spring assisted type. For circuit breakers with electrical power operating mechanism, provision shall also be made for manual spring charging. Closing time of circuit breakers with manual operating mechanism shall be independent of the speed of the operating handle.

b) All stored energy operating mechanisms shall be equipped with the following features:

i) Failure of springs, vibrations or shocks shall not cause unintended operation of breaker or prevent intended tripping operation.

ii) Closing of circuit breakers shall be prevented unless the spring is fully charged.

c) All electrical power operating mechanisms shall be suitable for remote operation and shall be equipped with the following features:

i) Provided with universal motor operable on AC or DC control supplies.

ii) Provided with emergency manual charging facility. The motor shall be automatically, decoupled (mechanically) once the manual-charging handle is inserted.

iii) Closing operation of circuit breaker shall automatically initiate charging of the spring for the next closing operation without waiting for tripping of circuit breaker.

iv) Closing operation shall be completed once the closing impulse is given and the first device in the control scheme has responded even though the control switch / Push Button is released, provided no counter trip impulse is present.

9.1.7 Circuit breaker trip and closing coils, in case of electrically operated breakers and trip coil in case of mechanically operated breakers and circuit breaker indication shall be suitable for satisfactory operation on a control supply system indicated in data sheets/job specification.

9.1.8 Circuit breakers shall be provided with anti-pumping and trip free feature.

9.1.9 Circuit breakers shall be provided with operation counters.

9.1.10 Releases are not required to be provided with breakers where relays are used. However breaker-having AC control supply voltage shall be provided with under voltage release unless specified otherwise.

9.2 Switches

9.2.1 All switches or fuse switches shall be air break type provided with quick make/break manual operating mechanism. The operating handle shall be mounted on the door of the compartment having the switch.

9.2.2 Rating of switches for starter module shall meet the requirements of AC-23 duty as per IS/ IEC 60947 and minimum rating shall be as specified in job specification/data sheets.

9.3 Fuses

9.3.1 Fuses shall be non-deteriorating HRC cartridge link type.

9.3.2 Power fuses shall be pressure fitted type and shall preferably have ribs on the contact blades to ensure good line contact.

9.3.3 It shall be possible to handle fuses during off load conditions with full voltage available on the terminals. Wherever required fuse pullers shall be provided. The fuse base shall be so located in the modules to permit insertion of fuse pullers and removal of fuse links without any problem.

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9.4 Contactors

9.4.1 The contactors shall be air break type, equipped with three main contacts and minimum 1NO+1NC auxiliary contacts. The main contacts of a particular contactor for motor starter module shall have AC-3 or AC4 ratings, as specified in data sheet

9.4.2 Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240 V, 1 Phase, AC supply.

9.5 Thermal Overload Relay

9.5.1 Bimetal relays shall be provided for protecting the motor from thermal overload.

9.5.2 Bimetal relays shall be manually reset type with the reset push button brought out on the front of the panel. The reset push button shall be capable of being operated without opening the compartment door.

9.5.3 Bimetal relays shall be positive acting ambient temperature compensated type with adjustable setting range.

9.5.4 Bimetal relays shall have built-in single phasing prevention feature, which operates even with 50% rated current at the time of single phasing.

9.6 Moulded Case Circuit Breakers

9.6.1 MCCBs shall be provided with spring assisted quick make/ break manually operated trip free mechanism. Wherever specified, MCCB shall be suitable for remote tripping operation and the tripping device shall be suitable for the specified control supply voltage.

9.6.2 MCCBs shall be provided with a tripping device with inverse time characteristic for over load protection and instantaneous characteristics for short circuit protection and MCCB rated above 125A shall preferably have adjustable settings.

9.6.3 `ON' and `OFF' position of the operating handle of MCCB shall be displayed and the operating handle shall be mounted on the door of the compartment housing MCCB.

9.6.4 Each MCCB shall be provided with minimum 1 NO + 1 NC auxiliary contact and 1NO contact for tripping indication/alarm for owner's use.

9.6.5 MCCBs shall be provided with solenoid/ motorised closing mechanism to make them suitable for remote closing operation if specified. The closing solenoid/motor shall be suitable for specified control supply voltage.

9.6.6 MCCB's as part of motor starter module shall be current limiting type and type tested for type-2 co-ordination as per IS/ IEC-60947 considering energy efficient motors of IE-2 type unless otherwise specified elsewhere.

9.7 Relays

9.7.1 Type of relay shall be numerical, static or electro-mechanical type as specified in the data sheet /job specification.

9.7.2 All electro-mechanical protective relays shall be back connected, of drawout type, suitable for flush mounting, and fitted with dust-tight covers. Alternatively, "plug-in" type relays will also be acceptable. Auxiliary relays and lock out relays are acceptable in fixed execution.

9.7.3 The protective (static or electro-mechanical type) relay cases shall have a provision for insertion of a test plug at the front for testing and calibration purpose using an external power supply. It shall be possible to test the relays without disconnecting the wiring and without withdrawing the relays. The insertion of the test plug shall automatically short circuit the CTs and permits extension of external power supply to the relay.

9.7.4 Each protective relay shall be provided with minimum 2 numbers potential free contacts of required configuration.

9.7.5 Each tripping relay shall be of lockout type with hand reset coil cut-off contact.

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9.7.6 Protective relays shall be preferably mounted on the front side and upper part of the panel and mounting of relays on the lower portion shall be avoided.

9.8 Instrument Transformers (CTs/PTs)

9.8.1 Current transformers shall generally conform to IS: 2705 and any special requirement with respect to numerical relay shall be taken care by the vendor.

9.8.2 For general guidance the vendor shall note that the protective current transformers shall have an accuracy class "5 P" and an accuracy limit factor greater than "10 ". However CTs for restricted earth fault shall be of class "PS"/"PX". Vendor shall co-ordinate the knee point voltage, magnetising current for PS class CTs to avoid saturation and mismatching of CTs provided at other end by other vendor.

9.8.3 Current transformers for instruments shall have an accuracy class 1.0 and accuracy limit factor less than 5.0.

9.8.4 The current transformers in breaker feeders shall be capable of withstanding the applicable peak momentary short circuit and the symmetrical short circuit current.

9.8.5 The voltage transformers shall be cast resin type transformers and PT shall generally conform to IS: 3156. PT shall be provided with HRC fuses on primary side and Miniature circuit breakers with auxiliary contact on the secondary side.

9.9 Measuring Instruments

9.9.1 All measuring instruments shall be of 96 x 96 mm square pattern, flush mounting type for incomer and outgoing feeders in the switchboard. The accuracy class for all instruments shall be 1.0 as per IS: 1248.

9.9.2 All auxiliary equipment such as shunts, transducers, CT, PT, etc. as required shall be included in the supply of the switchboard.

9.9.3 All AC ammeters and voltmeters shall be of moving iron type. Ammeters for motor feeders shall have a non-linear compressed scale at the end to indicate motor starting current and red mark for the full load current.

9.9.3 The KW/KWH meters shall be suitable to measure unbalanced loads on 3 phases 4-wire system. Test terminal block shall be provided for KWH meters.

9.9.4 Digital meters shall be provided, if specified in job specification/data sheets. All digital meters shall be highly reliable, accurate, compact and self powered. Digital meter data shall be saved in case of power failure. Field programming from front of the meter shall be possible and shall have RS232/485 port in case specified in the job specification/data sheet.

9.10 Control Switches

9.10.1 All control switches shall be rotary type, having a cam operated contact mechanism. Switch shall have pistol grip handle for circuit breaker control and knob type handle for other applications.

9.10.2 Ammeter selector switches shall have make before break feature on its contacts. The selector switch shall generally have 4 positions, three for reading 3 phase currents and the fourth position for off. The voltmeter selector switch shall also have 4 positions. Three positions shall be used to measure phase-to-phase voltage and fourth shall be OFF position.

9.11 Push Buttons

Push button colours shall be as follows:

Stop /open/emergency stop	:	Red
Start/close	:	Green
Reset/test		Yellow / Black /white

The stop push button shall be stay put type.

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9.12 Indication

9.12.1 Clustered LED type indicating light with minimum 8mm diameter size shall be provided for indications.

9.12.2 Breaker positions (Close, Open, spring-charged, test position, service position) electrical indications, with colors as given below, shall also be provided:

Breaker `Closed'/ ON	:	Red lamp
Breaker `Open'/ OFF	:	Green lamp
Breaker auto-trip	:	Amber lamp
Trip circuit healthy	:	White lamp
Spring charging	:	Blue lamp

9.12.3 Outgoing feeder (Close, Open, trip) electrical indications, with colors as given below, shall also be provided:

`Closed'	:	Red lamp
`Open'	:	Green lamp
'Trip'	:	Amber lamp

9.13 Auxiliary Relays/Contactors

Auxiliary relays/contactors shall generally be used for interlocking and multiplying contacts. However, in the case of numerical relays, the interlocking logic shall be built in the relay itself.

9.14 Timers

For re-acceleration duty, timers shall be electronic type or static type. The time settings, where specified, shall be accurately set before despatch of the switchboard. Timer provided for control of capacitor feeder and re-acceleration feeders shall have minimum setting of 0-5 minutes.

9.15 Miniature Circuit Breaker

MCB shall provide high mechanical and electrical life, reliable protection of circuits against overload and short circuit and shall have minimum breaking capacity of 9kA unless otherwise specified. Positive ON/OFF indication shall be provided.

10.0 INSPECTION, TESTING AND ACCEPTANCE

10.1 During fabrication, the switchboard shall be subject to inspection by EIL / Owner, or by an agency authorised by the Owner, to assess the progress of work, as well as to ascertain that only quality raw material is used. The manufacturer shall furnish all necessary information concerning the supply to EIL / Owner's inspectors.

10.2 For testing requirements refer Inspection & Test Plan No. 6-81-1018. Prior notice of minimum 4 weeks shall be given to EIL/owner for witnessing the final testing of the complete assembly to ensure satisfactory operation of all components. Tests shall be carried out at manufacturer's works under his care and expense.

10.3 Vendor shall provide certificates to prove that the design of switchgear/switchboard has been successfully type tested as per IEC-61439 and IEC-61641(for arcing due to internal faults).

11.0 PACKING AND DESPATCH

All the equipment shall be divided into several shipping sections for protection and ease of handling during transportation .The equipment shall be properly packed for selected mode of transportation i.e. by ship/rail or trailer. The panels shall be wrapped in polyethylene sheets before being placed in wooden crates /cases to prevent damage to the finish. Crates /cases shall have skid bottoms for handling. Special precaution notations such as 'Fragile', 'This side

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up', 'Centre of gravity', 'weight', Owner's particulars, Purchase order number etc. shall be clearly marked on the package together with other details as per purchase order.

The equipment may be stored outdoors for long periods before installation. The packing should be suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance manuals and a set of final drawing shall be supplied duly enclosed in a waterproof cover along with the shipment.

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बैटरी चार्जर के लिए विनिर्देश

SPECIFICATION FOR BATTERY CHARGER

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	17/11/16	REVISED AND REISSUED AS STANDARD SPECIFICATION	PB/MHR	RS	BRB	RN
4	11/04/11	REVISED AND REISSUED AS STANDARD SPECIFICATION	RS	PG	UAP	DM
3	10/09/08	REVISED AND REISSUED AS STANDARD SPECIFICATION	RS	NS	JMS	VC
2	25/03/02	REVISED AND REISSUED AS STANDARD SPECIFICATION	VCB	JMS	VPS	GRR
1	30/08/96	REVISED AND REISSUED AS STANDARD SPECIFICATION	RKM	VPS	SG	AS

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Abbreviations:

AC	:	Alternating Current
Ah	:	Ampere-hour
BIS	:	Bureau of Indian Standards
BS	:	British Standard
CEA	:	Central Electricity Authority
CFL	:	Compact Fluorescent Camp
CRCA	:	Cold Rolled Cold Annealed
DC	:	Direct Current
DCDB	:	Direct Current Distribution Board
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standard
LED	:	Light Emitting Diode
MCB	:	Miniature Circuit Breaker
MCCB	:	Moulded Case Circuit Breaker
MR	:	Material Requisition
MSL	:	Mean Sea Level
NEMA	:	National Electrical Manufacturers Association
Ni-Cd	:	Nickel Cadmium
PO	:	Purchase Order
PVC	:	Poly Vinyl Chloride
RFI	:	Radio Frequency Interference
RMS	:	Root Mean Square
UPS	:	Uninterrupted Power Supply
V	:	Volt
VDE	:	Verband Der Elecktrotechniker, Elektronik und Information stechnik
VRLA	:	Valve Regulated Lead Acid

Electrical Standards Committee

Convenor: Mr. B.R. Bhogal

Members: Ms. Sumita Anand
Mr. Parag Gupta
Mr. M.K. Sahu
Ms. N.S. Bhattacharya
Mr. Saeed Akhtar (Inspection)
Ms. N.P. Guha (Projects)

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1.0 SCOPE

This specification covers the design, manufacture, testing at manufacturer's works, packing and supply to site of Battery Chargers and Distribution Boards.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of the following standards issued by BIS/ IEC:

IS 5	Colours for ready mixed paints and enamels.
IS 1248	Direct acting indicating analogue electrical measuring instruments and accessories.
IS 3700	Essential rating and characteristics of semi-conductor devices.
IS 3715	Letter symbols for semi-conductor devices.
IS 4411	Code of designation of semi-conductor devices.
IS 5001	Guide for preparation of drawings for semi-conductor devices and integrated circuits.
IS 5469	Code of practice for the use of semi-conductor junction devices.
IS 6619	Safety code for semiconductor rectifier equipment.
IS 7204	Stabilised power supplies DC output.
IS 12021	Control transformers for switchgear and controlgear for voltages not exceeding 1000VAC.
IS 13703	Low voltage fuses for voltages not exceeding 1000VAC or 1500VDC.
IS/ IEC 60947	Low voltage switchgear and control gear.
IEC 60146	Semiconductor converters.

2.2 In case of imported equipment, the standards of the country of origin shall be applicable, if these standards are equivalent or more stringent than the applicable Indian standards.

2.3 The equipment shall also conform to the provisions of CEA regulations with latest amendments and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

2.5 In case of any conflict between various referred standards/ specifications/ datasheets and statutory regulations, the most stringent requirement shall prevail and Owner's/ EIL's decision in this regard shall be final and binding.

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of the art technology and a proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

3.3 Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/spares to enable the end user to place order for spares and services.

4.0 SITE CONDITIONS

The Battery Chargers shall be suitable for installation and satisfactory operation in a pressurised or non-pressurised substation with restricted natural air ventilation in a tropical, humid and corrosive atmosphere. The Battery Chargers shall be designed to operate under

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site conditions as specified in the data sheet. If not specifically mentioned therein, design ambient temperature of 40°C and altitude not exceeding 1000 m above MSL shall be considered for all equipment.

5.0 TECHNICAL REQUIREMENTS

5.1 Input Power Supply

5.1.1 The Battery Chargers shall be suitable for input power supply as defined in the data sheet. If not specified therein, these shall be suitable for the following input power supply:

Voltage : 415V ± 10%
Frequency : 50 Hz ± 3%

In addition to the above variations, the input voltage may be subject to transient variations comprising of voltage dips up to 20% of normal voltage during motor start-up, voltage interruptions during short circuits as well as frequency variations due to large motor start-up. The Battery Chargers shall operate satisfactorily with a total harmonic distortion of up to 5% in the input power supply.

The Battery Chargers shall also be designed to operate satisfactorily while drawing input power from an emergency diesel generator set.

5.1.2 The incoming power supply to the Battery Charger system shall be provided by 2 independent feeders. One feeder shall supply power to each rectifier.

5.2 Battery Charger

5.2.1 **Design Basis**

5.2.1.1 The Battery Charger system shall have two chargers (Charger-1 & Charger-2). Both chargers shall be of identical design and rating. The battery to be connected to the chargers shall be of Nickel Cadmium/ flooded electrolyte Lead Acid/ VRLA type as indicated in the data sheet. Battery Chargers for flooded Lead Acid and Nickel Cadmium batteries shall be sized to provide quick charging of the battery within a duration of 10 hours. Battery Chargers for VRLA battery shall be sized to provide quick charging of the battery up to 90% of rated Amperehours within a duration of 24 hours and to 100% within 4 days. Each charger shall be sized for the most stringent of the following duty conditions, whichever is higher:

a. Offline quick charging of the battery assembly. The charger shall be sized as under:

Charger rating in Amps. = 0.14 Ah(C_{10}) of battery (for Lead Acid battery)
= 0.2 Ah(C_{10}) of battery (for VRLA battery)
= 0.2 Ah(C_5) of battery (for Nickel Cadmium battery).

b. Online float charging of the battery assembly while feeding the complete DC load. The charger shall be sized as under:

Charger rating in Amps. = 1.15 x Average DC load + float charging current
(Average DC load = Area under the battery duty cycle/ battery duty cycle duration).

5.2.1.2 Each charger shall have a 3 phase full wave, controlled rectifier bridge with protective devices.

5.2.1.3 Independent current limits shall be provided for charger load current and battery charging current. Subsequent to a discharge cycle and completion of quick charging, when battery is connected to charger under float mode, the battery current shall be monitored, controlled and limited to set value automatically irrespective of the value of load current. Fast acting semi-conductor fuses shall be provided for protection against internal short circuits. In case of external short circuits, the chargers shall be protected by rapid shutdown of the semi-conducting power devices. The high speed semi-conductor fuses used for rectifier protection shall be complete with trip indication.

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5.2.1.4 Filter circuits consisting of smoothing choke and condenser, complete with protection to limit the ripple content at the output, shall be provided.

5.2.1.5 Silicon blocking diodes shall be provided in the charger output circuit to prevent back-feed from battery into the charger and filters.

5.2.1.6 Protection against reverse battery connection and DC earth fault relay for earth leakage detection shall be provided.

5.2.1.7 Silicon blocking diodes (min. 4 nos.) connected to 80% tap of the battery bank shall be provided to maintain continuity in the DC supply to the load.

5.2.1.8 Internal cooling of the charger unit shall preferably be by natural ventilation. If forced air cooling is necessary, a redundant air cooling fan shall be provided. The charger components shall be capable of delivering their rated output with one forced air cooling fan out of service. Under this condition, maximum continuous temperature of components shall not exceed the permissible limits. In case of chargers with forced cooling, loss of ventilation alarm/ trip with override facilities shall be provided.

5.2.1.9 Selection, sizing and suitability of all components used for various applications shall be vendor's responsibility and the rating of components shall be increased, if required, to suit associated components during execution of the order without any claim for extra price or time.

5.2.1.10 The DC system shall be unearthed. However, a high impedance earth fault relay shall be provided for the protection of the battery.

5.2.1.11 Each charger shall be galvanically isolated from the input power supply by providing a double wound transformer at its input. The transformer shall be natural air cooled, dry type suitable for location inside a panel.

5.2.1.12 An RFI filter shall be provided to suppress the radio frequency interference to permissible limits. The production of radio frequency interference voltages shall not exceed the value of suppression grade N as defined in VDE-0875.

5.2.1.13 Transient/ surge protection devices shall be provided in the input circuit of chargers to protect them against surges & voltage spikes.

5.2.1.14 The Chargers shall be designed to draw power from mains supply at a minimum power factor of 0.85 lag while sharing the rated load in normal operating configuration.

5.2.1.15 The chargers shall be designed to ensure that the harmonic component in the input currents are limited so as not to cause undue harmful effects on other sensitive equipment operating on the same supply bus. Suitable filters/ harmonic traps shall be provided, as required, for this purpose.

5.2.1.16 All breakers shall be adequately rated for the required continuous rating and breaking capacity as applicable. Paralleling of breaker/ switch/ contactor poles to achieve the required current rating is not acceptable. All output isolating devices shall be double pole type. The DC contactors shall be operated with a DC control supply using ON/ OFF selector switches and not push buttons.

5.2.1.17 All the thyristors, diodes and other power electronic devices shall be protected with high speed semiconductor fuses. I^2t co-ordination between fuse and semi-conducting power devices shall be ensured.

5.2.1.18 The Battery Chargers shall be specifically designed to limit float and quick charging voltages to the battery to limits recommended by the battery manufacturer. Output voltage shall be limited to maximum +10% of nominal system voltage when the battery is float charged while feeding the load. Vendor shall specifically ensure that the charger output voltage does not exceed the recommended limits of operation under any conditions of internal/ external fault or operation, including:

- Filter capacitor fuse failure of either charger

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- DC output switch OFF of either charger
- DC output fuse blown of either charger.

Other specific current/ voltage limits during normal charging/ operation of the chargers shall also be incorporated in the design of the chargers.

5.2.2 **Operation and Performance**

5.2.2.1 **Operation (Option – I)**

The DC system shall comprise of 2 Nos. Float cum quick Chargers (each rated for 100% capacity) with 1 set of battery (Refer typical scheme block diagram option – I).

a. Normal operation requires that the battery assembly shall be float charged simultaneously by both Chargers-1 & 2 while feeding the DC load, the chargers thus operating in parallel and equally sharing the total load.

b. However in case of failure of either of the chargers, the other charger shall float charge the battery while feeding the complete DC load. Faulty charger shall automatically get disconnected from the healthy system.

c. In case of AC mains failure, the battery shall continue to supply the load.

d. The process of changeover from float to quick charging and reverting from quick to float charging shall be selectable in Automatic or Manual mode by means of an Auto/ Manual selector switch. In Automatic mode, the changeover from float to quick charging shall be initiated through a current sensor, set at a preset value. Similarly, the changeover from quick to float charging shall also be automatic based on current sensing. In Manual mode, both change over from float to quick charging and from quick to float charging shall be performed manually using push buttons. When quick charging mode is selected, the battery charger shall initially charge the battery under constant current mode followed by constant voltage (finishing charging) mode or as per the battery manufacturer's recommendation. Changeover from constant current to constant voltage (finishing charging) mode shall be fully automatic. A backup synchronous or digital timer shall also be provided for initiating the changeover to float mode by default after a preset time period. The timer range shall be 0 to 24 hours or the nearest available as per manufacturer's standard range.

e. In the event of failure of the charger feeding the load, when battery is being quick charged by the other charger, continuity in DC supply shall be maintained from the battery to the load through 80% tap of the battery bank followed by full battery supplying the load through contactor C-2 (refer block diagram Option – I).

f. Interlock shall be provided to ensure that when either of the chargers is selected in quick charging mode, it will be disconnected from both the DC load and the other charger operating under float charging mode.

g. The chargers shall have facility for manual mode of operation in the event of failure of controller under closed loop control. The selection shall be done through Auto/ Manual selector switch.

h. Energisation of contactor for DC critical lighting shall be initiated by means of an AC mains failure relay complete with Auto/ Manual selector switch, On/ Off push buttons etc.

5.2.2.2 **Operation (Option – II)**

a) The DC system shall comprise of 2 nos. Float cum quick Chargers (each rated for 100% capacity) and 2 sets of Batteries (each of the battery sets rated for 50% AH capacity unless specified otherwise in datasheet/ job specification). (For typical scheme, refer block diagram Option - II).

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b) Normal operation requires that Battery–1 shall be float charged by Charger-1 while Battery-2 shall be float charged by Charger-2. In this case both the chargers 1 and 2 shall feed the DC load by operating in parallel and equally sharing the total load.

c) Selection of Float / quick mode shall be Automatic or Manual based on the position of selector switch for Auto / Manual selection.

d) In case of failure of either of chargers, the other charger shall float charge both the batteries while feeding the complete DC load. Faulty charger shall automatically get disconnected from the healthy system.

e) In case of AC mains failure, both the batteries shall continue to supply the load.

f) After restoration of power supply, one of the Charger (say Charger-1) shall float charge Battery-1 and also feed the complete DC load while the other Charger-2 shall quick charge Battery-2. Upon completion of quick charge of Battery-2, Charger-2 shall switchover to float mode and shall float charge Battery-2 and also feed the complete DC load while the other Charger-1 shall switchover to quick mode and shall quick charge Battery-1.

g) The process of changeover from float to quick charging and reverting from quick to float charging mode shall be selectable in Automatic or Manual mode by means of Auto / Manual selector switch.

h) In automatic mode, the changeover from float to quick charging shall be initiated through a current sensor set at a preset value. Similarly, the changeover from quick to float charging shall also be automatic based upon current sensing and through timer.

i) In manual mode, both the changeovers i.e. from float to quick charging and from quick to float charging shall be performed using push buttons. When quick charging mode is selected, one of the battery charger (say Charger-1) shall initially charge the battery under constant current mode followed by constant voltage (finishing charging) mode or as per the battery manufacturer's recommendation. Changeover from constant current to constant voltage (finishing charging) mode shall be fully automatic. A back-up synchronous or digital timer shall also be provided for initiating the changeover to float mode by default after a preset time period. The timer range shall be 0 to 24 hours or the nearest available as per manufacturer's standard range.

j) In the event of failure of charger feeding the load (say Charger-1), when Battery-2 is being quick charged by the other Charger-2, Charger-2 shall changeover to float mode and continuity of 100% DC supply to the load shall be maintained from the Charger-2 while float charging both Battery-1 as well as Battery-2 after providing suitable time delay.

k) In an event of AC mains failure, when one of the Charger (say Charger-1) is float charging the Battery-1 and supplying the 100% DC load while the other Charger-2 was quick charging Battery-2, continuity of 100% DC supply to the load shall be maintained from Battery-1 (through 100% tap). Further, Battery-2 (which was being quick charged) shall also be made available, after providing suitable time delay, to feed the DC load by operating in parallel with Battery-1 and sharing the total load.

l) Interlock shall be provided to ensure that when either of the chargers (say Charger-1) is selected in quick charging mode, it will be disconnected from both the DC load as well as the other Charger-2 operating under float charging mode.

m) The chargers shall have facility for manual mode of operation in the event of failure of controller under closed loop control. The selection shall be done through Auto/Manual selector switch.

n) Energisation of contactor for DC critical lighting shall be initiated by means of an AC mains failure relay complete with Auto/Manual selector switch, On/Off push buttons etc.

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5.2.2.3 **Performance**

a. Both chargers shall be of solid state design, constant voltage and current limit type. The output voltage shall be stabilised to within ±1% of set value in float charging mode for mains steady state voltage and frequency variation of ±10% and ±3% respectively, and load variation of 10 to 100% at any temperature up to the design ambient temperature specified in the data sheet. However, the variation in output voltage can be up to ±2% for chargers with rated output voltage up to 24V.

b. Under constant current quick charging condition, the DC output current shall be maintained within ±2% of set value.

The output voltage dynamic response of the charger unit with battery disconnected shall not vary more than ±10% of nominal output voltage in the event of step load of up to 50% of the rated output. The output voltage shall be restored to a value within the steady state limits within 250 msec.

c. The maximum allowable RMS ripple voltage, with battery disconnected, shall be equal to or less than 2% of the nominal output voltage.

d. The maximum noise level from the chargers measured at 1 metre distance in any position, at any load between 0- 100% with all normal cooling fans running shall not exceed 75 dB(A).

5.2.2.4 **Controls**

The minimum controls shall include but not be limited to those shown in the block diagrams (OPTION-I or OPTION-II as applicable):

5.2.2.5 **Panel Metering and Indication**

These shall include but are not limited to those shown in the block diagrams (OPTION-I or OPTION-II as applicable):

LEDs provided for indication shall be cluster type with adequate brightness and minimum 2 Nos. LEDs chips per light. LEDs shall be connected in parallel and each LED chip having diameter not less than 3mm.

5.2.2.6 **Annunciation**

Static type audio-visual annunciator with annunciation windows, acknowledge, test and reset push buttons and hooter shall be provided on each charger for the following annunciations. Any additional relays/ components, including DC undervoltage relay and current sensors, required for this purpose shall be provided in the chargers. Facility for bypassing the audio alarm on each charger shall also be provided.

- DC under voltage
- DC overvoltage
- DC earth leakage
- AC incoming power supply failure
- AC input fuse blown-off
- Thyristor/ diode failure or Thyristor/ diode protection fuse failure
- DC output fuse blown-off
- DC battery fuse blown-off
- Filter Capacitor fuse blown-off
- Load on Battery (using current direction sensing with time delay)
- Battery undervoltage/ Disconnected during discharge (using zero current sensing)
- Cubicle fan failure/ cubicle temperature high (for chargers with forced cooling).

One summary alarm potential-free contact each for Battery, Charger-1 and Charger-2 shall be wired to terminal block for remote annunciation.

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5.2.2.7 **Printed Circuit Boards (PCBs)**

PCBs used in the chargers shall be made of glass epoxy material. The PCBs shall be firmly clamped in position so that vibration or continued usage do not result in loose contacts. All PCBs shall be fitted in a manner to avoid replacement of a PCB by a wrong spare card. The PCBs shall be provided with visual light emitting diode (LED) status indications, monitoring points/ test connections and setting potentiometers in a readily accessible location which is visible without removing the PCBs.

5.2.2.8 Vendor shall provide adequate protection to the system.

5.3 Construction of Chargers/ Distribution Board

5.3.1 Each Battery Charger and DC distribution board shall be housed in a separate free standing cubicle with minimum IP-31 degree of protection. All panels shall be of the same height so as to form a panel line up which shall have good aesthetic appearance. Chargers-1 & 2 shall be installed side by side whereas DCDB may be located separately and interconnected to the charger through cables. The DCDB shall accommodate outgoing feeders as desired. Each panel shall be provided with an 11W CFL light or LED lamp of required wattage with a door operated switch and a thermostatically controlled MCB protected space heater.

The DCDB shall be compartmentalised with each outgoing feeder housed in a separate compartment. Cable alley of minimum 200mm width with suitable supports shall be provided for the termination of cables for each vertical arrangement of outgoing feeders in DCDB.

5.3.2 The Chargers, DCDB and Cell Booster enclosures shall be fabricated from structural/ CRCA sheet steel. The frames shall be fabricated by using minimum 2 mm thick CRCA sheet steel while the doors and covers shall be made from minimum 1.6 mm thick CRCA sheet steel. Wherever required, suitable stiffeners shall be provided. The panels shall be provided with suitable louvers for ventilation backed by wire mesh. They must be suitable for use in a tropical climate. Hinged doors shall be provided at the front and back as required. Inter panel sheet steel barriers shall be provided.

5.3.3 Bus bars shall be colour coded and live parts shall be shrouded to ensure complete safety to personnel intending routine inspection by opening the panel doors. All the equipment inside the panel and on the doors shall have suitable nameplates and device tag numbers as per the schematic diagram. All wires shall be ferruled and terminals shall be numbered.

5.3.4 The DCDB incomer and main bus bars shall be rated based on the maximum load current considering an additional 10% design margin for contingencies. The rating shall be selected from standard available ratings and shall be adequate for the expected short circuit current. The bus bar voltage shall be higher than the recommended quick charging voltage for the system. The insulation for all equipment where provided shall be heat resistant, moisture proof and tropicalised.

5.3.5 All power and control switches shall be rotary/ cam operated type. All power switches shall be air insulated load break type. Vendor shall ensure that all equipment/ components such as incomer switches, outgoing DC switches, MCCBs, push buttons, indicating lamps, charger mode selector switches, voltage control switches, annunciator windows etc. are suitably located on the charger and distribution board door such that they can be operated without opening the front door. Power switches shall be provided with a door interlock. In case of difficulty in installation on the charger front panel door, the AC incoming power switches, DC outgoing switches and MCCBs may be installed within the panel provided that they are operable after opening the front panel door. However, all other selector/ control switches, push buttons, indicating lamps, annunciators, meters etc. shall necessarily be installed on the front panel door as specified above.

5.3.6 All instruments shall be switchboard type, back connected and maximum 96 x 96 mm square size. Accuracy class of all meters shall be 1%. Digital meters capable of displaying different parameters can be considered subject to Owner's/ EIL's approval. Analogue instrument scales shall have a red mark indicating maximum permissible operating rating.

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5.3.7 All fuses shall be link type and shall be located inside the panel. Diazed fuses shall not be accepted.

5.3.8 All power and control wiring connections within the panels shall be carried out with 660V grade, PVC insulated, Flame Retardant Low Smoke (FRLS), BIS marked wires having stranded copper conductors. However, copper strip connections shall preferably be used for currents exceeding 100A. Control wiring for electronic circuits/ components shall be through flat ribbon cable or copper wire of minimum 0.5mm diameter. Ferruling of wires shall be as per relevant IS.

5.3.9 For all cabling external to panels, power cables shall be with aluminium/ copper conductors and control cables shall be with copper conductors. All cable connections shall be from the bottom of the panel. Removable bolted undrilled gland plates shall be provided along with single compression type nickel plated brass cable glands for all external cable connections. Separate test terminals shall be provided for measuring and testing the equipment to check performance.

5.3.10 A suitably sized earth bus shall be provided at the bottom of the panels running through the panel line up with provision for earth connections at both ends to owner's main earth grid. All potential free metallic parts of equipment shall be suitably earthed to ensure safety.

5.3.11 The maximum height of the operating handles/ switches shall not exceed 1800 mm and the minimum height shall not be below 300 mm.

5.3.12 All components/ devices/ feeders shall be provided with screwed nameplates and lettering shall be of minimum 6 mm height.

5.3.13 Panels shall undergo manufacturer's standard cleaning and painting cycle. After preparation of the under surface, the panel shall be painted with two coats of epoxy based final paint. Colour shade of final paint shall be 631 of IS 5/ RAL 7032. All unpainted steel parts shall be suitably treated to prevent rust formation. If these parts are moving elements, then they shall be greased.

5.4 Cell Booster

Cell booster shall be suitable for charging one to six cells within the time duration specified at Cl.5.2.1.1. It shall be suitable for charging not only new cells before being introduced to the battery bank but also for any treatment to be given to individual weak cells. Cell booster shall be suitable for 240 V $\pm$ 10%, 50 Hz $\pm$ 3% SPN input power supply. Cell booster output voltage shall be in the range of 0-18V and 0-12V for Lead Acid and Nickel Cadmium batteries respectively. Cell booster shall be sized as under:

For Lead Acid battery	=	0.14 x Ah(C_{10}) of cell
For VRLA battery	=	0.2 x Ah(C_{10}) of cell
For NiCd battery	=	0.2 x Ah(C_5) of cell.

Cell booster shall have a heavy duty switch fuse or MCCB on both AC incomer and DC output sides, along with AC voltmeter, DC ammeter, DC voltmeter and indicating lamps for AC/ DC power ON. The output voltage and current of cell booster shall be manually controlled using a suitably rated variac or a full wave controlled rectifier bridge. Suitable interlock shall be provided so as to ensure that the variac/ controlled rectifier is at its minimum position while switching on the cell booster. Cell booster shall be portable type with wheels. Each cell booster shall be supplied with 5 m long flexible copper conductor, PVC insulated braided cables for both AC incoming power supply and DC output connection to the battery. An industrial type 3 pin 15A plug shall be provided on AC incoming cable end and lugs shall be provided on DC outgoing cable end.

5.5 Reliability

All necessary care shall be taken in selection, design, manufacture, testing and commissioning of the equipment for ensuring high system reliability. The following design considerations shall be taken into account to ensure maximum availability of the system:

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5.5.1 There shall be no common device between the two units, the failure of which could cause shutdown of more than one charger.

5.5.2 It shall be possible to attend to any individual power circuit for maintenance without affecting the total DC supply.

5.5.3 Series-parallel combination of smaller devices to achieve specified rating shall not be acceptable.

6.0 INSPECTION, TESTING AND ACCEPTANCE

6.1 During fabrication, the equipment shall be subjected to inspection by EIL / Owner or by an agency authorised by the Owner. Manufacturer shall furnish all necessary information concerning the supply to EIL's/ Owner's inspector. Tests shall be carried out at manufacturer's works under his care and expense.

6.2 For testing requirement, Inspection & test plan for battery chargers (Standard no. 6-81-1019) shall be followed.

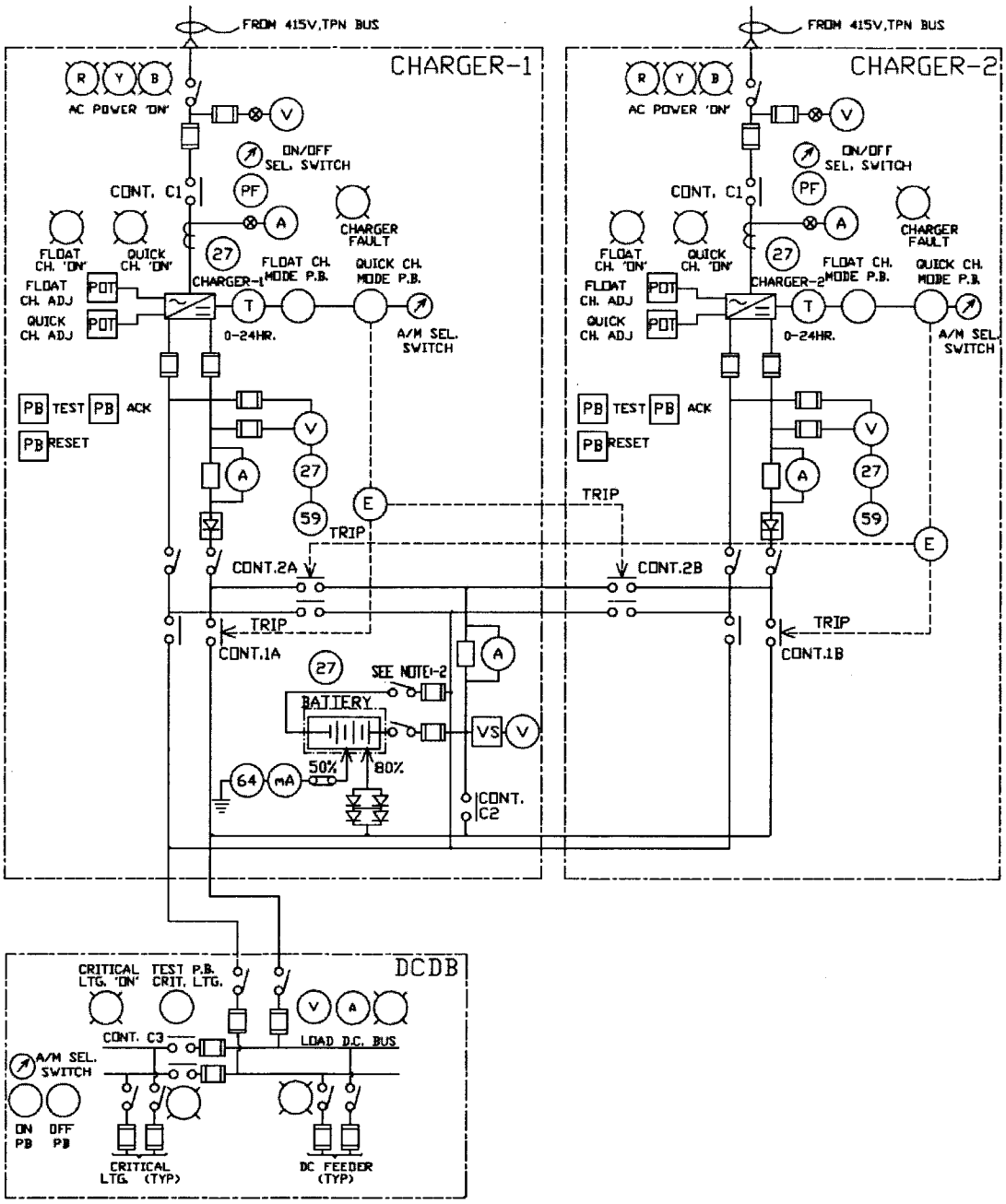
7.0 PACKING & DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by ship/ rail or trailer. It shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. The crates/ cases shall have skid bottoms for handling. Special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight', 'Owner's particulars', 'PO Nos.' Etc., shall be clearly and indelibly marked on the packages together with other details as per purchase order.

The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage in areas with heavy rains and high ambient temperature. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance manuals and a set of final drawing shall be supplied along with the shipment duly enclosed in a waterproof cover.

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OPTION–I

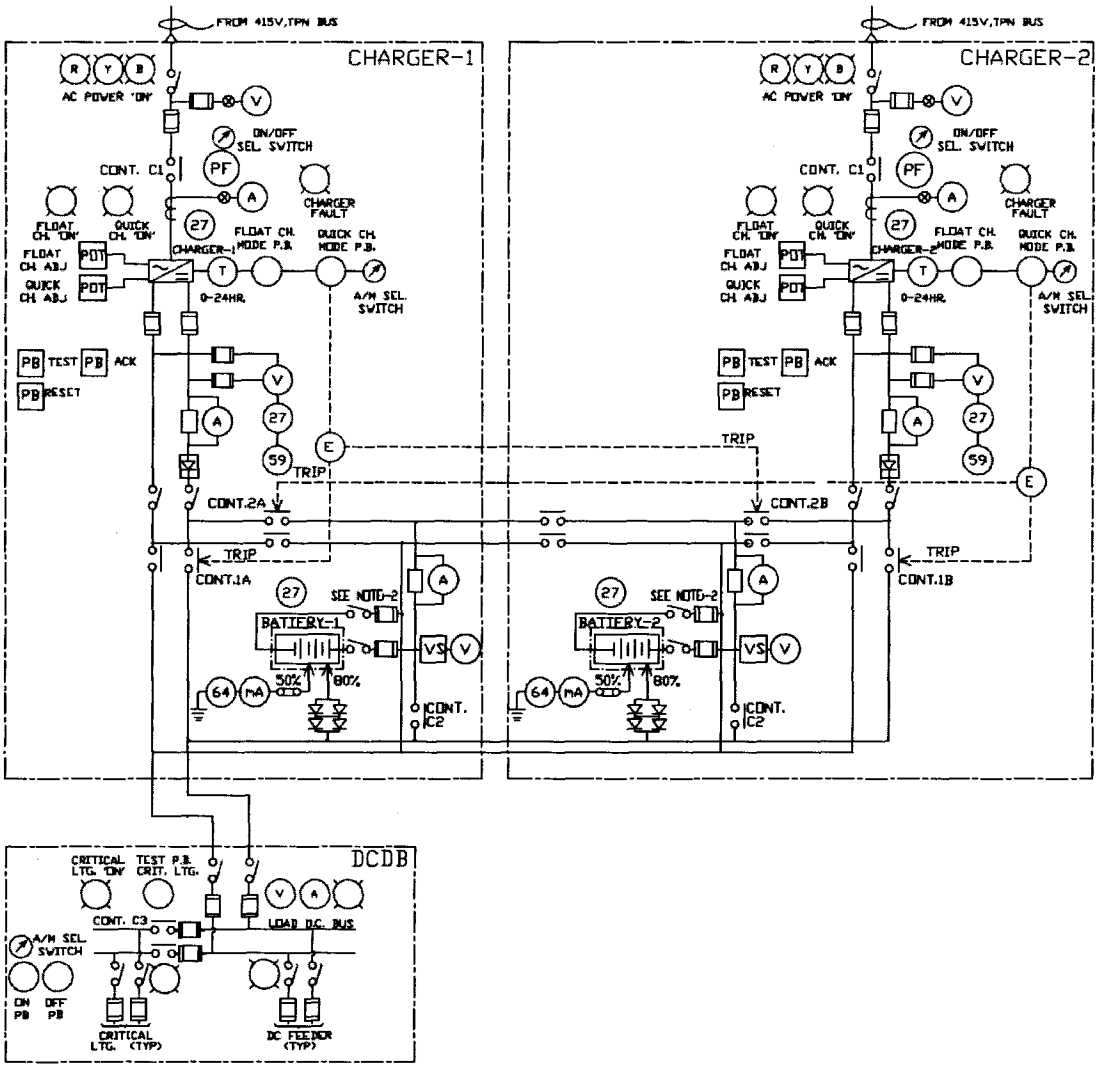


NOTES: –

1. a) THE DC CONTACTORS SHALL HAVE A TESTED/ PUBLISHED DC RATING EQUAL TO OR EXCEEDING THE MOST STRINGENT CURRENT CARRYING AND BREAKING REQUIREMENTS CONSIDERING ADEQUATE DESIGN MARGINS.
   b) PUSH BUTTONS ARE NOT ACCEPTABLE IN PLACE OF SELECTOR SWITCHES FOR THE ON/OFF SWITCHING OPERATIONS OF THE CONTACTORS.
   c) THE DC CONTACTORS SHALL BE OPERATED WITH A DC CONTROL SUPPLY.
2. SUITABLY RATED DC MCCB CAN BE ACCEPTED IN PLACE OF SWITCH FUSE UNIT AT BATTERY OUTPUT.

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OPTION–II



1. a) THE DC CONTACTORS SHALL HAVE A TESTED/ PUBLISHED DC RATING EQUAL TO OR EXCEEDING THE MOST STRINGENT CURRENT CARRYING AND BREAKING REQUIREMENTS CONSIDERING ADEQUATE DESIGN MARGINS.
   b) PUSH BUTTONS ARE NOT ACCEPTABLE IN PLACE OF SELECTOR SWITCHES FOR THE ON/OFF SWITCHING OPERATIONS OF THE CONTACTORS.
   c) THE DC CONTACTORS SHALL BE OPERATED WITH A DC CONTROL SUPPLY.
2. SUITABLY RATED DC MCCB CAN BE ACCEPTED IN PLACE OF SWITCH FUSE UNIT AT BATTERY OUTPUT.
3. BATTERY CONFIGURATION SHALL BE 2X50% AH CAPACITY UNLESS SPECIFIED OTHERWISE IN DATASHEET/ JOB SPECIFICATION.

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एम.वी. वैरीएबल फ्रीक्वेन्सी ड्राईव सिस्टम के लिए विनिर्देश

SPECIFICATION FOR MV VARIABLE FREQUENCY DRIVE SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	20.08.14	REVISED AND ISSUED AS STANDARD SPECIFICATION	MK/SA	HK	BRB	SC
1	24.04.09	REVISED AND ISSUED AS STANDARD SPECIFICATION	AM	SG	JMS	ND
0	24.09.02	ISSUED AS STANDARD SPECIFICATION	RM	AAN	VPS	GRR

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Abbreviations:

AC	:	Alternating Current
BIS	:	Bureau of Indian Standards
BS	:	British Standard
CBCT	:	Core Balance Current Transformer
CEA	:	Central Electricity Authority
CFL	:	Compact Fluorescent Lamp
CRCA	:	Cold Rolled Cold Annealed
DC	:	Direct Current
DCS	:	Distributed Control System
DOL	:	Direct On Line
ELR	:	Earth Leakage Relay
EM	:	Electromagnetic
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IGBT	:	Insulated Gate Bipolar Transistor
IO	:	Input/Output
IP	:	Ingress Protection
IS	:	Indian Standard
LED	:	Light Emitting Diode
MCB	:	Miniature Circuit Breaker
MCCB	:	Moulded Case Circuit Breaker
MTBF	:	Mean Time Between Failure
NEMA	:	National Electrical Manufacturer's Association
PCC	:	Point of Common Coupling
PLC	:	Programmable Logic Controller
PO	:	Purchase Order
PVC	:	Poly Vinyl Chloride
r.m.s	:	Root Mean Square
THD	:	Total Harmonic Distortion
VDE	:	Verband Deutscher Electrotechniker
VFD	:	Variable Frequency Drive

Electrical Standards Committee

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1.0 SCOPE

The scope of this specification is to define the minimum technical requirements for the design, manufacture, testing and supply of Medium Voltage, AC Variable Frequency Drive (VFD) System. The VFD system shall be complete with Squirrel Cage Induction motor as specified in data sheet, Converter, Converter input transformer(if required), DC link/AC line reactor with associated auxiliaries, filters(if required) and field mounted local motor control panel. Separate dedicated panel(s) shall be provided for each VFD system.

The Vendor shall be responsible for engineering and functioning of the complete system, meeting the intent and requirement of this specification and data sheets.

This specification applies to drives connected to line voltage up to 1000 V, AC.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the latest editions of the following standards unless specified otherwise:

IS:325	Three-phase Induction Motors
IS:3700	Essential Ratings and Characteristics of Semiconductor Devices
IS:3715	Letter symbols for semi-conducting devices
IS:4411	Code of designation of semi-conducting devices
IS:5001	Guide for preparation of drawings of semiconductor devices and Integrated Circuits
IS:5469	Code of practice for the use of semiconductor Junction Devices
IS:8789	Values of Performance characteristics for Three Phase induction motor
IS: 12615	Energy Efficient Induction Motors- Three Phase Squirrel Cage
IS:14901	Semi-conductor devices- Discrete devices & Integrated Circuits
IS:15880	Three Phase Cage Induction motors when fed from IGBT Converters- Application Guide
IS/IEC:60947	Low Voltage Switchgear and Controlgear
IEC:60146-1-3	Semiconductor Convertors general requirements and line commutated convertors-Transformer & reactors
IEC:61800	Adjustable speed electrical power drive systems
IEEE:519	Recommended Practices and requirements for Harmonics Control in Electrical Power Systems

2.2 In case of imported equipment, the standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

2.3 The equipment shall also conform to the provisions of CEA Regulations and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

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2.5 In case of any conflict between requirements specified in various applicable documents, the most stringent one shall prevail. However, owner's decision in this regard shall be final and binding.

3.0 SITE CONDITIONS

3.1 The AC drive system shall be designed to operate under specified site conditions as specified in the data sheets. If not specifically mentioned therein, a design ambient temperature of 40^{O}C and an altitude not exceeding 1000 metres above mean sea level shall be considered.

3.2 The AC drive shall be installed indoors in a non-hazardous, air-conditioned or pressurised room, as specified in data sheet.

3.3 All the equipment shall be designed for continuous duty as per nameplate rating under the specified ambient conditions.

4.0 GENERAL REQUIREMENTS

4.1 The offered equipment shall be brand new with state of the art technology and a proven field track record. No prototype equipment shall be offered.

4.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

4.3 Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/ spares to enable the end user to place order for spares and services.

4.4 The vendor shall be responsible for design, engineering and manufacturing of the complete VFD system to fully meet the intent and requirements of this specification and attached data sheets.

5.0 TECHNICAL REQUIREMENTS

5.1 Performance Requirement

5.1.1 The system shall be energy efficient, and shall provide very high reliability, high power factor, low harmonic distortion and low vibration / wear / noise. It shall be easy to install in minimum time and expense and no special tools shall be required for routine maintenance.

5.1.2 The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the load, with input supply variation of ±10% and frequency variation of ±3%. The system shall be suitable for the load characteristics and the operational duty of the driven equipment. It shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short-circuit.

5.1.3 The drive system shall be designed to operate in one or more of the following operating modes as specified in the data sheet:

a) Variable torque changing as a function of speed i.e. Speed squared
b) Constant torque over a specific speed range
c) Constant power over a specific speed range where the torque decreases when speed increases
d) Any other as specified in data sheet

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5.1.4 The drive controller shall be equipped with microprocessor based digital regulator with programmable functions. The power control regulator logic shall provide for an acceleration/deceleration current limit curve and shall be capable of field adjustments without shutting the system down. Linear acceleration and deceleration shall be separately programmable from 0.1 to 20 seconds.

5.1.5 The System shall be suitable for single quadrant operation and the speed variation shall be with range 1:100 unless otherwise specified with speed set accuracy of ±1% of rated maximum speed and steady state regulation of ±0.5% of rated speed.

5.1.6 The total harmonic distortion (THD) of the voltage and current at inverter output shall be as per IEC 61800 and same shall be considered in the design of the motor. The dv/dt limits & V_{peak} shall also be as per IEC-61800-2.

5.1.7 Harmonic at the supply side of the drive system at PCC (point of common coupling) shall be restricted within the maximum allowable levels of current and voltage distortion as per recommendations of the latest edition of IEEE-519.

5.1.8 The controller output overload capacity shall be 150% of rated current of motor for one minute for constant torque applications, and 110% of rated current for one minute for variable torque applications at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload. If load demand exceeds the current limit for more than 1 minute, the drive shall shut down to prevent over heating of the motor and damage to the drive.

5.1.9 During operation, the system shall be capable of developing sufficient torque under all load conditions to respond to a 20% alteration in set point within a time limit up to 60 seconds.

5.1.10 The integrator action of the set point alteration shall be independently adjustable for both an upward and a downward alteration. The minimum time interval between set point adjustment by the distributed control system shall be considered as 10 seconds.

5.1.11 Drive shall trip in case the speed exceeds 105% of the maximum operational speed and / or reduces to 95% of the minimum operational speed for more than 10 seconds.

5.1.12 Maximum noise level from the drive at 1 meter distance, under rated load with all normal cooling fans operating shall not exceed 75 dB(A).

5.1.13 Variable frequency drive shall be arranged so that it can be operated in an open circuit mode, disconnected from the motor for start-up adjustments and troubleshooting.

5.2 Control Requirement

5.2.1 The system shall operate on constant V/f supply with required voltage boost capability in low frequency mode of operation.

5.2.2 Short time voltage dips upto 20% of nominal (e.g. in case of a large motor start up connected to the same bus as VFD), shall not cause the control system to stop functioning and shall not trip the drive system.

5.2.3 The system shall also be equipped with a momentary powerloss ride through feature which will restart the system in case of voltage dip over 20% or power interruptions for less than 2 seconds, with recovery of the voltage to its nominal value. The drive shall have the facility to block this feature, if required by the operator. Upon restart, the converter shall be capable of re-synchronizing onto running motor and develop full acceleration torque within 10 seconds.

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5.2.4 The system shall be suitable for number of starts as per attached standard specification for Medium Voltage Induction Motors.

5.2.5 The power controller shall be regulated to always start the motor in the forward direction. Logic shall be provided to prevent the motor from being started in the reverse direction.

5.2.6 The drive motor shall be speed regulated corresponding to 4-20 mA or 0-10 V reference input signal. Upon complete loss of the user's speed reference signal, the drive shall automatically run at constant speed as determined by the last speed reference available prior to the loss of signal.

5.2.7 It shall be possible to vary the speed of the drive in either manual or auto mode. Auto/Manual selection shall be from VFD panel unless otherwise specified.

a) With the selector switch in "manual" mode, the operator shall be able to set the speed through key pad (mounted on front of the drive panel) or from speed increase/decrease push buttons (from the field). Motor operated potentiometer shall be provided as a speed set point device.

b) With the selector switch in "auto" mode, speed of the motor shall be controlled from a 4-20 mA signal, from owner's PLC/DCS (Process Control) system. Necessary equipment required for interfacing with PLC/DCS shall also be provided in the VFD panel.

c) Local/Remote selector switch shall be provided in local control station (in Field). With the selector switch in "Local" mode, the operator shall be able to start and set the speed through local control station (in Field). With the selector switch in "Remote" mode, speed of the motor shall be controlled either from VFD panel or from Owner's PLC/DCS as explained in a) and b) above. (For local control station, also refer Cl. 5.5.7 below).

5.2.8 The required provision for the interface with PLC/DCS (located at remote control room) including the details of communication module and data transfer facility, I/O details shall be furnished. The communication interface shall be via serial communication link with industry standard open protocol i.e. MODBUS/Data Highway Plus/IEC-61850/ RS-485 etc. and same shall be coordinated with the interfacing equipment. In case the vendor is using their proprietary software, the interface software for use with owner's system (software) shall be provided.

5.3 Panel Construction

5.3.1 The panel shall include suitable isolating device (i.e. Circuit breaker/MCCB/ Switch fuse) for main supply, contactors, semi conducting power devices (Diodes / IGBT) modules with protective devices, reactors, filters, output isolating device, control circuit, control accessories, indication and annunciation etc.

5.3.2 Main isolating device shall function as a manual disconnect and shall be an AC thermal-magnetic circuit breaker or a fused switch with dual element fuse to trip automatically on fault currents, as specified in data sheet. Devices shall be lockable in the open position and shall have a minimum interrupting capacity as specified in data sheet. Interlock shall be provided between the door, so that door cannot be opened unless the breaker/switch is open.

5.3.3 The drive shall be suitably housed in sheet steel panels and shall be fabricated using cold rolled sheet steel. The sheet steel used for the panel shall be of minimum 2 mm CRCA except the doors & covers that may be made of 1.6mm CRCA. The panel shall be suitable for indoor installation, if not otherwise specified. The panel shall be free standing with degree of

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protection as min. IP-41. The maximum and minimum operating height shall be 1900 mm and 300 mm respectively.

5.3.4 Bolted undrilled gland plate shall be provided at bottom with single compression type cable gland. Clamp type terminals shall be used for connection of all wires up to 10 mm^2 and terminal for higher sizes shall be bolted type suitable for cable lugs. Minimum space for power cable termination shall be 300mm clear.

5.3.5 Bus bars shall be of electrolytic copper/aluminium, colour coded. All the live parts shall be sleeved / shrouded to ensure complete safety to personnel intending to carry out routine inspection by opening the panel doors. All the equipment inside the panel and on the doors shall be provided with suitable nameplate. All wires shall be ferruled and terminals shall be properly numbered, minimum 20% spare terminals shall be provided.

5.3.6 All the power and control switches shall preferably be mounted on the door and shall be operable externally. All the analogue instruments, wherever provided, shall be switch board type, back connected, 96x96mm size. Scale shall have red mark indicating maximum permissible operating rating.

5.3.7 Each panel shall be provided with illuminating lamp/11 W CFL with switch and fuse. 5/15A, 240V power socket with switch and fuse shall be provided. Each panel shall have space heater with switch fuse and variable setting thermostat.

5.3.8 Copper earth bus of min. 30X6 mm size shall be provided at the bottom of the panel extending outside the panel on both sides. All the non-metallic components/parts shall be connected to the main earth bus bar. In case a separate earth bus for electronic control system is required, the same shall be indicated in the drawings.

5.3.9 All panels shall be of same height so as to form a uniform line-up, to give good aesthetic appearance.

5.3.10 All the control wiring shall be enclosed in plastic channel. Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC ferrules. Power and control wiring inside the panel shall be done with BIS approved, PVC insulated, flame retardant, low smoke, copper conductor wire. 1.5 mm^2 size wire shall normally be used provided the control fuse rating is 10 Amps or less and 2.5 mm^2 size for control fuse rating above 16 A for electrical circuits and 0.5 mm^2 for electronic circuits.

5.3.11 All electronic modules and components shall be accessible from front of panel only. Modular plug-in/draw-out assemblies for both the system control electronic equipment and power electronic equipments shall be used.

5.3.12 Suitable removable type hooks shall be provided for lifting the panel.

5.4 Cooling

Cooling system shall include well-dimensioned panel, adequate cooling airflow path, module cooling fan and if necessary, panel cooling fan. Vendor shall ensure that the panel dimensions and flow paths have been designed for continuous running at the specified ambient without overheating. For fan cooled drives, redundant ventilating fans (N+1) shall be provided. Necessary starters shall be provided within the VFD panels for these fans. In case redundant cooling fan is not possible to be mounted, same shall be supplied loose.

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5.5 Equipment/ Component Specification

5.5.1 Motor

The motor shall be designed, constructed and tested in accordance with the attached standard specification for Medium Voltage Induction Motor, in addition to the following requirements:

a) The motor shall be inverter grade motor suitable for operation with a solid state power supply consisting of an adjustable frequency inverter for speed control.

b) The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.

c) The motor shall be designed to operate continuously at any speed over the range (1-100%) of rated speed or as specified in data sheet.

d) Motor shall be provided with thermistor type temperature detector.

e) The motors shall be provided with Class 'F' insulation with temperature rise limited to Class 'B'.

f) The permitted voltage variation should take into account the steady state voltage drop across the AC drive.

g) Motors required to be transferred to DOL by-pass mode shall be rated for specified variations in line voltage, frequency and starting current limitations as specified in data sheet.

h) The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid state power supply.

i) The motor insulation shall be designed to accept the applied voltage wave form, within the V_{peak} and dv/dt limits as per IEC-61800-2.

j) The drive manufacturer shall be solely responsible for proper selection of the motor for the given load application and the output characteristics of the drive.

k) Induced voltage at the shaft end of the motor at no load shall not exceed 250 mV rms for roller and ball bearings and 400 mV for sleeve bearings. The non driving end bearing shall be insulated from the motor frame to avoid circulating current. The insulated bearing end shield or pedestal shall bear a prominent warning.

5.5.2 Converter Transformer

The converter transformer shall be suitable for use with the variable frequency drive system. The impedances of transformers with two secondary windings for 12 pulse systems shall be selected to ensure equal load/current sharing between the two secondary windings, the converters and the motor windings under all operational conditions including starting and restarting. The transformer shall be provided with ± 5% off circuit taps in steps of ± 2.5%.

5.5.3 Power Converter

a) The static power converter shall consist of a line side power converter for operation as a rectifier and a load side power converter for operation as a fully controlled inverter.

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b) Normally, for all output short circuits, the inverter shall interrupt the current before any semi-conductor fuse blows. For internal short circuits, semi-conductor fuse protection shall be provided, and for faults upstream of semi-conductor fuses, the converter shall be able to withstand a three-phase short circuit current until interrupted by normal breaker operation. In case of fuseless design, the failure shall be limited to the particular device, without causing any damage to other parts of the power module. There must be clear annunciation of the failure of the device.

c) All power converter devices shall include co-ordination by peak voltage protecting snubber networks and di/dt and dv/dt networks.

d) The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full load of the VFD through the whole speed range.

e) All power diodes shall be of silicon type with minimum V_{BO} rating as 2.5 times the rated operating voltage.

f) The power converter circuit shall be designed so that motor can be powered at its full name plate rating continuously without exceeding its rated temperature rise due to harmonic currents generated by the inverter operation.

g) The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions/tools.

h) The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.

i) All the power transistors, thyristors and diodes shall be protected with high-speed semiconductor grade fuse. I^2t particulars of the power controller devices and the fuses shall be properly co-ordinated for the selection of fuses.

5.5.4 DC Link / AC line Reactor

a) Smoothing reactors for the DC link shall be designed to sufficiently decouple the rectifier and inverter portion of the converter and to limit fault currents in this circuit. AC line reactors, if provided as per standard vendor design, shall be suitable for harmonic suppression and fault current limitation.

b) The reactor shall be dry type, air cooled or fan cooled type located within the panel. In case of fan cooled type, operation of fans shall be monitored.

c) Reactor shall be suitable for operation with the non-sinusoidal current wave shapes and DC components under all operational conditions of the system without exceeding its temperature limits.

5.5.5 Output filter

VFD output current waveform shall be inherently sinusoidal at all speeds, with harmonic limits as per Cl.5.1.6. Output filter capacitors shall be provided with discharge circuits to ensure that all residual stored charge is reduced to less than 50 V DC within 60 seconds after a loss of AC voltage.

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The VFD system shall inherently protect motor from high voltage dv/dt stress, independent of cable length to motor. Output filter shall be an integral part of the VFD system and included within the VFD enclosure.

5.5.6 **Bypass Feature**

5.5.6.1 Output contactor/Load Break Switch shall be provided for isolation between the output of the controller and the motor for VFD systems with Bypass feature.

5.5.6.2 Bypass feature shall be provided, if specified in the data sheet. Accordingly Bypass feature with Bypass starter shall meet the following requirements, unless otherwise specified in the data sheet:-

- Bypass starter shall comprise of switch-fuse, contactor, bimetal relay meeting the requirements of Type-2 coordination as per IS/IEC-60947. CBCT and ELR shall be provided for motors rated above 22kW & upto 55kW unless otherwise specified in the data sheet. Heavy duty starters shall be provided with saturable type current transformer operated overload relay only, which shall be suitable for motor starting time of 15-60 seconds. For motors rated above 55kW, ACB/MCCB and motor protection relay along with necessary metering shall be provided.

- Bypass starter shall be in separate compartment and it shall be possible to isolate and maintain the VFD while drive motor runs in Bypass mode. Three contactors/ breakers shall be used for this purpose, one contactor in the bypass and two contactors across the drive, such that in case of drive mal-operation, the motor could be taken on bypass control, while the drive could be attended by opening its contactors. Suitable interlock shall be provided such that bypass mode and VFD mode shall not operate simultaneously.

5.5.7 **Local Control Station**

The local control station shall conform to the attached standard specification(s).

Meters in the local control station for motors rated above 5.5kW shall be suitable for 4-20mA transducer outputs and shall be calibrated for the actual motor current unless specified otherwise. Further, for drives with bypass facility, the meters shall be capable of reading bypass full load and starting currents, as well as the drive current. Local-off-Remote selector switch shall be provided in the LCS for selection of control from Local (i.e. LCS in Field) and Remote (i.e. from VFD panel / DCS / PLC).

5.6 Protection, Control, Metering and Indication / Annunciation

5.6.1 The manufacturer shall provide all the necessary system control, protection, alarm equipment and metering for the entire drive system and its auxiliary equipment.

5.6.2 Automatic sequence control shall include start-up of cooling system, interlock checking, automatic start and run-up of drive, planned and emergency shutdown. The same shall be processed through microprocessor based system.

5.6.3 **Operator Control Panel**

Each drive shall be equipped with a front mounted operator control panel consisting of a backlit alphanumeric display and a keypad with keys for Run/Stop, Local/Remote, Increase/Decrease, menu navigation and parameter select/save. All parameter names, fault messages, warnings and other information shall be displayed in Complete English words or standard English abbreviations to allow the user to understand what is being displayed without the use of a manual or cross-reference table. This shall also be used for the modification of all

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5.6.4 **Protective Features**

The system offered shall incorporate adequate protective features, properly coordinated for the drive control and for motor but not limited to the following:

i) Incoming line surge protection
ii) Under / Over voltage protection
iii) Phase loss, phase reversal protection
iv) Programmable Over current protection
v) Inverter Fault protection
vi) Over frequency /Over speed protection of motor
vii) Ventilation loss (In case same is not provided, drive shall generate an over temperature fault alarm. Suitable sensors as required for same shall be provided)
viii) Over temperature protection of equipment
ix) Complete motor protection
x) System Earth fault Protection

5.6.5 **Alarms**

The system shall incorporate protection alarms, required for various fault conditions, for the Drive motor, Supply cables, Converter Transformer, DC Reactor and the Converter. Alarms shall also be included for the failure of various auxiliaries together with identification of the failing unit, loss of cooling system, various protection devices provided for converter transformer etc.

5.6.6 **Controls**

The following controls shall be provided as a part of the Operator Control Panel or through separate switches.

i) Start/Stop
ii) Speed control (Raise/lower)
iii) Forward/Reverse
iv) Auto/Manual mode
v) Emergency stop
vi) Start/stop for by pass starter
vii) Trip-Remote upstream feeder

5.6.7 **Indications**

The following indications shall be provided as a part of the Operator Control panel.

i) Motor running
ii) Motor stopped
iii) VFD System Fault
iv) System ready to start
v) AC mains ON
vi) Motor over speed
vii) Drive 'ON'
viii) Motor zero speed
ix) Remote breaker trip

Potential free contacts of items i) - iv) shall be wired separately for indications in DCS system.

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5.6.8 **Metering**

Digital display of the following parameters shall be as a part of the Operator Control Panel, selectable by the operator.

i) Input AC voltage
ii) Input AC frequency
iii) Input AC Current
iv) Output voltage
v) Output current VFD / Bypass
vi) Output frequency
vii) Drive thermal state
viii) Motor speed
ix) Motor energy meter
x) Run hour meter

Necessary transducer shall be provided with 4-20mA output for indicating motor speed and motor current in DCS.

5.6.9 **Annunciations**

Potential free contacts shall be provided for following annunciations and shall be wired up to terminal block for owner's use for remote monitoring:

i) Rectifier fuse failure/Drive fault
ii) Main AC failure
iii) Inverter fuse failure/Drive fault
iv) Inverter overload
v) Inverter high temperature/Drive fault
vi) Failure of panel cooling system
vii) Motor failed to start/Drive fault

All drive internal faults will be annunciated as drive fault.

5.7 Fault Diagnostic

Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available for a period of minimum 4 days (96 hours) after a shut down even though no supply would be available to the system. The system may be totally de-energized for maintenance or otherwise. It shall be possible to retrieve the record of events prior to tripping of the system or de-energisation. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care by the manufacturer for this purpose.

5.8 External Control Circuit

Control supply for devices external to VFD module i.e contactors control, space heater supply for Motor / VFD, indicating lamps digital meters (Ammeter, Speedometer) etc. shall operate on 240 V control supply derived from single-phase control supply transformer, with switch-fuse provided in primary and MCB in secondary, located inside the drive controller.

5.9 Reliability Features

i) The expected life time of the VFD shall be minimum 20 years. The VFD including all individual components forming part of the system shall have an availability of minimum 0.997 and a minimum MTBF of 4 years.

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ii) The controller design shall incorporate the following reliability features:

- Pre-tested components with power components to be 100% tested under dynamic conditions.
- Printed circuit boards shall be computer tested and adjusted.
- Printed circuit boards shall be temperature cycled for a minimum of 40 hours.
- Printed circuit boards shall be treated for tropical, humid and corrosive environment.

5.10 Maintenance Features

The controller design shall incorporate the following maintenance features:

- Modular construction
- Printed circuit boards shall be plug connected.
- All components shall be easily accessible from the front of the enclosure.
- Standard diagnostics to aid maintenance personnel. These shall include LED or alphanumeric displays, test or measurement points.

5.11 Painting

5.11.1 All metal surfaces shall be thoroughly cleaned and de-greased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under-surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The under-surface shall be made free from all imperfections before undertaking the finishing coat.

5.11.2 After preparation of the under surface, the panel shall be provided with epoxy based powder coating. The color shade of the final paint shall be RAL-7032, unless otherwise specified. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint, etc.

5.11.3 All unpainted steel parts shall be zinc passivated, cadmium plated or suitably treated to prevent rust and corrosion. If these parts are moving elements, then these shall be greased.

6.0 INSPECTION, TESTING AND ACCEPTANCE

6.1 During fabrication, the VFD shall be subject to inspection by EIL / Owner, or by an agency authorized by the Owner, to assess the progress of work, as well as to ascertain that only quality raw material is used. The manufacturer shall furnish all necessary information concerning the supply to EIL / Owner's inspectors.

6.2 All tests shall be carried out at the manufacturer's works under his care and expense. The tests shall be witnessed by an inspector of EIL/ Owner or of an agency authorized by the owner. Prior notice of minimum 4 weeks shall be given to the inspector for witnessing the tests.

6.3 All Routine & Type Tests shall be conducted as per the ITP for MV variable frequency drive 6-81-1038 on the complete VFD system (as defined in Cl.1.0 above) as per IEC 61800-2.

6.4. String Test with Driven Equipment

If a string test with driven equipment is required, this will be mentioned in the data sheet of the driven equipment.

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7.0 PACKING AND DESPATCH

All the equipment shall be divided into several shipping sections for protection and ease of handling during transportation. The equipment shall be properly packed for selected mode of transportation i.e. ship/rail or trailer. The panels shall be wrapped in polyethylene sheets before being placed in wooden crates/cases to prevent damage to the finish. Crates/cases shall have skid bottoms for handling. Special notations such as 'Fragile', 'This side up', 'Weight', 'Owner's particulars', 'PO nos.' etc., shall be clearly marked on the package together with other details as per purchaser for scrutiny.

The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage, in areas with heavy rains/high ambient temperature.

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स्टेशनरी निकल केडमियम बैटरीज के लिए विनिर्देश

SPECIFICATION FOR STATIONARY NICKEL CADMIUM BATTERIES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
3	14.07.2016	REVISED AND ISSUED AS STANDARD SPECIFICATION	PB/MHR	RS	BRB	RN
2	11.04.2011	REVISED AND ISSUED AS STANDARD SPECIFICATION	CS	PG	UAP	DM
1	27.08.2007	REVISED AND ISSUED AS STANDARD SPECIFICATION	AP	NS	JMS	VC
0	28.03.2002	ISSUED AS STANDARD SPECIFICATION	SSM	AAN	VPS	

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Abbreviations:

AC	Alternating current
Ah	Amperehour
BIS	Bureau of Indian Standards
BS	British Standard
CEA	Central Electricity Authority
DC	Direct current
EIL	Engineers India Limited
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical & Electronics Engineers
IS	Indian Standard
MSL	Mean Sea Level
NEMA	National Electrical Manufacturers Association
PO	Purchase Order
PVC	Polyvinyl Chloride
UPS	Uninterrupted Power Supply
VDE	Verband der Elektrotechnik,Elektronik und Information stechnik
V	Volt

Electrical Standards Committee

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Mr. Parag Gupta
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Mr. Saeed Akhtar (Inspection)
Ms. N.P. Guha (Projects)

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8.0 PACKING AND DESPATCH 6

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1.0 SCOPE

This specification covers the design, Manufacture, testing and supply requirements of stationary vented type Nickel Cadmium cell/batteries for DC power system /AC UPS system application.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of the latest revision of the following standards issued by BIS:

IS-10918 Specification for Vented type Nickel Cadmium batteries

2.2 In case of imported equipment, standards of the country of origin shall be applicable if these standards are equivalent or more stringent than the applicable Indian standards.

2.3 The equipment shall also conform to the provisions of CEA regulations with latest amendments and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

2.5 In case of any conflict between various referred standards/ specifications/ datasheets and statutory regulations, the most stringent requirement shall prevail and Owner's/ EIL's decision in this regard shall be final and binding.

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of the art technology and proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

3.3 Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/ spares to enable the end user to place order for spares and services.

4.0 SITE CONDITIONS

Stationary Nickel Cadmium cell/battery shall be suitable for operating satisfactorily in humid and corrosive atmosphere found in refineries, petrochemical and gas processing plants, metallurgical plants and other industrial plants. Service conditions shall be as specified in the data sheets/job specification. If not specifically mentioned therein, a design ambient temperature of 40°C and an altitude not exceeding 1000m above MSL shall be considered, with a minimum temperature of 10°C for battery sizing.

5.0 TECHNICAL REQUIREMENTS

5.1 The Nickel Cadmium cell/battery shall be suitable for float duty operation with a constant voltage permanently applied to its terminals which is sufficient to maintain it in a state close to full charge and shall be designed to supply load in the event of normal power supply failure. Type of plate construction for batteries shall be as per the data sheet.

5.2 The standard rated ampere hour capacity of the cell/ battery shall be at a reference temperature of 27°C, constant current discharge at 5 hours rate (C5) and an end cell voltage of 1.0 V/cell.

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5.3 Ampere hour of the battery shall be selected based on the following criteria:

a. Minimum site ambient temperature of 10°C
b. Discharge duty cycle
c. End cell voltage
d. Ageing factor of 0.8
e. Capacity rating factor

5.4 Number of cells and end cell voltage shall be decided by the vendor on the basis of maximum permissible voltage to the load when batteries are float charged while feeding the load and minimum DC system voltage. However, the minimum number of cells and end cell voltage shall be as per the data sheet.

5.5 The battery shall be suitable for being quick charged to fully charged condition from fully discharged condition within 10 hours.

5.6 Battery assembly shall be supplied empty, dry and uncharged. Packed unused liquid electrolyte with 10% extra shall be delivered with the battery in suitable non returnable sealed containers.

5.7 Each cell/battery shall have a separate container of 1.2V (nominal voltage). The cell container shall be of high strength alkali resistant material and designed to withstand mechanical stresses, shocks and vibrations. The cell container shall be translucent/transparent.

5.8 The terminal posts shall be of nickel plated steel. The terminals shall be suitable for short circuit current and specified discharge current without damage to the cell as a result of terminal heating.

5.9 Stationary Nickel Cadmium cells/battery shall be designed to withstand the mechanical stresses encountered during normal transportation and handling.

5.10 Flame arrestor shall be mounted on the cell so that all the vented gases diffuse through the arrestor to the outside environment. The construction of the arrestor shall be such that hydrogen burning on the external surface of the arrestor shall not propagate back into the cell to cause explosion.

5.11 The following information shall be permanently marked on the cell.

- Nominal voltage
- Name of manufacturer/model reference
- Rated capacity in ampere hours (Ah) with End Cell Voltage
- Voltage for float operation at 27°C with tolerance of ±1%
- Month and year of manufacture
- Polarity Marking

5.12 Each set of battery shall be supplied with all the accessories, including, but not limited to the following:

a. Battery stand in formation as per data sheet. Mild steel stand pretreated and epoxy painted epoxy powder coated / PVC coated.
b. Inter cell, inter row and inter bank connectors and end take offs. These shall be of nickel plated copper/flexible insulated copper cable/completely insulated solid copper connectors.
c. Cell insulator as applicable.
d. Stand insulator.
e. Cell number plates/permanent stickers, Lugs for cable termination, as required.
f. Other accessories and their quantity as per data sheet.

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6.0 PERFORMANCE

Nickel Cadmium batteries shall have been type tested to meet the performance requirements for each design and Ah rating of cells as per Indian Standard referred in clause 2.1 above.

7.0 INSPECTION, TESTING AND ACCEPTANCE

Batteries shall be subject to inspection by EIL/owner or by an agency authorized by the owner, to assess the progress of work. The manufacturer shall furnish all the necessary information concerning the supply to EIL/owner's representative. EIL/owner's representative shall be given free access in the works from time to time for stage wise inspection and progress reporting. Four weeks advance notice shall be given to witness the final routine tests and other tests as agreed upon.

The routine, acceptance & type testing shall be carried out as per Inspection & test plan for stationary nickel - cadmium battery (Standard no. 6-81-1047). Routine tests shall be conducted on each cell/battery. Acceptance tests & Type tests shall be conducted on few cells/battery as per relevant Indian standard.

Battery load test shall also be performed at site after installation as part of commissioning.

8.0 PACKING AND DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by ship/rail or trailer. The equipment shall be wrapped in polythene sheets before being placed in crates/cases to prevent damage to finish. Crates/cases shall have skid bottom for handling. Special notations such as `Fragile', `This side up', `Centre of gravity', `Weight', 'Owner's particulars', 'PO nos.' etc., shall be clearly marked on the package together with other details as per purchase order.

The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage in areas with heavy rains/high ambient temperature. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance manuals and a set of final drawing shall be enclosed in a waterproof cover along with the shipment.

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ऊर्जा दक्ष मध्यम वोल्टेज इंडक्शन मोटरों के लिए विनिर्देश

SPECIFICATION FOR ENERGY EFFICIENT MEDIUM VOLTAGE INDUCTION MOTORS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
1	12.08.14	REVISED & ISSUED AS STANDARD SPECIFICATION	SS/SHIRALI	VKJ	BRB	SC
0	20.04.09	ISSUED AS STANDARD SPECIFICATION	SD	BRB	JMS	ND

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Abbreviations:

AL	:	Aluminium
BASEEFA	:	British Approvals Service for Electrical Equipment in Flammable Atmospheres
BIS	:	Bureau of Indian Standards
BS	:	British Standards
CEA	:	Central Electricity Authority
CIMFR	:	Central Institute of Mines and Fuel Research
CPRI	:	Central power research institute
CT	:	Current Transformer
CU	:	Copper
DGMS	:	Directorate General of Mines Safety
DOL	:	Direct On Line
EIL	:	Engineers India Limited
ERTL	:	Electronics Regional test laboratory
FM	:	Factory Mutual
FRP	:	Fiber Reinforced Plastic
IEC	:	International Electro-technical Commission
IEEE	:	Institute of Electrical & Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standard
JEC	:	Japanese Electro-technical Committee
KLPL	:	Karandikar laboratories Pvt. Ltd.
LCIE	:	Laboratoire Central des Industries Electriques
NEMA	:	National Electrical Manufacturers Association
PESO	:	Petroleum and Explosive Safety Organisation
PO	:	Purchase Order
PVC	:	Poly Vinyl Chloride
RPM	:	Revolutions per Minute
UL	:	Underwriter's Laboratories
VFD	:	Variable Frequency Drive
VDE	:	Verband Deutscher Elektrotechniker

Electrical Standards Committee

Convenor: Mr. B.R. Bhogal

Members: Ms. S. Anand
Mr. Parag Gupta
Mr. M.K. Sahu
Mr. A.K. Chaudhary (Inspection)
Ms. N.P. Guha (Project)

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1.0 SCOPE

This specification covers the design, manufacture, testing, packing and supply of energy efficient-High efficiency (IE2) three phase medium voltage squirrel cage induction motors.

2.0 CODES AND STANDARDS

2.1 The squirrel cage induction motors and their components shall comply with the latest editions of following standards issued by BIS (Bureau of Indian Standards) unless otherwise specified:

IS - 5	:	Colours for ready mixed paints and enamels.
IS - 325	:	Three phase induction motors.
IS - 1076	:	Preferred numbers.
IS - 1231	:	Dimensions of three phase foot mounted induction motors.
IS - 1271	:	Electrical insulation- Thermal evaluation and designation.
IS - 2223	:	Dimensions of flange mounted AC Induction motors.
IS - 2253	:	Designation for types of construction and mounting arrangement of rotating electrical machines.
IS - 2254	:	Dimensions of vertical shaft motors for pumps.
IS - 2968	:	Dimensions of slide rails electric motors.
IS - 4029	:	Guide for testing three phase induction motors.
IS - 4889	:	Method of determination of efficiency of rotating electrical machines.
IS - 6362	:	Designation of methods of cooling of rotating electrical machines.
IS - 7816	:	Guide for testing insulation resistance of rotating machines.
IS - 8223	:	Dimensions and output series for rotating electrical machines.
IS - 8789	:	Values of performance characteristics for three phase induction motors.
IS - 9283	:	Motors for submersible pump sets.
IS - 12065	:	Permissible limits of noise level for rotating electrical machines.
IS - 12075	:	Mechanical vibration of rotating Electrical Machines with shaft heights 56 mm and higher - measurement, evaluation and limits of vibration severity.
IS – 12615	:	Energy Efficient induction motors - Three phase squirrel cage.
IS - 12824	:	Type of duty and classes of rating assigned to rotating electrical machines.
IS - 13529	:	Guide on effects of unbalanced voltages on the performance of three phase cage induction motors.
IS - 13555	:	Guide for selection and application of three phase induction motors for different types of driven equipment.
IS - 14568	:	Dimensions and output series for rotating electrical machines, frame numbers 355 to 1000 and flange numbers 1180 to 2360.
IS / IEC60079-0:		Electrical apparatus for explosive gas atmospheres (General requirements)
IS/IEC-60079-1:		Explosive atmospheres-Equipment protection by flame proof enclosures “d”.
IS/IEC60079-2 :		Explosive protection by pressurized enclosure “p”.
IS/IEC60079-7 :		Explosive atmospheres-Equipment protection by increased safety – “e”.
IS/IEC-60079-15:		Construction, test & marking of type of protection “n” electrical apparatus.
IS/ IEC: 60529	:	Degree of protection provided by enclosures (IP Code)
IS/IEC 60034-1 :		Rotating electrical machines:-Rating & Performance
IS/IEC-60034-5:		Degrees of protection provided by the internal design of rotating electrical machines.

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IS/IEC 60034-8: Rotating electrical machines-Terminal marking and direction of rotation
IS/IEC 61241: Electrical apparatus for use in the presence of combustible dust

2.2 In case of imported motors, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian Standards.

2.3 The motors shall also conform to the provisions of CEA regulations and other statutory regulations currently in force in the country.

2.4 In case Indian Standards are not available, standards issued by IEC/ BS/ VDE/ IEEE/ JEC/NEMA or equivalent agency shall be applicable.

2.5 In case of any conflict between requirements specified in various applicable documents, the most stringent one shall prevail. However, owner's decision in this regard shall be final and binding.

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of the art technology and proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment at least for 10 years from the date of supply.

3.3 Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/spares to ensure the end user for placement of order for spares and services.

4.0 OPERATING CONDITIONS

4.1 Ambient Conditions

Motors shall be suitable for operating satisfactorily in humid and corrosive atmosphere found in refineries, petrochemical, fertilizer and metallurgical plants. Service conditions shall be as specified in the motor data sheet. If not specifically mentioned therein, a design ambient temperature of 40 ° C and an altitude not exceeding 1000 meters above mean sea level shall be taken into consideration.

4.2 Frequency and Voltage Variations

Unless otherwise agreed, motors shall be designed for continuous operation at rated output under the following conditions:

a) The terminal voltage differing from its rated value by not more than $\pm$ 6 % or
b) The frequency differing from its rated value by not more the $\pm$ 3 % or
c) Any combination of (a) and (b)

4.3 Starting

a) Motors shall be designed for direct-on-line starting or other method of starting as specified in datasheet.
b) Motors shall be designed for re-acceleration under full load after a momentary loss of voltage with the residual voltage being 100% and is in phase opposition to the applied voltage.
c) Minimum locked rotor thermal withstand time at rated voltage shall be 10 seconds under cold conditions and 8 seconds under hot conditions. In addition, Locked Rotor

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withstand time under hot conditions at 75% & 100% voltages, shall be minimum 1.4 times the starting time at the corresponding voltage.

d) Unless otherwise specified, all motors shall be suitable for starting under specified load conditions with 75 % of the rated voltage at the motor terminals.

e) Motors shall be designed to allow the minimum number of consecutive starts indicated in Table below:

Starts	Min. no. of consecutive starts
No. of consecutive start-ups with initial temp. of the motor at ambient level (cold)	3
No. of consecutive start-ups with initial temp. of the motor at full load operating level (hot).	2

4.4 Direction of Rotation

Motors shall be suitable for either direction of rotation. In case unidirectional fan is provided for motors, direction of rotation for which the motor is designed shall be permanently indicated by means of an arrow. Directional arrow should be manufactured from corrosion resistant material. When a motor is provided with bi-directional fans, a double-headed arrow should be provided.

Normally, clockwise rotation is desired as observed from the driving (coupling) end, when the terminals UVW are connected to a power supply giving a terminal phase sequence in the order UVW. Counter-clockwise rotation of the motor shall be obtained by connecting the power supply to terminals so that the phase sequence corresponds to the reversed alphabetical sequence of the terminal letters. Ample space shall be provided at the terminal box for interchanging any two external leads for obtaining the reverse phase sequence.

5.0 PERFORMANCE

5.1 Motors shall be rated for continuous duty (S_1), unless otherwise specified.

5.2 Unless specified, the starting current (as % rated current) shall be limited to maximum 600-700% (based on number of poles and KW rating) as per IS 12615:2011, subject to IS tolerance

5.3 In particular cases, when the starting current is to be limited, care shall be taken such that the design values of torque meets the load requirement while at the same time complying to clause 4.3 above of this specification. Unless otherwise specified the minimum pull-up torque of motors, at rated voltage & frequency shall be minimum 50% of the rated full load torque.

5.4 In particular cases, when the starting with reduced voltage is specified, care shall be taken such that the design values of torque meets the load requirement while at the same time complying to clause 4.3 above of this specification.

5.5 Starting torque and minimum torque of the motor shall be compatible with the speed torque curve of the driven equipment under specified starting and operating conditions.

In case where characteristics of driven equipment are not available while selecting the motor, minimum starting torque shall be 110% of rated value for motors up to 75 kW and shall be 90% of rated value for motors above 75 kW.

5.6 The breakdown torque at the rated voltage shall be not less than 175% of the rated load torque with no negative tolerance. Unless otherwise agreed, the breakdown torque shall not exceed 300% of the rated load torque.

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In case of motors driving equipment with pulsating loads (e.g. reciprocating compressors, crushers, ball mills) the minimum value of pull out torque at 75% of the rated voltage shall be more than the peak value of pulsating torque and the current pulsation shall be limited to 40%.

5.7 Motors fed by variable frequency drive shall additionally meet the following requirements.

5.7.1 The motors shall be suitable for the current wave forms produced by the power supply including harmonics generated by the drive. The necessary coordination by motor manufacturers with drive manufacturers regarding harmonics generated by VFD shall be taken care and incorporated in motor design suitably.

5.7.2 The motors shall be designed to operate continuously at any speed over the range as per process requirement with minimum range as 10–100% of rated speed or as specified in data sheet. The characteristics shall be based on the application – in terms of constant torque / variable torque as per the driven equipment. Additional cooling fan shall be provided if required to limit the temperature rise to specified limits, alternatively option of applying suitable de-rating may be considered.

5.7.3 The motors shall withstand torque pulsation resulting from harmonics generated by the solid state power supply.

5.7.4 The motors required to be transferred to DOL bypass mode shall be rated for specified variations in line voltage and frequency.

5.8 The minimum values for performance characteristics of these motors shall be as given in the tables 1, 2 & 3 of IS 12615-2011 for IE2 motors, subjected to tolerance as per IS/IEC. Motor meant for application with VFD, the efficiency value can be one class lower as per IS.

6.0 CONSTRUCTIONAL DETAILS

6.1 Windings

6.1.1 Unless otherwise specified, motors shall be provided with class `B' insulation as a minimum. In case of motors with class 'F' insulation, the permissible temperature rise above the specified ambient temperature shall be limited to those specified in the applicable Indian standards for class `B' insulation.

6.1.2 The winding shall be tropicalised. The windings shall preferably be vacuum impregnated. Alternately the windings shall be suitably varnished, baked and treated with epoxy gel for operating satisfactorily in humid and corrosive atmospheres.

6.1.3 Windings shall be adequately braced to prevent any relative movement during operation. In this respect, particular care shall be taken for the stator windings for direct-on-line starting squirrel cage motors. Insulation shall be provided between coils of different phases that lie together. Core laminations must be capable of withstanding burnout for rewind at 350 °C without damage or loosening.

6.1.4 In case of motors driving equipment with pulsating loads, special care shall be taken for the joints of rotor bars and end rings to avoid premature failures due to induced fatigue stresses.

6.1.5 The windings shall be connected in delta. However, for motors rated 2.2 kW and below, star connection may be accepted. In case of motors with star-delta starting, the motor windings shall be fully insulated for delta connection.

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6.1.6 The ends of the windings shall be brought out into a terminal box. These shall be terminated by means of terminals mounted on an insulating base made of non-hygroscopic and non-flammable material.

6.1.7 All motors shall be provided with six terminals and suitable links to connect them in star or in delta except for motors rated up to and including 2.2 kW which may be accepted with three terminals.

6.2 Terminal Box and Cable Entries

6.2.1 Unless otherwise agreed, the terminal box shall be located on the right hand side as viewed from the driving (coupling) end. The terminal box shall have side cable entry from non-driving end. However, as a special case, terminal box located on top may also be accepted, particularly for hazardous area motors, in case manufacturer has only top mounted terminal box design which is duly tested/certified by CIMFR and approved by PESO for installation in hazardous area. The terminal box design shall allow rotation in steps of 90 ° C to facilitate cable entry from any direction at site.

6.2.2 Terminal box cover shall be provided with handles to facilitate easy removal. However, for terminal box covers weighing less than 5 kg., terminal box covers without handles can be accepted.

6.2.3 The terminal box shall be provided entries for suitable cable glands corresponding to the size of the specified cable. Crimp type tinned Copper lugs and nickel-plated brass (or aluminum if specifically required), double compression type cable glands shall be supplied along with the motors for the specified cable sizes for power and space heater cables.

6.2.4 For flameproof motors, terminal box can be provided in increased safety 'Exe' execution.

6.2.5 The terminals, cable lugs, terminal box, cable entries and cable glands shall be suitable for the maximum cables sizes as specified below for 2 pole, 4 pole or 6 pole motors:

Motor rating up to and including	Size of phase conductor (mm^2)
2.2 kW and below	2.5 cu
3.7 kW	6 cu
5.5 kW	10 cu
7.5 kW	16 cu
9.3 kW	16 cu
11.0 kW	16 cu
15.0 kW	50 Al.
18.5 kW	70 Al
22.0 kW	70 Al
30.0 kW	95 Al
37.0 kW	120 Al
45.0 kW	150 Al
55.0 kW	240 Al
75.0 kW	2x95 Al
90.0 kW	2x120 Al
110.0 kW	2x240 Al
125.0 kW/132 kW	2x240 Al
160.0 kW	2x240 Al

6.2.6 Cable sizes for motors having synchronous speeds 750 RPM and below shall be as agreed between the purchaser and manufacturer.

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6.3 Motor Casing and Type of Enclosure

6.3.1 The minimum degree of motor enclosures including terminal boxes and bearing housing shall be IP-55 as per IS.

6.3.2 Motors for outdoor use shall be suitable for installation and satisfactory operation without any protective shelter or canopy. Motor casing shall be provided with a suitable drain for removal of condensed moisture except in case of flameproof motors (Type Ex d/Exde).

6.3.3 All internal and external metallic parts, which may come into contact with cooling air, shall be of corrosion resistant material or appropriately treated to resist the corrosive agents, which may be present in the atmosphere. Screws and bolts shall be of rust proof material or protected against corrosion.

6.3.4 Unless otherwise agreed, motors shall have standard frame sizes (min.) for various output ratings as stipulated in IS.

6.4 Bearing and Lubrication

6.4.1 Motors shall have grease lubricated ball or roller bearings. In all cases, the bearings shall be chosen to provide a minimum L-10 rating life of 5 years, (40, 000 hours) at rated operating conditions
(The L-10 rating life is the number of hours at constant speed that 90% of a group of identical bearings will complete or exceed before the first evidence of failure).

6.4.2 The bearings shall be adequate to absorb axial thrust produced by the motor itself or due to shaft expansion. Motors designed to handle external thrust from the driven equipment shall be supplied with a thrust bearing at the non-driving end.

6.4.3 In cases such as pumps for hot liquids where the driven equipment operates at high temperatures, bearings shall be cooled by a shaft-mounted fan. This shall ensure efficient ventilation of the bearing and disperse the heat transmitted from the driven equipment by conduction or convection.

6.4.4 Bearings shall be capable of grease injection from outside without removal of covers with motors in the running conditions. The bearing boxes shall be provided with necessary features to prevent loss of grease or entry of dust / moisture e.g. labyrinth seal/ oil seal/ V seal. Where grease nipples are provided, these shall be associated, where necessary, with appropriately located relief devices, which ensure passage of grease through the bearings.

6.4.5 Pre-lubricated sealed bearings may be considered provided a full guarantee is given for 4 to 5 years of trouble-free service without the necessity of re-lubrication.

6.5 Cooling System

All motors shall be self ventilated, fan cooled. Fans shall be corrosion resistant or appropriately protected. They shall be suitable for motor rotation in either direction without affecting the performance of the motor. If this is not possible for large outputs, it shall be possible to reverse the fan without affecting the balancing of the motor.

For motors operating in hazardous area, the fans shall be of an anti-static non-sparking material.

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6.6 Rotor

The rotor shall be of squirrel cage type, dynamically balanced to provide a low vibration level and long service life for the bearings. Die cast aluminum rotors for motors in hazardous areas may be accepted provided the same are type tested and approved by competent authorities.

6.7 Shaft Extension

Motors shall be provided with a single shaft extension with key-way and full key. Motor shaft shall be sized to withstand 10 times the rated design torque.

6.8 Lifting Hooks

All motors weighing more than 30 kg. shall be provided with lifting hooks of adequate capacity.

6.9 Earth Terminals

Two earth terminals located preferably on diametrically opposite sides shall be provided for each motor. Necessary nuts and spring washers shall be provided for earth connection.

7.0 MISCELLANEOUS ACCESSORIES

7.1 Anti-Condensation Heaters

All motors rated 30 kW and above shall be provided with 240 V anti-condensation heaters, sized and located so as to prevent condensation of moisture during shutdown periods.

For motors with heaters installed in hazardous atmospheres (Zone - 1 or Zone - 2), such heaters shall conform to the provisions of applicable Indian Standards and temperature classification specified in the motor data sheet.

The heater leads shall be brought out, preferably, to a separate terminal box which shall be of the same specification and grade of protection as the main terminal box.

A warning label with indelible red inscription shall be provided on the motor to indicate that the heater supply shall be isolated before carrying out any work on the motor.

7.2 Name Plates

In addition to the motor rating plate, a separate number plate for motor tag number shall be fixed in a readily visible position. This number shall be as per the motor data sheets.

8.0 CRITICAL SPEEDS

The first actual critical speed of stiff rotors shall not be lower than 120 % of the synchronous speed. For flexible rotors this shall be between 60 % and 80 % of the synchronous speed; the second actual critical speed shall be above 120 % of the synchronous speed.

9.0 PAINTING

All metal surfaces shall undergo manufacturer's standard cleaning /painting cycle. After preparation of the under surface, the equipment shall be painted with two coats of epoxy based final paint. Color shade of final paint shall be 632 of IS: 5/ RAL-7035. All unpainted steel parts shall be suitably treated to prevent rust formation. If these parts are moving elements, then these shall be greased.

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10.0 INSPECTION AND TESTING

10.1 All tests shall be carried out at manufacturer's shop under his care and expense.

10.2 The manufacturer shall submit all internal test records of the tests carried out by him on the bought-out items, motor sub-assembly and complete motor assembly.

10.3 The manufacturer shall carry out the following routine and acceptance tests as per applicable Standards/ITP on all the motors.

a) Visual check (Nameplate, terminal box location, terminal type, clearance, size, entries, space adequacy & gland size, direction of rotation etc.)
b) Dimension check (shaft height etc.)
c) Cable glands, cable lugs size and no. of entries in terminal box.
d) Winding resistance
e) No load test & measurement of voltage, speed, current, power input
f) Measurement of starting torque, starting current, full load torque, breakdown torque
g) Reduced voltage starting & running
h) Insulation resistance before and after high voltage test
i) High voltage
j) Vibration

10.4 The manufacturer shall submit the following type test certificates (one sample from each type/rating):

a) Full load test & measurement of voltage, current, power slip, power factor, bearing, noise
b) Efficiency & pf at 100%, 75% and 50% load
c) Temperature rise test
d) Momentary overload test
e) Vibration
f) Noise level
g) Over speed
h) Measurement of starting torque, starting current, full load torque.

10.5 For VFD fed motors, all tests as specified in the VFD specification shall be followed in addition to the above.

11.0 CERTIFICATION

The motors and associated equipment shall have test certificates issued by recognised independent test house (CIMFR/ CPRI/ ERTL/ BASEEFA/ LCIE/ UL/ FM/ KLPL or equivalent). All indigenous motors shall conform to Indian standards and shall be certified by recognised testing agencies. All motors (indigenous & imported) shall also have valid statutory approvals (e.g. PESO, DGMS etc). as applicable for the specified location. All indigenous flameproof motors shall have valid BIS license and marking as required by statutory authorities.

12.0 PACKING AND DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by ship/rail or trailer. The equipment shall be wrapped in polythene sheets before being placed in crates/cases to prevent damage to the finish. Crates/cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight', 'Owner's particulars', 'PO Nos.' etc. shall be clearly marked on the package together with other details as per purchase order.

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The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage in areas with heavy rains/high ambient temperature, unless otherwise agreed.

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विद्युत संस्थापनों के साइट निरिक्षण, परिक्षण व कमीशनिंग के लिए विनिर्देश

SPECIFICATION FOR FIELD INSPECTION, TESTING AND COMMISSIONING OF ELECTRICAL INSTALLATIONS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
3	10.6.14	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	AKG	SA	BRB	SC
2	03.03.09	REVISED & ISSUED AS STANDARD SPECIFICATION	RKS	NS	JMS	ND
1	14.07.03	REVISED & ISSUED AS STANDARD SPECIFICATION	HKM	RSG	VPS	SKG
0	02.08.01	ISSUED AS STANDARD SPECIFICATION	UAP	RR	VPS	MI

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Abbreviations:

AC	:	Alternating Current
AFC	:	Approved for Construction
BIS	:	Bureau of Indian Standards
CCOE	:	Chief Controller of Explosives
CEA	:	Central Electricity Authority
DC	:	Direct Current
DCS	:	Distributed Control System
DGMS	:	Director General for Mines and Safety
ECS	:	Electrical Control Station
GI	:	Galvanized Iron
HV	:	High Voltage
IS	:	Indian Standard
MV	:	Medium Voltage
OISD	:	Oil Industry Safety Directorate

Electrical Standards Committee

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Members: Ms. S. Anand
Mr. Parag Gupta
Mr. M.K. Sahu
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Ms. N.P. Guha (Projects)

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1.0 SCOPE

This specification covers the requirements for the field inspection, testing and commissioning of Electrical Equipment and Installation, forming part of electrical power distribution and utilisation system.

2.0 CODES AND STANDARDS

2.1 The field inspection, testing and commissioning of electrical equipment shall be carried out in line with this specification and the latest edition of following Indian Standards and OISD standards.

SP-30(BIS)	National Electrical Code.
IS 1255	Code of practice for installation and maintenance of power cables up to & including 33 kV rating.
IS-7816	Guide for testing Insulation resistance of rotating machines.
IS 10810(Part 43)	Method of Test for cables; Part 43 Insulation resistance.
IS 10810(Part 45)	Method of Test for cables; Part 45 High voltage test.
IS 12729	HV Switchgears
OISD 137	Inspection of Electrical Equipment.
OISD 147	Inspection and safe practice during electrical installation.

2.2 In addition to the above it shall be ensured that the installation conforms to the requirements of the following as applicable:

a. CEA Regulations

b. Regulations laid down by CEA / Electrical Inspectorate.

c. Regulations laid down by Tariff Advisory Committee/Loss prevention council.

d. Regulations laid down by CCoE/DGMS (as applicable).

e. The petroleum rules (Ministry of Industry, Government of India).

f. Any other regulations laid down by central / state / local authorities / insurance agencies

3.0 FIELD INSPECTION, TESTING AND COMMISSIONING

3.1 Contractor shall carry out complete field inspection, testing and commissioning of electrical equipment as per Inspection & Test plans.

3.2 Before the completed installation or an addition to the existing installation is put into service, inspection / pre-commissioning checks and tests shall be carried out by contractor. In the event of defects being found out, the same shall be rectified and the installation retested as applicable.

3.3 The pre-commissioning inspection among other requirements shall include visual inspection, checking the workmanship of the installation, the rating of equipment, safety clearances, sizes of cables installed, conformance to the AFC document, soundness of switchgear bus connections, wiring properly dressed and labeled, sealing of unused cable entries, checking of all safety interlocks, control/interface functions as per requirement etc.

3.4 Visual inspection for soundness of bus bar connections of busducts, terminal connections of equipment/motor shall be carried out. It shall be ensured that no foreign materials are present inside busduct and equipment terminal boxes. After the visual inspection, all the covers of terminal boxes, inspection chambers shall be refitted with gaskets, bolts & nuts as per equipment manufacturer's instructions.

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3.5 Pre-commissioning tests shall include but not be limited to the following:

- Continuity test for each winding and power and control circuits.
- Insulation test for each winding and power and control circuit
- High voltage test for cables
- Dielectric strength test on transformer oil.
- Checking the correctness of wiring schemes, control circuit interlocks for intended functioning.
- Verification of phase sequence.
- Testing of all types of relays/releases for required operation.
- Testing of measuring instruments for proper functioning.
- Earth continuity test for all circuits.
- Checking of safety features for correctness of operation, etc.
- Checking of all wired interface contacts (analogue, digital input/output contacts) for DCS and ECS interface, at panel and equipment terminal chambers as applicable.

  (Electrical contractor shall co-ordinate with other agencies involved for the above and provide support services for checking interfaces of electrical equipment and the intended functioning)

- Earth resistance measurement for each earth electrode, and the earthing system as a whole.
- Lighting installation shall be tested for correct illumination levels, with fittings installed. Fittings shall be operated only with specified type of a lamp or tube.

3.6 After the above tests and inspection are completed, control circuits shall be tested for correct operation under all operating combinations and proved correct before applying power to main circuit.

3.7 Plant Communication, Fire alarm detection and telephone system shall be checked for correct operation and intended function.

3.8 A close visual inspection of electrical equipment in hazardous areas shall be made to ensure that equipment is suitable for the classified zone and gas group and correctly installed, with all covers, bolts, nuts and hardwares intact and there is no physical damage mark seen on the enclosure

3.9 Site Acceptance Test procedure for specific equipment shall be furnished by the respective equipment vendor. The contractor shall provide necessary assistance to the equipment vendor to perform Site acceptance testing to enable the equipment vendor to perform the same.

3.10 All pre-commissioning checks and tests shall be carried out as per the directions of Engineer-in-charge. In addition to the equipment manufacturer's instructions, pre-commissioning check requirements shall also be complied. All tests shall be carried out by contractor in the presence of EIL/Owner's representatives

3.11 The contractor shall bring to site all required tools, tackles, and testing instruments for carrying out field testing. Contractor shall use only calibrated measuring and test instruments and shall maintain valid calibration records.

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3.12 The **Insulation Resistance** test values for various electrical equipment shall be as below:

3.12.1 **Cables**

The insulation resistance test values for cables shall be as per following table:

Rated voltage of the Cable	**DC Test Voltage in Volts**	**Minimum Insulation resistance in Mega ohms**
Lighting and power circuit wiring	250	1
650/1100V grade cables	1,000	10
1,900/3,300V grade cables	1,000	200
3,800/6,600V grade cables	1,000	200
6,350/11,000V grade cables	5,000	200
8,700/15,000V grade cables	5,000	200
12,700/22,000V grade cables	5,000	200
19,000/33000V grade cables	5,000	200

3.12.2 **HV, MV and Miscellaneous Switchboards**

The insulation resistance test values for the switchboards shall be as per following table:

Rated voltage of the Switchboard	**DC Test Voltage in Volts**	**Minimum Insulation resistance in Mega ohms**
33,000V	5,000	200
11,000V	5,000	200
6,600V	1,000	200
3,300V	1,000	200
415V	1,000	100
240V	500	10
110V	500	10

3.12.3 **Generators and Motors**

3.12.4 The insulation resistance test values for the Generators and Motors shall be as per following table:

Rated voltage of the Generators and Motors	**DC Test Voltage in Volts**	**Minimum Insulation resistance in Mega ohms at 40 °C**
11,000V	5,000	120
6,600V	1,000	80
3,300V	1,000	50
415V	1,000	15
240V	500	12

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3.12.5 **Transformers**

3.12.6 The insulation resistance test values for the Transformers shall be as per following table:

Rated voltage of the Transformers	DC Test Voltage in Volts	Minimum Insulation resistance in Mega ohms at 40 °C
Up to 600V	1,000	100
601 to 5000V	2,500	1,000
5001 to 15,000V	5,000	5,000
15001 to 35,000V	5,000	10,000

3.12.7 It shall be ensured that during insulation tests, electronic devices and components that are liable to get damaged on applied test voltage shall be disconnected from circuit. The instructions of equipment/panel manufacturer shall be followed strictly in this regard.

3.13 High-voltage Testing

3.13.1 DC high voltage test shall be conducted as per following table on all HV feeder cables and also on 1100 V grade cables where straight through joints have been made.

Rated Voltage of Cable (kV)	TEST VOLTAGE (kV) BETWEEN		Duration (Minutes)
U_o / U*	Any Conductor and Metallic Sheath/ Screen/Armour	Conductor to Conductor (For Unscreened Cables)	
0.65/1.1	3	3	5
1.9/3.3	5	9	5
3.3/3.3	9	9	5
3.8/6.6	10.5	18	5
6.6/6.6	18	18	5
6.35/11	18	30	5
11/11	30	30	5
12.7/22	37.5	-	5
19/33	60	-	5

*U_o : Phase Voltage

U : Line Voltage

The cable cores must be discharged on completion of DC high voltage test and cable shall be kept earthed until it is put into service.

DC test voltage for old cables shall be 1.5 times rated voltage or less depending on the age of cables, repair work or nature of jointing work carried out, etc. In any case, the test voltage shall not be less than the rated voltage.

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3.13.2 AC high voltage test shall be conducted as per following table on all HV Switchboards.

Rated Voltage (rms Value in kV)	Rated 1 Min. Power Frequency Withstand Voltage (rms Value in kV)		Duration in Minutes
U	To Earth, Between Poles and Across Open Switching Device	Across the Isolating Distance	
3.6	10	12	1
7.2	20	23	1
12	28	32	1
24	50	60	1
36	70	80	1
72.5	140	160	1

The withstand voltage values across the isolating distances are valid only for switching devices, where the clearance between open contacts is designed to meet the safety requirements specified for disconnectors.

3.14 All protective relays including thermal overload relays shall be tested by secondary injection current. Primary injection tests shall be carried out for differential protection, restricted earth fault protection at full/reduced current to ensure correctness of complete wiring.

3.15 Before energizing any equipment, 'COMMISSIONING CLEARANCE FORM' as per standard format shall be duly filled in by contractor and submitted to EIL/owner.

3.16 It shall be ensured that the electrical inspectorate approval is available before energizing the equipment

4.0 RECORDS

Contractor shall keep up-to-date records of all activities carried out and test results. Field inspection / test reports shall be submitted to EIL / Owner by the contractor in bound volumes (triplicate copies).

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प्रोग्रामेबल लॉजिक कंट्रोलर के लिए मानक विनिर्देशन

STANDARD SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLERS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards committee Convener	Standards Bureau Chairman
					Approved by	
2	30.06.15	Revised and Reissued	AR	MA	RG	SC
1	24.11.09	Revised and Reissued	MN	RP	TGM	ND
0	22.04.98	ISSUED AS STANDARD SPECIFICATION	PM	RK	BRS	AS

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Abbreviations:

AC	:	Alternating Current
Baseefa	:	British Approval Service for Electrical Equipment in Flammable Atmospheres
CPU	:	Central Processing Unit
CSA	:	Canadian Standards Association
DC	:	Direct Current
DCS	:	Distributed Control System
DMR	:	Dual Modular Redundant
DVD	:	Digital Versatile Disc
EMI	:	Electromagnetic Interference
ESD	:	Emergency Shutdown System
EXIDA	:	Excellence in Dependable Automation
FAT	:	Factory Acceptance Test
FMEDA	:	Failure Modes, Effects and Diagnostic Analysis
HART	:	Highway Addressable Remote Transducer
HW	:	Hardware
HWC	:	Hardwired Console
IEEE	:	Institute of Electrical and Electronic Engineers
I/O	:	Input / Output
LAN	:	Local Area Network
LCD	:	Liquid Crystal Display
LCIE	:	Laboratorie Central Industries Electriques
LED	:	Light Emitting Diode
MIS	:	Management Information System
MTBF	:	Mean Time Between Failure
MTTR	:	Mean Time to Repair
OPC	:	OLE for Process Control
PC	:	Personal Computer
P&ID	:	Piping and Instrumentation Diagram
PID	:	Proportional, Integral and Derivative
PLC	:	Programmable Logic Controller
PTB	:	Physikalisch Technische Bundersanstalt
PLC	:	Programmable Logic Controller
RFI	:	Radio Frequency Interference
SIL	:	Safety Integrity Level
TCP / IP	:	Transmission Control Protocol / Internet Protocol
TMR	:	Triple Modular Redundant
TUV	:	Technische Uberwachungs Vereine
UHF	:	Ultra High Frequency
UPS	:	Uninterrupted Power Supply
UL	:	Underwriter's Laboratories
VDU	:	Video Display Unit
VHF	:	Very High Frequency

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1.0 GENERAL

1.1 Scope

1.1.1 This specification, defines the minimum functional requirements for the design, hardware, software and firmware specifications, nameplate marking, testing and shipping of Programmable Logic Controllers (PLC) designed for reliable, effective and optimum control and monitoring of a process plant (hydrocarbon and non-hydrocarbon) and captive power plant.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions, unless otherwise specified: -

API	American Petroleum Institute	
	RP 552	Transmission Systems
EEMUA	Engineering Equipment & Material User Association	
	191	Alarm System - A Guide to Design, Management and Procurement
BS	British Standards	
	EN 10204	Inspection Document for Metallic Products
IS/IEC	Indian Standards / International Electrotechnical Commission	
	IS/IEC60079	Electrical Apparatus for Explosive atmospheres
	IS/IEC60529	Classification of Degree of protection provided by enclosures (IP Code).
	IEC 60584-2	Thermocouples. Part 2: Tolerances
	IEC 60617	Graphical Symbols for Diagram
	IEC 60751	Industrial platinum resistance thermometers and platinum temperature sensors
	IEC 61000-4-3	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test.
	IEC 61000-4-4	Electromagnetic Compatibility (EMC) –Part 4-4: Testing and Measurement Techniques – Electrical Fast Transients / Burst Immunity Test
	IEC 61000-4-5	Electromagnetic Compatibility (EMC) –Part 4-5: Testing and Measurement Techniques – Surge Immunity Test
	IEC 61000-6-2	Electromagnetic Compatibility (EMC) –Part-6-2: Generic Standards – Immunity for Industrial environments.
	IEC 61508	Functional Safety of Electrical / Electronic / Programmable Electronic Safety-related Systems.

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	IEC 61131	Programmable Logic Controllers
	IEC 61511	Functional Safety – Safety Instrumented Systems for the Process Industry Sector
	IEC 61643-21	Low voltage surge protective devices - Part 21: Surge protective devices connected to telecommunications and signaling networks - Performance requirements and testing methods
	IEC 62561-3	Lightning protection system components (LPSC) - Part 3: Requirements for isolating spark gaps (ISG)
IEEE 802.3	Telecommunication and Information Exchange between Systems – Local and Metropolitan Area Networks – Specific Requirements – Part 3: Carrier Sense Multiple Access with Collisions Detection (CSMA / CD) Access Method and Physical Layer Specifications	
IS	Indian Standards	
	3043	Code of Practice for Earthing
ISA	International Society of Automation	
	5.1	Instrumentation Symbols and Identification
	5.2	Binary Logic Diagrams for Process Operations
	5.3	Graphic Symbols for Distributed Control / Shared Display Instrumentation, Logic and Computer System.
	5.4	Instrument Loop Diagrams
	5.5	Graphic Symbols for Process Displays
	18.1	Annunciator Sequences and Specifications
	71.01	Environmental Conditions for Process Management and Control Systems: Temperature and Humidity
	71.04	Environmental Conditions for Process Measurement and control Systems: Airborne Contaminants
ANSI/ISA	American National Standards Institute / International Society of Automation	
	TR 99.00.01	Security technologies for Industrial Automation and Control Systems
ISO	International Organization of Standardization	
	216	Writing Paper and Certain Classes of Printed matter-Trimmed Sizes- A & B Series and indication of machine direction
	9241-5	Ergonomic requirements for office work with visual display terminals (VDTs) -- Part 5: Workstation layout and postural requirements

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9241-302 Ergonomics of human-system interaction -- Part 302: Terminology for electronic visual displays

1.1.3 In the event of any conflict between this specification, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

a) Statutory regulations

b) Job Specifications/ Data Sheets

c) Standard Specifications

d) Codes and Standards

1.1.4 In addition to meeting purchaser's specifications in totality, vendor's extent of responsibility shall also include the following:

a) Purchaser's data sheets specify the minimum acceptable functional requirements for the programmable logic controllers. It shall be vendor's responsibility to select proper hardware, software and firmware to meet the specified functional requirements, keeping the integrity of functional blocks specified in the configuration diagram attached with the Requisition.

b) Purchaser's data sheets specify the scan time / cycle time and loading requirements. Vendor shall be responsible for sizing and selecting their standard product i.e. hardware, software and firmware to meet the requirements specified in the purchaser's data sheets.

c) Adequacy of Bill of Material selected to meet purchaser's requirements including spares. Vendor to note that bill of material shall not be verified by the purchaser during evaluation stage. Any hardware, software and firmware required to meet the purchaser's specified requirements shall be provided by the vendor without any implication.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the Requisition. Vendor's quotation shall enumerate and include the detailed specification of each subsystem and each module of programmable logic controller, detailed system configuration, hardware and software capabilities, programming aids, display facilities and other relevant information.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following:

a) Compliance to the specifications.

b) Detailed specification sheet for each sub-system. The specification sheet shall provide information regarding hardware specifications, software specifications, redundancy requirements, capacity, power consumption etc. of the programmable logic controllers and its accessories. The material specifications and unit of measurement for various items in vendor's specification sheets shall be to the same standards as those indicated in purchaser's data sheets.

c) System security features and design details.

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d) Proven references for each offered model in line with clause 1.2.4 of this specification whenever specifically indicated in the purchaser's specifications.

e) A copy of approval for flameproof enclosure, intrinsic safety etc whenever specified, from local statutory authority, as applicable, like Petroleum and Explosives Safety Organisation (PESO) / Chief Controller of Explosives (CCE), Nagpur or Director General of Mines Safety (DGMS) in India along with:

i) Test certificate from recognised house CIMFR (Central Institute of Mines & Fuel Research) / ERTL (Electronics Research and Test Laboratory) etc. for specified protection class as per relevant Indian Standard for all Indian manufactured equipments or for equipments requiring DGMS approval.

ii) Certificate of conformity from agencies like LCIE, Baseefa, PTB, CSA, UL etc., for compliance to ATEX or other recognised standards for all equipments manufactured outside India.

f) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason to deviate from the specified requirement, they must include a list of deviations item wise, summing up all the deviations from the purchaser's data sheets and other technical specification along with the technical reasons for each of these deviations.

g) Certificate for specified SIL requirement (e.g. SIL-3) from Independent Testing Agency (e.g. TUV/EXIDA).

h) Catalogues giving detailed technical specifications, model decoding details and other related information for each item / sub-system covered in the bid.

1.2.3 The equipment being offered / supplied shall be of latest proven version available in the current manufacturing range.

1.2.4 The system hardware, software and firmware as offered, shall be field proven and should have been operating satisfactorily for a period of minimum 6 months continuously on the bid due date in the validly similar size and application specified in the purchaser's data sheet. Items with prototype design shall not be offered or supplied.

1.2.5 The detailed scope of work, specific job requirements, exclusions, deviations, additions etc. shall be indicated in the job specifications which shall be part of Requisition

1.2.6 Whenever specified, vendor shall furnish tested values of failure rates, probability of failure on demand and test intervals for safety integrity level analysis.

1.2.7 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation, operation and maintenance manuals shall be in English language only.

1.2.8 Vendor shall also quote for the following:

a) Two year's operational spares for each sub-system and their accessories which shall include the following as a minimum:

i) All type of electronic modules e.g. I/O modules, processor modules, communication modules, power supply modules etc.

ii) All type of auxiliary items e.g. barriers / isolators, hardwired instruments, annunciator modules, receiver switches, trip amplifiers, temperature element converters etc.

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iii) Switches, lamps, fuses, connectors, terminals, pre-fabricated cables, circuit breakers, relays etc.

iv) Video display units, keyboards, disc drives, PC's, network items (e.g. switches, hubs etc.) etc.

b) Any special tools and test equipments needed for the maintenance of PLCs and other items being offered by vendor. Vendor must confirm in their offer if no special tools or test equipments are needed for maintenance other than those specifically indicated in purchaser's data sheet.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of prints and soft copies shall be dispatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design manuals, installation manual, operation and maintenance manual etc., submitted by the vendor after placement of purchase order shall include the following, as a minimum:

a) Specification sheet for each sub-system, auxiliary instrument and bought out item.

b) Certified drawings for complete system including the following:

i) System Configuration Diagram

ii) General Arrangement drawings for panels, cabinets, marshalling racks, hardwired consoles, operator console, programming terminal etc with complete dimensional details, internal construction and weight in kilograms.

iii) Control room layouts e.g. console room, rack room and engineering room layout with all dimensions in millimeters.

iv) Channel base frame drawings for console room, rack room and engineering room.

v) Input/ output assignment.

vi) Logic/ Ladder diagrams.

vii) Loop wiring diagram for all tags.

viii) Power supply distribution diagram.

ix) Memory loading calculations/ Scan time calculations.

x) Modbus address mapping/ Protocol/ Pin Detail wherever required as per requisition.

xi) Dynamic graphic diagrams.

xii) System grounding drawing.

c) Design manuals and functional design specifications which shall include hardware design manual, software design manual and special software specifications.

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d) Copy of type test certificates.

e) Copy of test certificates for all tests indicated in this specification.

f) Installation manual containing installation procedure for programmable logic controllers and other items covered in the Requisition.

g) Power-on, start-up and internal testing procedures.

h) Software debugging and system configuration procedures.

i) Calibration and maintenance manual containing maintenance procedures including replacement of parts, application modification etc.

j) Any other drawings and documents specifically indicated in vendor data requirement enclosed with the Requisition.

2.0 DEFINITIONS

The various terms used in this specification are defined as follows:

2.1 Programmable Logic Controller

The class of control systems which can be programmed to execute plant shutdown and / or interlock / sequence logics to the specified safety integrity levels and also regulatory control functions in specific applications.

2.2 Accessible

A system feature that is viewable by and interactive with the operator and allows the operator to perform user permissible control action e.g. set point change, auto-manual transfers or on-off actions.

2.3 Assignable

A system feature that permits an operator to direct a signal from one device to another without the need for change in wiring, either by means of switches or via other data entry devices like keyboard commands to the system.

2.4 Configurable

The capability to select and connect standard hardware modules to create a system or the capability to change functionality or sizing of software functions by changing parameters without having to modify or regenerate software.

2.5 I/O

Input / Output with respect to process / operator.

2.6 PLC Console (Operator)

PLC console (Operator) is the operator's main plant interface device through which operator can view, monitor and control the plant and can give instructions to peripherals to execute commands, and shall have protective access to configure and maintain the system.

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2.7 PLC Engineering Console (Programming)

PLC Engineering console (Programming) shall be the engineer's main interface device through which engineer can configure / program and maintain the system, and shall have protective access to monitor and control the plant, give instructions to peripherals to execute commands.

2.8 Local Level

All those sub-systems, which directly interface with field devices shall be referred to as local level.

2.9 Central Level

Operator Console and Programming Terminal, which present data acquired from local level devices, shall be referred as Central Level.

2.10 Database

Database shall be defined as the information stored temporarily or permanently in the system which can be accessed by various programs to meet all its functional requirements.

2.11 Loop Integrity

A system shall be said to have loop integrity if the failure of one component in the system/ sub-system does not affect more than one loop.

2.12 System Loading

System loading for a sub-system is defined as the percentage of time a sub-system spends in carrying out various activities referred to the use of memory, CPU time and communication capacity in the worst case of high sub-system operation out of the designed / designated cycle time of the sub-system.

2.13 Redundancy

A system component shall be termed as redundant if it takes over automatically the operation in the event of the failure of the main component without causing any interruption in the system and upsetting the process. The repaired or replaced device shall be brought in-line only through operator action without upsetting system operation.

2.14 Switchover Time

Time required for a back up instrument / system to come on-line automatically in case of the failure of the main instrument / system.

2.15 Processor Cycle Time (t_{pc})

Processor cycle time is the measure of the processing speed of a processor. Processor cycle time for a sub-system of the programmable logic controller shall be defined as follows:-

Processor cycle time for programmable logic controller shall be defined as the total time taken by the processor to read input supplied by input module, execute all computations (analog as well as logic as configured) and write the outputs for the output module.

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2.16 Scan Time (t_s)

Scan time of a logic loops is the end-to-end response time of a sub-system and shall be defined as follows:

The scan time for a logic loop shall be defined as the total time taken by a sub-system e.g. programmable logic controller to read input from the input terminal, process input, execute logic, updating logic output and write output at the output terminal for all the logics configured within the subsystem.

2.17 User's Memory

Free memory space available after utilisation of memory required for system operation, configuration and implementation of application and other system related functions for implementation of user defined specific programs such as plant calculations, process optimization or MIS (like free formatting of certain logs). The programs shall either be written in high level language or system specific language.

2.18 Event

An event shall be defined as any action taken by the operator via operator keyboard or switches on hardwired console like change of set point, change of control mode, start/stop of motor, open/close of shut down valves, alarm acknowledge, etc.

2.19 Sequence of Event (SOE)

Arranging events in the sequence of their occurrence in time with a specified time resolution by a program is defined as sequence of event.

2.20 Sequence of Event Recorder (SER)

Sequence of event recorder, when specified, shall identify, store and print alarms with the specified time resolution between two events. SER shall also transfer data to operator sub system over communication sub system.

2.21 Real Time Trend

Real time trend shall be defined as a continuously progressing graphical record showing updated parameter with most recent value and a past record of minimum of 10 minutes without pressing any additional key for moving backward in time.

2.22 Plant Information Network

High-level communication network which serves various users within a plant and transfer information for the purpose of unit / plant monitoring. This network is different than control network and is generally realised using open communication protocol network e.g. OPC etc.

2.23 Tag

A Tag is a collection of attributes that specify either a control loop or a process variable, or a measured input, or a calculated value, or some combination of these, and all associated control and output algorithms. Each tag is unique.

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3.0 SPARES PHILOSOPHY

3.1 The system including sequence of event recorder, hardwired instruments etc. shall meet the following spare philosophy. This philosophy shall also be applicable for items like barriers, relays, terminals, lamps, push buttons etc.

3.1.1 Mandatory Spares

Vendor shall include following mandatory spares in their scope of supply:

3.1.1.1 Installed Engineering Spares

Installed engineering spares shall be provided in each sub-system for each type of module to enhance the specified system functional requirements by 20%. The basis of offering installed engineering spares shall include:

a) For a system with conventional and / or smart analog input / output, discrete (contact) input / output, 20% spare input / output of each type shall be considered for calculating I/O modules and all other related accessories.

b) For all serial input / outputs to the system, 20% spare serial I/O ports of each type of serial input / output shall be provided.

c) 20% spare accessories like relays, switches, lamps, fuses, circuit breakers, barriers, isolators, terminals etc.

d) The engineering spares shall be wired up to the field cable interface and shall be in ready-to-operate condition when field cable is connected to spare assigned terminals.

e) Spare pairs of the incoming cables shall be terminated on spare terminals in the marshalling / barrier cabinets as applicable.

f) The system shall be fully engineered considering 20% installed engineering spares including processor loading.

3.1.1.2 Spare Space Requirement

In addition to installed engineering spares specified in Clause 3.1.1.1 of this specification, the system shall be provided with following spare space:

a) The cabinets of the of the programmable logic controller system shall have 10% usable spare space for installing additional I/O cards of each type in future and the PLC processor shall have additional 10% capacity to handle these I/O's. In addition, provision shall be kept for internal wiring of the same up to the I/O terminals.

b) Processor system of programmable logic controller shall have capability to execute additional 20% logics.

c) Each operator console shall contain 20% usable spare group and related display capability in addition to as specified in para 3.1.1.1 of this specification.

d) The system shall have capability to extend its historical trending, logging and user's memory by 20% to meet future expansion with/without adding additional memory modules.

e) The communication sub-system shall have sufficient capacity to handle additional data contributed by addition of 20% I/O over and above installed engineering spares.

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f) Usable spare space in cabinets to install 10% spare hardwired items like relays, switches, lamps, fuses, circuit breakers, barriers, isolators, terminals etc. in future.

3.1.1.3 Spare Memory Requirement

a) The system shall be provided with a minimum of 40% spare memory capacity, as required for application program and data base to meet specified functional requirements.

b) It shall be possible to extend the memory by at least 20% over and above the actual requirement at a later date.

3.1.1.4 Spare Software Capability

a) Sufficient additional software capacity shall be available in the system to take care of spares requirement as specified in para 3.1.1.1 and 3.1.1.2 of this specification to meet all functional requirements as per para 4.0 of this specification.

b) Unless specifically indicated otherwise, the offered system shall have software licenses to cover all the tag numbers indicated in the Requisition, including installed engineering spares and spare space indicated in clause 3.1.1.1 and 3.1.1.2 of this specification.

3.1.1.5 Predefined Mandatory Spares

a) Mandatory spares shall be ware-house spares and shall be supplied as loose items.

b) Mandatory spare module of 5% or one module of each type, whichever is higher, must be supplied for each type of modules being used excluding modules used in consoles, servers, Personal Computers.

c) For items like, Video Display Units, keyboards, disc drives, network components, hardwired instruments like barriers, lamps, fuses and circuit breakers, complete item limited to 5% or minimum one of each type shall be supplied as predefined mandatory spare. But this shall not include hardware like hard discs, terminals.

3.1.1.6 Consumable Spares

Any paper, ribbon, printer heads, toner and ink required for printers, video copier or any other consumable item shall be supplied along with system required for minimum of six months duration after system acceptance.

3.1.1.7 Commissioning Spares

Unless otherwise specified, vendor shall be responsible to supply all spares which are found necessary to replace failed modules, failed sub-systems, or corrupted / faulty software while performing pre-commissioning and commissioning activities.

3.1.2 Two Years Operational Spares

Two years operational spares shall be as per Clause 1.2.8(a) of this specification and shall be quoted separately.

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4.0 DESIGN AND CONSTRUCTION

4.1 Design Requirements

4.1.1 Programmable logic controller shall be microprocessor based system which shall be used to execute all the process and safety shut-down logic of the plant. When specified, it shall also execute plant interlock logics and sequence operation and analog control. Programmable logic controller shall be an independent unit and shall not depend on any of its functionality on any other system including Distributed Control System.

In case of common engineering database for DCS and PLC, engineering data for DCS and PLC shall be segregated and the data access shall be through respective engineering stations of DCS and PLC only. Such configuration shall meet the SIL3 compliance by third party certifying agency like TUV/ EXIDA etc

Moreover, wherever exchange of safety parameters between the different PLC sub-systems is required for interlock execution, separate communication network shall be provided between these PLC sub-systems. For SIL certified PLCs, this communication network between PLC nodes shall also be SIL certified.

4.1.2 The system shall be of modular construction and expandable in future by adding additional modules which shall be easily accessible for maintenance and repair. The type of modules shall be kept to the minimum possible in order to have interchangeability and low inventory.

4.1.3 **System Availability**

a) The system shall be designed 'fault tolerant' as a minimum by selecting high grade components of proven quality and proper design of system electronics.

Redundancy shall be provided, as a minimum, as per this specification to improve system availability and reliability. Due considerations shall be given to the environmental conditions particularly for field mounted sub-system, if specified in job specifications, during system design.

b) The system shall have a high MTBF value and shall have well proven record of operating in hydrocarbon plants.

c) The system shall be designed with 99.995% or greater availability. The availability shall be defined as follows:

$$\text{Availability} = \frac{\text{Mean time Between Failure (MTBF)}}{\text{MTBF + Mean time to repair (MTTR)}}$$

For the purpose of calculations, consider mean time to repairs as four (4) hours unless the manufacturer recommends higher value for MTTR. It is therefore necessary that:

i) Vendor covers all necessary spare parts in 2 years recommended operational spares which shall be necessary to meet specified MTTR time.

4.1.4 **Operating Environmental Conditions**

4.1.4.1 Environmentally Controlled Location Installation

a) All subsystem of Programmable Logic Controllers located in Control Room, Local Control Room or in Satellite Rack Room shall be able to operate satisfactorily from 15°C to 30°C and 20% to 80% non condensing humidity.

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b) In addition to above, all such sub-systems shall also be able to operate satisfactorily in case of air conditioning failure with ambient temperature of 50°C and 90% non-condensing humidity until the system safe operating limits are exceeded. The minimum period of continuous operation in such condition shall be 48 hours at least once in a month without any damage or degradation of system performance. Vendor, therefore, shall provide continuous temperature monitoring for each cabinet housing items / equipments generating heat, such as system cabinets, barrier cabinets, relay cabinets, consoles etc and also provide alarm for operator alert in case the safe operating temperature limits are exceeded. For marshalling cabinets and Power distribution cabinets, temperature monitoring through temperature switches is acceptable.

c) Chemical filters have been provided in the incoming air conditioning air to limit the concentration of contaminants below following limits:

Contaminants (Corrosive Gases)	Concentration
SOx	< 0.01 ppm by volume
NOx	< 0.05 ppm by volume
H_2S	< 0.003 ppm by volume
Cl_2	< 0.001ppm by volume

All sub-systems and system components shall be suitable for operating continuously in the above mentioned corrosive environments.

4.1.4.2 Outdoor Installations

a) Sub-systems or system components which are installed outdoor shall be suitable to continuously operate at ambient temperature and humidity specified under ambient conditions. The heat generation effect of current carrying for the electronic modules shall also be considered. For this purpose, the system shall be rated for minimum 5 deg C more than the maximum ambient temperature specified. In case the system is not suitable for the above conditions, necessary cooling arrangement shall be provided.

b) Unless otherwise specified, all PLC sub-systems or system components installed outdoor shall have corrosive environmental protection coating meeting the environmental classification class G3 as per ISA-S71.04.

4.1.5 **Transient, Static and EMI / RFI Protection**

4.1.5.1 The system shall be internally protected against system errors and hardware damage resulting from:

a) Electrical transients on power wiring.

b) Electrical transients on signal wiring.

c) Connecting and disconnecting devices or removing or inserting printed circuit boards in the Programmable Logic Controller (PLC).

4.1.5.2 All sub-systems and system components shall be capable of accepting various signal inputs for its direct use while preventing noise errors due to electromagnetic interference (EMI) or radio frequency interference (RFI) including nearby radio stations, hand held two way

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radios, solenoids, relays or contactors carrying heavy currents as per levels of Environmental electromagnetic phenomenon defined in IEC-61000-6-2. The system shall have total noise immunity from UHF / VHF radio communication equipments, (RFI) and (EMI) noise generating equipments as per IEC-61000-4.

4.1.5.3 For interplant, inter unit and other system cables routed in the field, the level of surge immunity required for equipment signal ports shall be increased to level 4 as defined in IEC-61000-4-5 and the system shall operate according to performance criterion B as defined in IEC-61000-6-2.

4.1.6 **On-line Replacement**

4.1.6.1 On-line replacement of any module of programmable logic controller shall be possible in such a way that removal and addition of the module shall be possible and safe without de-energising the system. Furthermore, there shall not be any interruption of the system and process upset while replacing a faulty module in case of TMR, QUAD and dual redundant PLCs.

4.1.6.2 Apart from system modules, power supply units shall be replaceable on-line without disrupting the process and without affecting the system redundancies. It shall be possible to hot swap any faulty system module without degrading the system safety or operation or freezing the output status. The switchover to the healthy module shall be bumpless. The swapped module shall take over the function of the failed module without any manual programming.

4.1.7 **Electrical Isolation**

Galvanic or optical isolation shall be provided for all field signals. The isolation levels shall be as follows:

Analog I/O channel to system ground	:	1500V AC
Discrete I/O channel to system ground	:	500V AC

External isolator shall be provided, if necessary to meet the above.

Isolation shall also be provided between Engineering / operator console/PLC programming terminal and related sub-systems connected to it if there is any possibility of high voltage being transmitted to the sub-systems.

4.1.8 **Design Requirements of Equipments in Hazardous Area**

4.1.8.1 Unless specifically indicated, the field devices are beyond the scope of this specification. However vendor shall be fully responsible for integrating these devices with their system including compiling and maintaining the engineering data base of these devices and incorporating the data base into the Integrated Asset Management System (whenever specified in the requisition).

4.1.8.2 General requirements

a) Unless otherwise specified, all instruments in hazardous area shall be intrinsically safe type. Other concepts shall be used when specified.

b) For conventional instrumentation, entity concept shall be used for selecting proper barriers / isolators.

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4.1.9 **Repeat Signals**

4.1.9.1 Unless otherwise specified in the job specifications, following philosophy shall be followed for repeat signals:

a) Whenever repeat signal/ contact outputs are required as per job specifications following philosophy shall be followed:

i) For intrinsically safe input, isolating barrier with dual output shall be utilized.

ii) For Non-intrinsically safe input, isolator with dual output shall be utilized.

ii) For other contact inputs, repeat contact shall be provided using electro- magnetic relays.

4.1.10 **Surge Protection**

4.1.10.1 Surge protection devices (SPD's) shall be provided on the system to limit the surge voltages reaching beyond the safe limits, under normal, abnormal or lightning strike condition. Unless otherwise specified, SPD's shall be provided at least at the following locations:

a) All serial signal cables (UTP / STP / coaxial and not fibre optical) going from or to control system and from one location to another outside the control building at both control system end.

b) All power incoming cable (110V AC, 110V DC, 240V AC, etc), UPS or non UPS, at the power supply distribution cabinet.

4.1.10.2 The selection of type and rating of SPD shall be selected such that the introduction of this device shall not change the characteristics or reliability of an application, whether it is for the protection of power system, signal such as analog or communication signal, as applicable. The SPDs shall comply with the requirements of IEC-61643-21.

4.1.11 The system shall be designed fault tolerant and shall utilize high quality components of proven quality. Any single system fault shall not degrade the system safety or functionality or affect operation. The system shall have certified Safety Integrity Level as per IEC-61508 / 61511 as applicable and specified in job specification. Unless otherwise specified, it shall meet the availability requirement specified in Clause 4.1.3 of this specification.

4.1.12 Unless otherwise specified in the requisition, the scan time of programmable controller shall be of the order of 250 milliseconds for SIL certified PLCs. The scan time for standard Non-SIL PLCs shall be of the order of 100 milliseconds. Scan time for a PLC shall be as defined under para 2.16 of this specification. The PLC processor sizing shall be done considering the PLC scan time for the units as mentioned in the requisition. Other activities like diagnostics routines, output / dump of data to peripherals, development of sequence blocks or any other activity which consume processor time shall also be accounted while computing scan time. For SIL certified PLCs, this shall also be in line with SIL certification.

4.1.13 Operation of the PLC shall be completely unaffected by a momentary power loss of the order of 20 milliseconds.

4.1.14 The system shall be programmed in principle as per the logic diagrams.. Owner / Consultant reserve the right to revise or review the logic diagrams even after acceptance of any offer. The programming language of offered PLC shall be as per IEC 61131.

4.1.15 Whenever the requirement of SIL is specified for the PLC, it shall meet the requirements of SIL level specified and shall be certified by an independent body (e.g. TUV/EXIDA) for complying requirements of IEC-61508 / 61511 as specified. For shutdown application requiring SIL certification, PLC shall always meet SIL 3 requirements.

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4.1.16 The system shall have extensive set of self diagnostics hardware and software for easy and fast maintenance of PLC. Routine checks should run automatically at frequent intervals for identifying any fault in software or hardware. Diagnostics shall be required at local as well as console level.

4.1.17 Safety barriers shall be provided by the vendor for intrinsically safe input/output circuits wherever specified. In such cases, the system shall be designed intrinsically safe based on entity concept. The barriers shall be certified by a statutory authority like Baseefa, LCIE, CSA, UL, PTB, CIMFR etc., for the use in the area classification as specified elsewhere in the job specifications. The proper selection of the safety barriers shall be the vendor's total responsibility. In case of smart transmitter, the entity parameters of the hand held terminals shall also be considered while selecting proper barriers.

4.1.18 Unless otherwise specified all intrinsically safe barriers shall be 3 port isolating type only providing isolation between;

i) Input and output (non-hazardous to hazardous side of barriers)

ii) Power supply and input

iii) Power supply and output

The minimum isolation level shall be 250V.

4.1.19 **Alarm By-pass Switches**

4.1.19.1 Startup by-pass (SBS) switches for alarms

All SBS's shall be configured in the ESD system (i.e. PLC) and shall be operable from operator console. All such by-pass switches shall be alarmed and shall have audit trail.

4.1.20 All Emergency (ESD) switches shall he hardwired and shall preferably be pull type with red coloured knob. Control room mounted ESD switches shall be installed on hardwired console.

4.1.20.1 The ESD switch contact shall be used in ESD system (PLC etc) for logic implementation and event history.

4.1.20.2 Additionally, wherever specified in the requisition, ESD switches shall also directly trip the final ESD element without any intermediate device. Where multiplication of ESD switch contacts is necessary, fail safe relays shall be utilized.

4.2 System Configuration

4.2.1 General

a) PLC system configuration shall be as specified in the job specification. For emergency shutdown system application specified with SIL classification, the system configuration shall be TMR or QUAD or DMR as per the job specification and shall be certified by independent agency e.g. TUV/ EXIDA.

b) Regardless of the action feature selected (except for single architecture), the failure of single component shall not result in a failure of correctly executed safety function. The degradation mode for the selected configuration e.g. 4-2-0 or 3-2-0 or 3-2-1-0, etc. shall be documented in SIL certification report.

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c) In general, the PLC system shall comprise of various sub-systems as described in the subsequent clauses of 4.2.

4.2.2 **Input/Output subsystem**

4.2.2.1 Each I/O module shall have its own processor. I/O modules configured in redundant configuration, shall have their processors properly synchronised.

4.2.2.2 Unless otherwise specified, system shall accept analog 4 – 20mA inputs and contact inputs. The maximum number of Input/Output per I/O module shall be limited as per the following table.

Sl. No.	Type of Configuration	Maximum No. of I/Os
1	Single I/O system	8
2	Dual I/O system	16
3	Triple Modular Redundant system (TMR)	32
4	Quadruple Modular redundant System (QUAD)	16

In case of PLC certified for SIL requirements, the maximum number of I/O's shall be governed by the SIL certification applicable for specified SIL level.

4.2.2.3 Each I/O shall be galvanically isolated from external control circuit by suitable means. The minimum isolation level between I/O and logic circuit shall be 1000 volts AC. External isolators/ barriers / relays shall be provided for all inputs and outputs of the PLC.

4.2.2.4 Each I/O shall be protected against the reversal of polarity of the power voltage to I/O.

4.2.2.5 Each input shall be provided with filters to filter out any noise in the input line and contact bouncing noise, as applicable.

4.2.2.6 All the inputs / outputs shall be double ended upto the I/O card i.e. two wires per input / output and not with common return for all inputs/ outputs.

4.2.2.7 The interrogation voltage to the inputs and power supply for 2-wire instruments shall be powered from separate redundant power supply / supplies and shall not be a part of PLC, unless otherwise specified. This power supply shall be supplied at one point and shall be distributed by the vendor.

4.2.2.8 a) Each I/O module channel status shall be represented on the operator console.

b) When specified, input module shall be capable of monitoring the input contacts for any wire open fault and short circuit.

4.2.2.9 Analog Input Module

a) Input module shall be able to accept 4~20 mA DC input from smart transmitters (e.g. 4 – 20mA HART).

b) The module shall have 16 bit A/D resolution accuracy of ±0.25% of full scale over the entire range, unless otherwise specified.

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4.2.2.10 Output Contact

a) Output contacts from the PLC shall be potential free dry contacts with contact rating as per para 4.2.2.10 b) of this specification. Vendor must provide arc suppression device for each output contact.

b) The output contact rating shall be as follows:

Sl. No.	APPLICABLE FOR	VOLTAGE RATING	CURRENT RATING
1.	All output cards driving solenoid valve and alarm annunciator system unless otherwise specified Category – I	110 V AC/ DC	0.5 A
	Category - II	24 V DC	2 A
2	All motors/pumps/compressor output cards unless otherwise specified. Category – I	240 V AC	5.0 A
	Category - II	220 V DC / 110 V DC	0.2 A

c) The category of contacts shall be specified in the Requisition. Each output shall be short circuit proof and protected by fuse. Visual indication of fuse blown must be provided for each module.

d) When specified contact output module shall have monitored output features like wire open and short circuit.

4.2.2.11 Where inputs or outputs have multiple field devices for the same measurement or device, the corresponding inputs / outputs shall be configured in separate I/O modules.

4.2.2.12 Where single input signal is available for QUAD or TMR configuration, inputs shall be multiplied to feed inputs to each input modules / channels.

4.2.2.13 PLC shall be provided with Auto I/O testing facility as a standard diagnostics features. PLCs which do not have auto I/O testing facility, manual testing facility shall be provided to detect any system fault. For manual testing, manual switches shall be provided to bypass each input at a time and its effect on the output shall be monitored.

4.2.3 **Processor System**

4.2.3.1 The processor shall have capability to implement all the control functions required to implement the logic scheme as logic/ladder diagram.

4.2.3.2 The size of the memory shall be sufficient for storage of the program instructions required by the logic schemes and other functional requirements. Offer shall indicate the amount of memory capacity occupied by the actual program and spare capacity available for future program modifications or additions.

4.2.3.3 Memory shall be non-volatile. However in case volatile memory is provided, battery backup shall be provided with a minimum of 3 months lifetime to keep the program storage intact. A battery drain indication shall be provided at least one week before the battery gets drained.

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4.2.3.4 Watchdog timer shall be a software device. The healthiness of processors shall be continuously monitored by watchdog timer. Any hardware or software problem in the processor system, which shall include, CPU, memory, power supply, communication interface etc. shall cause the watch dog timer to report processor failure.

4.2.3.5 Wherever dual redundant processor is specified, redundancy shall be provided in such a way that in case of failure of the main processor, the standby shall take over automatically. The changeover shall be bumpless. Redundancy shall be provided for complete processor system including processor, power supply and communication sub system.

4.2.3.6 In case of triple modular redundant system all the three processors shall execute the same instructions/program and check their results and vote to correct any faulty result. The faulty processor diagnostic shall be made available.

4.2.3.7 In case of Quad system, individual processor shall execute the same instructions/ programs and check their results within same CPU module and majority vote to correct any faulty result. The faulty processor diagnostic shall be made available.

4.2.3.8 Failure of a single processor in dual redundant, triple redundant system and two processors in QUAD system shall not affect the system. In case of failure of complete processor system i.e. both processors in case of dual configuration, two or more in case of triple redundant system and more than two in case of QUAD system, outputs shall take failsafe state automatically unless otherwise specified in the data sheets.

4.2.3.9 In case multiprocessor configuration is offered, the processors must be able to communicate with each other over the interconnecting data link. Vendor must ensure that system performance shall not be degraded by any means when such a system is offered.

4.2.3.10 It shall be possible to generate the first out alarm by the PLC in case where a group of parameters are likely to trip a system.

4.2.4 PLC Console (Engineering / Programming)

4.2.4.1 The PLC console shall be used for programming, program storing, fault diagnostics and alarm monitoring. Whenever specified, it shall also be possible to use this console for plant operation. The functionality to operate as engineering / programming terminal or operator terminal or both shall be as specified in the job specification.

4.2.4.2 It shall consist of at least one coloured 21" active matrix TFT type LCD display unit with backlit LED and one programming / operating keyboard, mouse and printer. If laptop is specified in the job specifications, the same shall be of 15" TFT type LCD display.

4.2.4.3 PLC console when used for plant operation shall also meet the functional requirements as per clause 4.2.5 of this specification.

4.2.4.4 The keyboard shall be easy to operate with each key clearly identified.

4.2.4.5 All illegal entries shall be rejected by the terminal and shall be identified by warning signal on VDU.

4.2.4.6 Manual forcing of any input or output contact connected to PLC shall be possible from keyboard. Forced functions shall have an associated audit trail.

4.2.4.7 It shall be possible to modify, add or delete the application program on line without affecting the outputs.

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4.2.4.8 PLC Console shall display logic and/or ladder diagram indicating power flow and shall show description and status of each contact. It shall also be possible to display process alarms and diagnostic messages as and when they appear. Further it shall also be able to display I/O map in a user defined format.

4.2.4.9 It shall be possible to print out the ladder/logic diagram on the dedicated PLC printer. The printer in addition shall also print out:

a) The diagnostic messages as and when generated and diagnostic reports, when called for.

b) Process alarms connected to the programmable logic controller as and when they appear and alarm report whenever initiated. The choice of printing alarms on this printer shall be operator selectable from a key lock / password protected switch on PLC console.

c) The I/O maps showing status of all inputs and corresponding outputs in a user defined format.

4.2.4.10 The PLC console shall be provided with self diagnostics feature which shall display error messages and initiate an audible alarm if the fault is detected. Wherever specified, a potential free contact for diagnostic group alarm shall be provided which shall be connected to the hardwired alarm annunciator system.

4.2.4.11 The system shall be able to identify the failure at least up to the module level including I/O system and redundant processor and report print out.

4.2.5 **PLC Console (Operator)**

4.2.5.1 Where dedicated PLC operator console is specified, it shall be used for operation of plant, fault diagnostics, alarm monitoring and report generation.

4.2.5.2 It shall consist of coloured 21" active matrix TFT type LCD display unit with backlit LED, operator keyboard and printer unless specified otherwise.

4.2.5.3 At least two number cursor control devices shall be provided in addition to keyboard which may include touch screen, mouse, track ball etc.

4.2.5.4 PLC operator console shall have complete graphic capability and shall be able to display process dynamic graphics, overview and group view displays. It shall be possible to operate the plant i.e. start and stop of rotating machinery, opening and closing of valves, PID function etc. from dynamic graphics and group displays available on PLC operator console.

4.2.5.5 It shall be possible to monitor, historise and print out all process alarms, diagnostic alarms and alarm reports.

4.2.5.6 The time stamping of all alarms shall be as per PLC processor time stamping or I/O module stamping.

4.2.5.7 The system shall be able to store and display stored data wherever required. The minimum storage capacity shall be for 30 days at 1 minute sample rate for all the inputs specified, diagnostic alarms, process and first out alarms, manipulation data etc.

4.2.5.8 The system shall be able to generate shiftly, hourly, daily, weekly and monthly reports. The log format shall be furnished during detailed engineering.

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4.2.5.9 The system shall be supplied with first out alarm generation capability. The resolution of alarm shall be as per processor cycle time, as a minimum.

4.2.6 **Communication Subsystem**

4.2.6.1 The PLC communication subsystem shall be a digital communication bus that provides a high speed data transfer rapidly and reliably between the processor, I/O sub-system, PLC console and other devices connected in the PLC system.

4.2.6.2 Redundancy in PLC communication subsystem shall be provided as follows unless otherwise specified:

a) For single architecture, the communication subsystem between PLC processor and I/O subsystem shall be single unless otherwise specified. This shall include single communication bus and single interfaces/buffers.

b) For dual I/O configuration, each I/O sub set shall have separate communication interface and bus for connecting to PLC processors.

c) For the triple redundant system, each processor shall have a separate set of PLC communication subsystem.

d) For the Quad systems each I/O subset shall have redundant communication interface and bus for connecting to the redundant CPU modules.

e) The communication subsystem between processor subsystem and PLC console shall be dual redundant, consisting of two separate communication interfaces and two buses, each one configured in redundant mode, unless this is only used as programming aid.

4.2.6.3 In case of redundant PLC communication sub system, on the failure of the active device, the redundant device shall take over automatically without interrupting the system operation. Information about the failed device shall be displayed at local as well as on PLC console. It shall be possible to manually switch over the communication from main bus / device to redundant bus / device without interrupting any system function.

4.2.6.4 The mechanism used by the system for error checks and control shall be transparent to the application information / program. Error checking shall be done on all data transfers by suitable codes.

4.2.6.5 In general, PLC shall provide data in a well established protocol format preferably MODBUS protocol.

Wherever remote I/O is specified in the requisition, it shall be redundant and SIL3 certified (for SIL3 PLCs).Segregation for the remote I/O shall follow the same philosophy of group wise PLC segregation specified in the requisition. Moreover, separate PLC in remote I/O location with peer to peer communication with Host PLC through third party (TUV/ EXIDA etc.) certified SIL3 redundant network is also acceptable for remote I/O requirement. However, separate PLC shall be considered for each of the Remote I/O subsystem within each location.

4.2.7 **System Power Supplies**

4.2.7.1 Unless specified otherwise, the programmable logic controller shall operate on uninterrupted power supply (UPS). However the system shall be capable of operating satisfactorily at the following power supply specifications:

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Voltage	110/ 240 V ±10% (as specified in requisition)
Frequency	50 Hz ±3 Hz
Harmonic contents	Less than 5%
Power interruption	10 millisecond

4.2.7.2 The power supply system shall be supplied with dual PLC feeders each capable of handling 100% of the total power supply load requirements. In case of failure of one feeder, redundant feeder shall supply the total load.

4.2.7.3 Each I/O rack shall be provided with redundant power supply system. The power supply for the I/O racks shall be sized to take full load of the I/O racks.

4.2.7.4 The processor rack shall be provided with separate power supply for each processor or redundant power supply module for the processor rack such that failure of one power supply does not affect the system operation.

4.2.8 **Self Diagnostics**

4.2.8.1 The system shall have an extensive set of self diagnostic routines which shall be able to identify all permanent and transient system faults / failures at least up to module level including redundant components and power supplies through detailed VDU displays and report print out.

4.2.8.2 At the local level, failure of a module in any subsystem shall be identified by an individual LED.

4.2.8.3 Diagnostic software shall have the capability to provide information about the failed module/system either in the form of a system configuration display or provide information in the form of a "statement".

4.2.8.4 Self diagnostic software shall have capability to detect faults which make the system permanently close/open in the I/O modules or I/O signal conditioning modules (in case of triple redundant system). This shall be achieved by automatically running the self diagnostic software at cyclic intervals. However, system performance shall not be degraded during the running of this diagnostic software.

4.2.8.5 System for the following functionalities shall be supplied when specified:

a) Long storage historisation

b) Log report generation

c) First out alarm generation

4.2.8.6 System diagnostics shall be capable of identifying, locating and reporting the following faults, as a minimum:

a) Processor fault

b) Communication fault

c) I/O module fault

d) Power supply fault

e) Over temperature monitoring

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f) Permanently close / open (stuck on or off) fault

g) Memory fault

h) Signal redundancy fault

Any other additional diagnostic alarm if available as a standard shall also be provided by vendor.

4.2.8.7 Testing software shall be capable of detecting faults in case of normally closed system as well as in normally open system.

4.2.8.8 Feedback must be provided in case of triple redundant system and QUAD system from the output voter system to detect any latest faults of the system in addition to other diagnostic software.

4.2.9 **System Software**

4.2.9.1 The system software shall include all programs for the PLC and PLC console which are required to perform all the PLC functions including communication and self-diagnostics. Whenever PLC is specified for shutdown application with SIL classification, the system shall be designed and engineered in full compliance with the requirement of IEC-61511. Whenever different functional logics are combined within a common PLC, the safety related I/O's of each functionality shall be kept segregated within the system.

4.2.9.2 Logic program shall also be recorded on the external electronic media like DVD which shall be delivered in duplicate together with the system.

4.2.9.3 The PLC programming language for implementation of logic operations shall be based on the following representations:

a) Logic diagrams - Binary logic symbols such as AND, OR, NOT Gates, Timers and Flip-Flops.

b) Ladder diagram - Series / parallel connection of relay contacts.

c) Combination of (a) & (b) above.

4.2.9.4 Diagnostic package and its related equipment and software shall be supplied. A list of additional diagnostic packages available and the packages provided, including the description and capabilities, shall be provided with separate quote, wherever asked.

4.2.9.5 It shall be possible to print out the ladder/logic diagram on a dedicated printer. The printer shall also print out all diagnostic reports. The software package shall enable the owner to modify/add/delete any part of program both on-line as well off-line and for documentation.

4.2.9.6 Software for the generation of various displays including dynamic graphics wherever specified to be provided as per given below:

4.2.9.6.1 It shall be possible to display dynamic graphic of plant on the operator console VDU screens. Graphic displays shall be field configurable only through PLC Console (Programming terminal) with standard / user defined graphic symbols. Dynamic graphic displays of different sections of the plant shall be displayed on different pages.

4.2.9.6.2 The system shall have graphic symbol library as per ISA-5.1 and 5.3. In addition standard industrial symbols like distillation columns, heat exchangers, pumps, compressors, tanks etc. shall also be provided as a standard.

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4.2.9.6.3 Graphic displays shall be interactive type through which it shall be possible to control the process. It shall also be possible to send motor start/stop and shutdown valve open/close commands, as specified in job specifications, from this display

4.2.9.6.4 It shall be possible to view the process variable and alarm points and view and change set point value, manipulated variable, controller mode etc. from the graphic display. Also rotating machinery (i.e. compressor / pump) status and valve status shall be displayed on the graphic display with different colours.

4.2.9.6.5 Various colours used in the generation of graphics like colour of the process lines, utility lines, Instrument signal lines and event modifier conditions shall be finalised during detailed engineering. The colours used to identify event modified conditions shall generally be as follows unless otherwise indicated during detailed engineering.

Red	:	All points alarm
Blue	:	Valve open, pump running.
Green	:	Valve closed, pump stopped.
Flashing green	:	Shut down valve transition state.

4.2.9.6.6 It shall be possible to go from any graphic page to related graphic pages or any group view or alarm summary in single key stroke using soft key function.

4.2.9.7 The software for printing alarms, system as well as process, and events on the PLC printer must be provided. All alarms must be printed as and when they appear.

4.2.9.8 Software package for displaying I/O map showing status of inputs and corresponding output providing tag numbers as per logic diagram shall be offered. The I/O map format shall be user definable.

4.2.10 **Power Supply Distribution**

4.2.10.1 All type of power supplies shall be made available at one point. Further distribution of power supply shall be in vendor's scope.

4.2.10.2 In general, all output contacts and solenoids shall be powered with 110V±10% DC/ 24V±10% DC power supply. However, the actual interrogation voltages shall be as per job specifications and logic diagrams.

4.2.10.3 The distribution network for interrogation voltage shall be designed such that a single fault in any branch shall not cause trip of the logic other than where the fault has occurred.

4.2.10.4 Sequential starting of various load centres shall be provided whenever specified.

4.2.10.5 Power distribution network must use bus bars of adequate capacity with DPDT (Double Pole Double Throw) switches and HRC (High Rupture Capacity) fuses in each branch network. Vendor may select circuit breaker if short circuit characteristics do not match the HRC fuse.

4.2.10.6 All cubicles lighting shall be on 240 V, 50 Hz AC normal power supply.

4.2.11 **PLC System Cabinets**

4.2.11.1 All PLC system cabinets shall be completely wired with all modules in place. Inside cabinet wiring shall preferably be done using ribbon type pre-fabricated cables.

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4.2.11.2 All the cabinets shall be free standing, enclosed type and shall be designed for bottom entry of cables. Cabinet structure shall be sound and rigid. Cabinet shall be provided with remova IS/IEC ble lifting lugs to permit lifting of the cabinets.

4.2.11.3 Cabinets shall be fabricated from cold rolled steel sheet of minimum 1.5 mm thickness for sides and rear and 2 mm thickness for doors and suitably reinforced to prevent warping and buckling. The rack/ rail mounting plates inside the cabinets shall be of 3 mm thickness. Cabinets shall be thoroughly deburred and all sharp edges shall be grounded smooth after fabrication. Cabinet frame shall be of 9 fold profiled CRCA or of Angle iron frame using minimum section of 50 x 50 x 4 mm angle.

4.2.11.4 Cabinet painting procedure shall include blast cleaning, grinding, chemical cleaning, surface finishing by suitable filler and two coats of high grade lacquer with wet blasting wherever required. Two coats of paint in the panel colour shall be provided for non-glossy high satin finish. Final coat shall be given after assembly at site. Colour of the panels shall be as per Requisition.

4.2.11.5 Each cabinet shall be maximum 2100 mm high (excluding 100 mm channel base), 800 mm wide and 800 mm deep, in general. Construction shall be modular preferably to accommodate 19" standard racks. All cabinets shall be of same height.

4.2.11.6 Cabinets shall be equipped with front and rear access doors. Doors shall be equipped with lockable handles and concealed hinges with pull pins for easy door removal.

4.2.11.7 In order to effectively remove dissipated heat from the cabinets, ventilation fans along with vent louvers backed by wire fly screen shall be provided as required. Ventilation fans shall be provided in all cabinets where the temperature rise with all doors closed and all internal and external loads energised shall exceed 10° C above the ambient temperature. A temperature element (resistance temperature detector or semiconductor type sensor) shall be provided in each System cabinets and temperature switch as a minimum in each marshalling/ PDB cabinet for temperature measurement. Ventilation fans shall be provided in dual configuration, as a minimum.

Each fan shall have a separate dedicated assembly and shall be replaceable on-line without shutting down any equipment/ cabinet/ console in part or in complete.

Ventilation fan assembly shall operate at 240V AC power supply. Each fan shall have its own dedicated circuit breaker.

Each ventilation fan shall be fitted with a protection type finger guard. Whenever, the numbers of cabinets are compacted (supplied in mechanical joined conditions), each cabinet shall be provided with separate ventilation fan assembly.

The maximum noise level with all fans operating and cubicle doors open shall not exceed 85dBA.

Following signals and alarms shall be provided separately as follows:

i) Fan failure alarm for each system cabinet in PLC

ii) Temperature indication of each system cabinet in PLC.

iii) A common high temperature and fan failure alarm in the PLC for each marshalling / PDB cabinets for a group of maximum 10 cabinets as per the requisition.

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4.2.11.8 Internal illumination shall be provided for cabinets to ensure proper illumination level of 250 lux for performing maintenance activities.

Lamps shall be provided in each cabinet which shall be activated individually by door operated switches. The lamps shall activate when door is opened and deactivate when the door is closed. The door lock switches selected shall have undergone life cycle cyclic test of at least 1000000 operations and test certificate for the same shall be provided from the manufacturer. A manual over-ride switch shall be provided inside the cabinet which shall keep the lamp deactivated even when the door is open. Cabinets housing memories, which are likely to be affected by fluorescent light, shall have incandescent lamps.

The cabinet lighting shall operate on 240V AC Non-UPS power supply.

4.2.11.9 Equipment within the cabinet shall be laid out in an accessible and logically segregated manner. Cable glands shall be provided and supplied by vendor for incoming and outgoing cables to prevent excessive stress on the individual terminals. All metal parts of the cabinet shall be electrically continuous and shall be provided with a common grounding lug.

4.2.12 **Control Panel /Hardwired Console**

4.2.12.1 Control panels, if required, shall be non-graphic self supporting, free standing cubicle with back doors made up of sectional steel panels. Each section shall be maximum 2100 mm high, 1200 mm wide and 1000 mm deep and shall be mounted on 100 mm high channel base. Care shall be taken to ensure that the face of the panel is truly flat and smooth.

4.2.12.2 Panels / hardwired console shall be fabricated from 3.0 mm thick cold rolled steel sheet. Angle iron frame shall use a minimum section of 50x50x4mm angle.

4.2.12.3 Front of panel/console instrument nameplates shall be black laminated plastic with white core. Nameplate shall be provided on the rear of the panel also for each instrument.

4.2.12.4 Document pocket / wallet shall be provided on the inner side of front and rear doors of each cabinet and on the inner side of the door of each panel. Similar arrangement shall also be made on the inner side of doors of console.

4.2.13 **Wiring Requirements**

4.2.13.1 All wiring shall conform to API RP 552- Transmission Systems. Different signal level cables shall be routed with separation distances as recommended by this code.

4.2.13.2 All wiring inside racks, cabinets, and back of the panels shall be housed in covered, non-flammable plastic raceways arranged to permit easy assembly to various instruments for maintenance, adjustments, repair and removal.

4.2.13.3 All wiring in the raceways shall be properly clamped. All incoming cable and outgoing cables shall be terminated by vendor at marshalling rack. Total wiring cross-sectional area shall not exceed 50% of the raceway cross sectional area.

4.2.13.4 Separate wiring raceways shall be used for power supply wiring, DC and low level signal wiring, and intrinsically safe wiring. Parallel runs of AC and DC wiring closer than 300mm shall be avoided.

4.2.13.5 Vendor can alternately offer prefabricated cables for interconnection between different cabinets and panels.

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4.2.13.6 Wire termination shall be done using self insulating crimping lugs. More than two wires shall not be terminated on one side of single terminal. The use of shorting links for looping shall be avoided.

4.2.13.7 Terminal housing shall be strictly sized with considerations for accessibility and maintenance. Minimum distance required between various components is listed below. These distances are clear distances and are excluding the width of the raceways or any other component / item mentioned herein. Following clearances should be considered:

a) Distance between terminal strip and side of the cabinet parallel to the strip, up to 50 terminals, shall be minimum 50 mm.

b) Distance between terminal strip and, top and bottom of the cabinet shall be minimum 75 mm.

c) Distance between two adjacent terminal strips shall be minimum 100 mm.

d) Additional distance for each additional 25 terminals shall be minimum 25 mm.

e) Distance between cable gland plate and the bottom of the strip shall be minimum 300 mm.

4.2.13.8 All terminal / terminal blocks shall be DIN Rail mounted type and shall be easily removable. The size of the terminal blocks / terminals of different types shall be consistent and identical. All terminal blocks shall be mounted on suitable anodised metallic or plastic stand-off.

4.2.13.9 No splicing is allowed in between wire/ cable straight run.

4.2.13.10 Terminal strips shall be arranged group-wise for incoming and outgoing cables separately. Terminal blocks for intrinsically safe wiring shall be separate. 20% spare terminals shall be provided, as a minimum, preferably in each terminal strip. Terminals shall be suitable for wires up to 2.5 sq. mm base solid or stranded conductor in general. For power cables, higher size terminals shall be used.

4.2.13.11 Cabinet and rack layout shall be made considering proper accessibility and maintenance.

4.3 Earthing

4.3.1 All system equipment such as marshalling cabinets, system cabinets and other powered equipment shall be provided with following type of grounding system:

a) Protective Earth / Electrical Earth

b) System earth / signal earth

Both system earth and safety earth shall be totally separate from protective earth.

4.3.2 Protective Earth / Electrical Earth

a) Earth metallic enclosure / cabinet / console etc. shall be provided with electrical earth lug, as a minimum.

b) Unless recommended otherwise by vendor, all earthing lugs of metallic equipment indicated in Clause 4.3.2(a) above shall be connected individually to electrical protective earthing system bus-bar / earthing station using a maximum of 10sq mm solid copper conductor PVC insulated wires.

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c) Where multiple cabinets are multiplexed together, earth looping with permanent shorting link cables shall be acceptable. Earthing connection wires as indicated in Clause No.4.3.2(b) above shall be used for connecting multiplexed cabinets to protective earth station / bus-bar.

4.3.3 **System Earth**

a) System earth shall be totally noise free dedicated earthing system and shall be fully isolated from electrical protective earth. This earth must be very high integrity system and shall be used to ground zero volt references and signal cable grounds.

b) System earth shall be less than one (1) ohm grounding system or as per vendor's recommendation with its own dedicated earth pits. The earth pits shall be suitably located outside the control room and away from any heavy noise plant equipment.

The earth pit design shall be as per IS-3043 code of practice for earthing. A minimum of two (2) number of earth pits, in redundant configuration, shall be provided in each Control room / SRR / Remote IO cabinet location for System earth. In case number of pits required to meet system earth resistance are more than one (1) number, the number of system earth pits shall be two times the actual number of pits required to meet the redundancy requirement specified above. All these system earth pits shall be securely connected with each other to form a one homogeneous system earth grid.

c) Each marshalling / system cabinet etc. shall be provided with system earth bus-bar which shall be insulated from the metallic body frame. This bus-bar shall be used to earth also signal zero volt references and signal cable screens. Terminals used for termination of spare conductor pairs / cores of multi-pair signal / control cables shall be connected to system earth bus-bar. Shorting links shall be used for spare terminal looping.

d) System bus-bars in the multiplexed cabinets can be joined together by permanent shorting links. System bus-bars of other cabinets can also be connected together provided they are permanently joined using 35 sq. mm stranded copper conductor cable.

c) The redundant System earth pits at each location shall be connected to the Electrical protective earthing system through suitable surge isolation and protection device for lightning equipotential bonding. These lightning surge isolation and protection devices shall comply to the requirements of IEC 62561-3.

4.4 Interface with DCS

The PLC shall be required to be interfaced to the Distributed Control System bus whenever specified. A suitable interface shall be offered in order to achieve the following functions:

a) Display of all input points under alarm/first out alarm connected to PLC or generated by PLC, continuous indication for analog signal on the main DCS operator console.

b) Generate shutdown reports on the logging printer of Distributed Control system.

c) To receive certain operational commands from the operator console for the operation of certain output devices connected to PLC

d) To display diagnostic message of PLC.

In general, PLC shall provide data in a well established MODBUS protocol format.

The interface shall be dual redundant unless otherwise specified.

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The speed of data transfer shall be such that any change in I/O which is to be updated on the operator console shall not exceed 3 second from the time event to update on the operator console screen considering one second standard update rate in DCS operator console.

4.5 Sequence of Event (SOE) Function Requirement

Sequence of Event, whenever specified, for analog and digital inputs shall be generated and time stamped in PLC. The maximum resolution between two events shall not exceed specified PLC scan time unless specified otherwise. A separate SOE PC with colour 21" active matrix TFT type LCD display unit with backlit LED and printer shall be provided for PLC sub-system unless specified otherwise.

The following signals or changes of state shall also be logged as part of the Sequence of Event functionality:

For each hard wired analog input:

- Shutdown / trip alarm
- Input Measurement diagnostic status (e.g. input out of range)
- Maintenance override status (wherever provided)
- Input force status.

For each hard wired digital input:

- Shutdown / trip alarm
- Input status (e.g., line breakage)
- Maintenance override status (wherever provided)
- Input force status.

5.0 TESTING, INSTALLATION, COMMISSIONING AND ACCEPTANCE

5.1 General

5.1.1 This specification defines the basic guidelines to vendor for factory testing and acceptance, installation, commissioning and field acceptance of the complete PLC system. On the basis of this specification, vendor shall submit their own detailed testing, installation, commissioning and acceptance procedure. For hardware, the procedure shall include test name, purpose of test, test equipment / set up, definition of input, test procedure, results expected and acceptance criteria. Similarly for software, it shall include test name, details of the method, list of tests, sequence of execution, results expected and acceptance criteria. For PLC system with SIL 3 requirement, certificate for hardware & software (Like TUV/ EXIDA) shall be verified.

5.1.2 The testing and acceptance of the system shall be carried out on the approved testing procedures and criteria based on this specification and vendor's standard testing requirements and procedures.

5.2 Factory Acceptance Tests (FAT)

5.2.1 Vendor shall test and demonstrate the functional integrity of the system hardware and software. No material or equipment shall be transported until all required tests are successfully completed and certified "Ready for Shipment" by the owner/consultant.

5.2.2 The purchaser reserves the right to be involved and satisfy himself at each and every stage of inspection. The purchaser shall be free to request any specific test on any equipment

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considered necessary by him although not listed in this specification, as a part of approval of factory testing procedure. The cost of performing all tests shall be borne by the vendor.

5.2.3 Vendor to note that acceptance of any equipment or the exemption of inspection or testing shall in no way absolve the vendor of the responsibility for delivering the equipment meeting all the requirements specified in Requisition.

5.2.4 It shall be vendor's responsibility to modify and/or replace any hardware and modify the software if the specified functions are not completely achieved satisfactorily during testing and factory acceptance.

5.2.5 Schedule of FAT shall be included in the Vendor's proposal.

5.2.6 Vendor shall not replace any system component/module/sub-system unless it is failed. A log of all failed components/modules in a sub- system shall be maintained which shall give description of the failed component/module, effect of failure on the sub-system, cause of failure and number of hours of operation before it failed. If malfunction of a component/module in a sub-system repeats, the test shall terminate and vendor shall replace the faulty component/module. Thereafter the test shall commence all over again. If even after this replacement, the sub-system fails to meet the requirements, vendor shall replace the full sub-system by the one meeting the requirements and the system shall be tested all over again. If a sub-system fails during the test, which is not repaired and made operational within four hours of active repair time after the failure, the test shall be suspended and restarted all over again only after the vendor has replaced the device in the acceptable operation.

5.2.7 Testing and FAT shall be carried out in two phases. The minimum requirements for testing during these two phases shall be as follows:

5.2.7.1 Under the first phase, vendor shall perform tests at his works to ensure that all components function in accordance with the specification for each type of test. A test report shall be submitted for purchaser review within one week of completion of this test. Phase II testing (witness inspection) shall start only after this.

All sub-systems shall undergo a minimum of 30 days (720 hours) burn-in period and this can include FAT duration. Should there be a failure noted during FAT, this duration shall be extended. It may include any such time for which the system has been kept powered on even for system generation and Phase-I testing.

Following tests shall be performed by the vendor and reports shall be forwarded to purchaser:

a) Quality control test which shall be carried out to assure quality of all components and modules in accordance with vendor's quality control and assurance procedures.

b) System pre-test which shall be physical check of all modules, racks, cabinets etc.

c) System power-up test which shall test functionally all hardware and software. This shall include testing of redundancy, System performance on power supply variations, application software testing and system diagnostic verification.

5.2.7.2 The second phase of testing shall systematically, fully and functionally test all hardware and software in the presence of purchaser representatives. All subsystems shall be interconnected to simulate, as close as possible, the total integrated system. Following minimum tests shall be carried out:-

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a) Visual and mechanical testing, which shall be carried out in principle to assure correct, proper, good and neat workmanship by the vendor This testing shall include dimensional verification, Layout verification as per approved GA drawings, Verification of Sheet thickness / Quality of painting (outer and inner) / Nameplates, identifiers and tag plates / Adherence to ferruling philosophy / Dressing of wires / prefabricated cables and clearances / Locks and handles as a minimum.

b) Verification of Bill of Material. The Bill of material verification shall include both hardware and software.

c) Functional testing:

This shall include the simulation of each input and output to verify proper system response. The testing as a minimum shall include:

i) Complete system configuration loading.

ii) Demonstration of all PLC system builder functions including addition/deletion of an input/output, addition/ deletion of a rung or an element in a rung, generation of dynamic graphics and other views, report generation etc.

iii) 100% checking of logics configured in the PLC by connecting switch/lamp at input/output, by simulating inputs and verifying outputs preferably using simulator, other related functions like forcing, first out shall also be verified.

iv) Checking of scan time. Scan time verification shall be carried out during Factory Acceptance Test based on the specified requirements considering discrete input by given step change and Step input or slow ramp input (typical frequency of 4 cycles / second) with amplitude corresponding to 16mA (4mA to 20mA or vice versa) for all conventional analog and smart (HART) inputs from a signal generator. The scan time values so observed shall be within 90% confidence level.
The inputs to the system shall be:

- Step input i.e. 0 or 1 for all contact inputs. Step input can be generated by wiring back a digital output configured for the purpose.
- Step input or ramp input for all analog inputs. However, for PLC, the scan time check with analog inputs shall only be for record purposes.

v) Checking of all PLC console displays, keyboard and touch-screen operation (wherever specified), printer/hard copier functions etc.

vi) System redundancy checks including correct changeover of the back-up unit in case of failure of main unit.

vii) System diagnostic checking for all subsystems on local level as well as on console, including checking of the testing software for I/O modules/signal conditioning modules, when specified.

viii) Checking of output status on processor failure.

ix) Checking of first-out alarm generation.

x) Simulation of power failure and system restart auto boot-up of system configuration and program after power restoration.

5.2.8 Vendor shall notify the purchaser at least three (3) weeks prior to factory acceptance test. In the event that representative arrives and the system is not ready for testing, vendor shall be liable for back charges for any extra time and expenses incurred.

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5.3 Installation, Testing and Commissioning

5.3.1 Vendor shall offer the services of an installation team which would install the equipment in the control room, lay the interconnecting cables inside control room, check-out, test and commission the system.

All technical personnel assigned to the site by the vendor shall be fully conversant with the supplied system and software package, and shall have both hardware and software capability to bring the system on line quickly and efficiently with a minimum of interference with other concurrent construction and commissioning activities.

5.3.2 Vendor's responsibility at site shall include all activities necessary to be performed to complete the job as per Requisition including:

a) Receipt of hardware/software and checking for completeness of supplies.
b) Installation of the system including for free supply equipment, if any.
c) Field cable termination and inter-cabinet cabling and termination.
d) Check out equipment installation.
e) Checking of interconnections, hardware and software configuration, overall system functioning etc.
f) Loop checking.
g) Field tests.
h) Commissioning and on-line debugging of the system.
i) Involvement during plant commissioning and performance of final acceptance test.
j) Co ordination for integration with DCS / other third party system.

5.3.3 **Field Inspection**

5.3.3.1 All equipments shall be inspected thoroughly by vendor after its receipt at site for completeness and proper functioning. Vendor must initiate the remedial action, in case unsatisfactory operation of any item is observed, with intimation to Engineer-in-charge.

5.3.3.2 Vendor must document all observations including details of any malfunction observed. Items/ equipments requiring total replacement must document the reasons for the same.

5.3.4 **Loop Checking**

5.3.4.1 Loop checking shall be carried out by vendor including checking the interconnections, configuration and overall system functioning.

5.3.4.2 Vendor's scope of work as a part of system installation and loop checking shall include termination of field cables in the control room, checking of interconnection between instrument/equipment, glanding, ferruling/tagging of interconnecting cables in control room, ferruling of field cables in control room and performing overall loop performance check.

5.3.4.3 Vendor shall coordinate with the field contractor for smooth and proper loop checking. Any discrepancy found during checking shall be brought to the notice of the Engineer-in-Charge. Complete loop checking shall be performed in his/her or his/her authorised representative's presence.

5.3.4.4 The input signals shall be simulated by disconnecting/connecting the field wires for all field switches connected to PLC. All field transmitters connected to control room shall be loop checked at 0%, 50% & 100% of full scale (for both increasing and decreasing signals). Wherever receiver cards are used, the set point shall be generated by giving the input signal to receiver card. All outputs shall be checked in field, either for actual operation of solenoid valve or actual pick-up of electrical contactor for rotary equipments. Shutdown schemes shall be checked for proper functioning, configuration and actuation.

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5.3.4.5 After loop checking is completed, vendor shall connect back any terminals and connections removed for loop checking.

5.4 System Acceptance

5.4.1 The owner shall provisionally takeover the system from vendor after System acceptance test. System acceptance test shall be started only after the satisfactory performance of loop checking and verification of all loop checking records by Engineer-in-charge.

5.4.2 The system acceptance test shall be carried out in the presence of owner's representative and Engineer-in-charge or his authorised representative. The tests carried out in System acceptance test shall be fully recorded and duly signed by all representatives participating in the System Acceptance Testing.

5.4.3 Vendor shall carry out the following functional tests, as a part of system acceptance test, as a minimum:-

a) Hardware verification as per final Bill of Material.
b) Visual and mechanical check-up for proper workmanship, identification, ferruling, nameplates etc.
c) System configuration as per approved configuration diagram.
d) Demonstration of all system function, display and diagnostics.
e) Checking of correct change-over of redundant devices.
f) Checking of various peripheral devices like printers and printing of all reports.
g) Complete checking of logic system, loading of user's program and checkout of results.
h) Checking of proper functioning of all disc drives, alarm summary, alarm history etc.
i) Proper information transfer on the information network by verifying system displays and printout.

5.5 Final Acceptance Test

The owner will take over the system from the vendor after the final acceptance test, which is defined as successful uninterrupted operation of the integrated system for three weeks. Vendor's personnel shall be present during the test. Any malfunctioning of the system components shall be replaced / repaired as required. Once the system failure is detected, the acceptance test shall start all over again from the beginning. The warranty period commences from the day owner takes over the system.

6.0 GENERAL REQUIREMENTS

6.1 Vendor shall comply fully with the general requirements of PLC system including logistic support services, documentation, warranty, maintenance contract and shipping instructions.

Post Warranty Maintenance Contract

Vendor shall quote separately for post warranty maintenance contract after warranty period for five years for the complete system as per commercial terms and condition of the requisition and the type (i.e. comprehensive or non-comprehensive) of post warranty maintenance shall be as specified in job specification. The personnel deployed during post-warranty maintenance shall have thorough knowledge of the system and at least two years of experience on the maintenance of similar system. Any other conditions of contract required by vendor shall be explained in the offer.

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7.0 SHIPPING

7.1 All the materials used for packing, wrapping, sealers, moisture resistant barriers and corrosion preventers shall be of recognised brands and shall conform to the best standards in the areas for the articles which are packed.

7.2 Workmanship shall be in accordance with best commercial practices and requirements of applicable specification. There shall be no defects, imperfections or omissions which would tend to impair the protection offered by the package as a whole.

7.3 The packing shall be suitable for storing in tropicalised climate, the ambient conditions, being specified in job specifications.

7.4 Shipment shall be thoroughly checked for completeness before final packing and shipment. Vendor shall be responsible for any delay in installation or commissioning schedule because of incomplete supply of equipments.

8.0 REJECTION

8.1 Vendor shall make his offer in detail with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summarily rejected.

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STANDARD SPECIFICATION FOR INSTRUMENTATION OF PACKAGE UNITS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
3	16.03.15	REVISED AND REISSUED	RK	RKG	RG	SC
2	29.06.09	REVISED AND REISSUED	RG	RP	TGM	ND
1	25.06.97	REVISED AND REISSUED.	RK	BRS	RB	AS
0	30.06.86	ISSUED AS STANDARD SPECIFICATION.	RK	RB	AKV	AK

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Abbreviations:

AARH	:	Arithmetic Average Roughness Height
AC	:	Alternating Current
AWG	:	American Wire Gauge
CPU	:	Central Processing Unit
CRCA	:	Cold Rolled Cold Annealed
DCS	:	Distributed Control System
DPDT	:	Double Pole Double Throw
DPST	:	Double Pole Single Throw
DTM	:	Device Tool Manager
DVD	:	Digital Versatile Disc
EDDL	:	Electronic Device Description Language
FDT	:	Field Device Tool
FF	:	Foundation Fieldbus
FISCO	:	Fieldbus Intrinsically Safety Concept
FNICO	:	Fieldbus Non-Incendive Concept
HART	:	Highway Addressable Remote Transducer
HIC	:	Hand Indicating controller
HMI	:	Human Machine Interface
HT	:	High Tension
I/O	:	Input /Output
IP	:	Ingress Protection
IU	:	Interface Unit
LAS	:	Link Activity Scheduler
LED	:	Light Emitting Diode
LT	:	Low Tension
MAWP	:	Maximum Allowable Working Pressure
MCB	:	Miniature Circuit Breaker
MCC	:	Motor Control Center
MR	:	Material Requisition
NB	:	Nominal Bore
NC	:	Normally Close
NO	:	Normally Open
NPT	:	National Pipe Threads
NPTF	:	National Pipe Threads Female
NPTM	:	National Pipe Threads Male
P&ID	:	Piping and Instrumentation Diagram
PID	:	Proportional, Integral and Derivative
PLC	:	Programmable Logic Controller
PTC	:	Performance Test Code
PTFE	:	Poly Tetra Fluoro Ethylene
PVC	:	Poly Vinyl Chloride
RAM	:	Random Access Memory
RB	:	Rockwell Hardness in B Scale
RTD	:	Resistance Temperature Detector

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RTU	:	Remote Terminal Unit
SOV	:	Solenoid Valve
SPDT	:	Single Pole Double Throw
TFT	:	Thin Film Transistor
TMR	:	Triple Modular Redundant
UPS	:	Uninterrupted Power Supply
URV	:	Upper Range Value
WC	:	Water Column

Instrumentation Standards Committee

Convener : Mr. Rajiv Gupta

Members : Mr S Bhowal
Mr M Nandi
Mr R K Gupta
Ms Rima Kundu
Mr S Mahesh Kumar
Ms. N.P.Guha (Proj.)

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PART I

GENERAL SPECIFICATION OF

INSTRUMENTATION

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1.0 GENERAL

1.1 Scope

1.1.1 This specification together with the attachments covers the design and engineering of instruments, control systems, accessories and materials, along with special test equipments, where the supply is part of a package being supplied by vendor. This specification is general and all instruments/systems included may not be required for the proposed package. The scope shall be as defined in the scope of supply of Instrumentation.

1.1.2 The detailed scope of work, specific job requirements, exclusions, deviations, additions etc. if any, will be indicated in Scope of Supply of Instrumentation and Job Specification of Instrumentation included in the material requisition.

1.1.3 This specification provides only the qualitative specifications of commonly used instruments. Specifications of Instruments not covered in this specification shall be submitted by vendor for review by Purchaser.

1.1.4 Vendor shall be fully responsible for design, material selection, sizing and selection of the proper instruments for their system. The compliance to this specification does not absolve the vendor of the responsibility towards contractual obligations with regards to completeness, proper selection, satisfactory operation and easy maintenance of the unit.

1.1.5 All items, as offered, shall be field proven and should have completed trouble free satisfactory operation for a period of minimum 6 months on the bid due date in the similar application with the process conditions similar to those as specified in the purchaser's data sheets. Items with proto-type design or items not meeting provenness criteria specified above shall not be offered

1.1.6 In the event of any conflict between this specifications, data sheets, related standards, codes etc., the vendor shall refer the matter to the purchaser for clarification and only after obtaining the same should proceed with the manufacturing/engineering of the item in question. DCS/ PLC is not included in this specification. Vendor shall refer specifications attached separately in case DCS/ PLC is included in scope of supply.

1.2 Bids

1.2.1 Vendor shall provide the following information along with their offer:

a) Compliance to Complete Material Requisition/Tender.

b) Utility requirements including Power consumption and Instrument air supply consumption. The offer shall indicate the power requirement for Uninterrupted Power Supply (UPS), Non-UPS and DC power clearly indicating the locations for each.

c) Estimated heat load for the equipment located in control room.

d) Control room size and layout (Tentative)

1.2.2 Vendor shall clearly define the operational philosophy proposed, which shall be in line with requirements specified in the job specification. Vendor shall also clearly indicate the provision of control panels and control systems required for the package along with offer.

1.2.3 Documents like Instrument list and typical specifications and any other details if submitted by vendor in their bid, shall not be reviewed and shall be retained for records only. All such details shall be submitted by vendor only after the finalisation of P&ID (Piping and Instrument Diagram) during detail engineering. No implication shall be admissible on the

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basis of these documents and vendor shall be responsible for completeness and correctness of the same with respect to Purchase Requisition/Tender.

1.2.4 Vendor's offer, catalogues, drawings, instrument manuals etc. shall be in English.

1.2.5 In addition to mandatory spares, commissioning and consumables indicated elsewhere in this specification, Vendor shall also quote recommended spares for 2 years normal operation for the complete instrument and control system for the offered package.

1.3 Applicable National/International Standards:

1.3.1 Design and terminology shall comply, as a minimum, with the latest edition of following codes, standard practices and publications, unless otherwise specified:

AGA American Gas Association, Gas Measurement Committee
Report No.3 Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids – Concentric, Square-Edged Orifice Meters
Report No.7 - Measurement of Natural Gas by Turbine Meter

AG181 Foundation Fieldbus System Engineering Guidelines

ASME American Society of Mechanical Engineers.
B 1.20.1 Pipe Threads.
B 16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
B 16.47-B Large diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch Standard
B 16.20 Ring Joint Gaskets and Grooves for Steel Pipe Flanges.

ANSI/FCI American National Standards Institute/Fluid Controls Institute
70.2 Control valve seat leakage classification.

API American Petroleum Institute
RP 520 Sizing, Selection and Installation of Pressure Relieving System in Refineries.
Part-I - Sizing and Selection
Part-II - Installation
RP 521 Guide for Pressure Relieving and Depressurising Systems.
RP 526 Flanged Steel Safety Relief Valves.
RP 527 Seat Tightness of Pressure Relief Valves.
MPMS Manual of Petroleum Measurement Standards.
RP 551 Process Measurement Instrumentation.
Part 1 - Process Control and Instrumentation.
RP 552 Transmission Systems
RP 554 Process Instrumentation and Control
RP 555 Process Analysers
S 2000 Venting Atmospheric and low pressure storage tank.
S 670 Machinery Protection Systems

ASME American Society of Mechanical Engineers.
- ASME Boiler and Pressure Vessel Code (BPVC), Section VIII, Division 1: Rules for Construction of Pressure Vessels.
PTC 19.3 TW :2010 & ERATA 2012
- THERMOWELLS Performance Test
MFC-3M Measurement of Fluid Flow in Pipes using Orifice, Nozzle and Venturi

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	MFC-14M	Measurement of Fluid Flow in Pipes using Small Bore Precision Orifice Meters
ASTM	American Society for Tests and Materials	
BS	British Standards	
	EN 50288-7	Multi Element Metallic Cables used in Analogue and Digital Communication and Control – Part-7 : Sectional specification for Instrumentation and Control cables
EN 10204	Inspection Document for Metallic Products	
IBR	Indian Boiler Regulations.	
IEC	International Electrotechnical Commission.	
	60079	Electrical Apparatus for Explosive Gas atmosphere.
	60085	Electrical Insulation – Thermal Evaluation and Designation
	60332	Tests on electric and optical fibre cables under fire conditions - Part 1-1: Test for vertical flame propagation for a single insulated wire or cable - Apparatus Parts and Sections
	60529	Classification of degree of protection provided by enclosures.
	60534-2	Industrial Process Control Valves-Flow capacity.
	60584-2	Thermocouples – Tolerances
	60751	Industrial Platinum Resistance Thermometer and Platinum Resistance Sensors
	61285	Industrial Process Control Safety of Analyser Houses
	61000-4	Electromagnetic compatibility for Industrial Process measurement and Control equipment
	61158	Foundation Fieldbus Specifications
	61804-3	Functional blocks for process control – part 3 Electronic Device Description Language (EDDL)
IS	Indian Standard	
	5	Colours for ready mixed paints.
	319	Specification for free cutting Brass bars, rods and sections
	1239	Mild steel tubes, tubulars and other wrought steel fittings
	1271	Specification of Thermal Evaluation and Classification of Electrical Insulation
	1554	PVC insulated (heavy duty) electric cables-working Part I voltage upto and including 1100V
	2074	Ready mixed paints, air drying, red oxide- zinc chrome.
	3624	Specification for pressure and vacuum gauges
	5831	PVC insulation and sheath of electric cables
	7358	Specifications for Thermocouples
	8784	Thermocouple compensating cables
ISA	International Society of Automation	
	S-5.2	Binary logic diagrams for process operations.
	S 7.0.01	Quality standard for Instrument Air
	S-75.xx	Standards related to Control Valves
ISO 5167	Measurement of fluid flow by means of orifice plates, nozzles and venturi tubes inserted in circular cross-section conduits	
ITK	Interoperability Test Kit (latest version)	

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NACE	National Association of Corrosion Engineers
NEC	National Electric Code
NEMA	National Electrical Manufacturer's Association
NFPA-496	National Fire Protection Association - Purged and pressurised enclosures for electrical equipment
OSHA	Occupational Safety and Health Authorit.
SAMA	Scientific Apparatus Maker's Association

1.4 Drawing and Data

1.4.1 Detailed drawings, data and catalogues required from the vendor shall be as per Vendor Data Requirement attached elsewhere in the Material Requisition / Tender.

1.4.2 The minimum requirements expected from the various documents listed in Vendor Data Requirement shall be as follows:

1.4.2.1 Document Control Index (DCI)

This document lists out all drawings and documents prepared and/or submitted by vendor to purchaser after placement of order through vendor portal. Following information shall be available in this document:

a) Name and number of each drawing and document listed.

b) Expected and Actual date of submission to purchaser.

c) Review category of the documents

1.4.2.2 Instrument Index

Instrument Index lists out all instruments appearing on the P&ID without any exception. It is a basic instrument document which is necessary for the smooth execution of a job and is also a reference document after the completion of job. Instrument Index shall be prepared in EIL Format. In case, any other format is used, it must contain all information as listed in this format as a minimum.

1.4.2.3 Sub Vendor List (for Instruments and Accessories)

This document shall list out all instrument items and accessories including control system along with the name of the sub-vendors from whom vendor is likely to procure these items. Instrument Sub-vendor shall meet the enlistment conditions of EIL approval at the time of placing the order on sub-vendor for the Project Approved Vendor List. The EIL approval conditions are available with the Sub-Vendors. Vendor shall follow the approval requirement.

For Instruments / items not covered in the vendor list, Vendor shall get approval from purchaser/ owner for the vendors proposed, prior to the placement of order. In such cases the sub-vendors suggested shall be manufacturer of repute and it shall meet the provenness criteria specified in this document.

1.4.2.4 Instrument Sizing Calculations

Instrument sizing calculations provide information regarding sizing (as per standards specified else-where in this document), type, selection and other related information.

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Following sizing calculations shall be applicable, in general, duly approved by the authority indicated in Vendor's Standard Quality Plan;

a) Control valve including noise and velocity.

b) Pressure relief valves/pilot operated pressure relief valves/rupture disc/breather valve/flame arrester.

c) Flow element including orifice plates, averaging pitot tubes, venturi, flow nozzle etc.

d) Utility consumption calculation including power supply (UPS/Non UPS), Instrument air, steam for tracing, cooling water, nitrogen etc.

e) Cable sizing calculations for power cables.

f) Intrinsically safe loop calculation for proper selection of cables considering various entity parameters.

g) Segment loading calculations.

h) Thermowell wake frequency calculations as pe ASME PTC 19.3 TW-2010

1.4.2.5 **Utility Requirements**

This document lists out the following information regarding utilities required by the vendor;

a) List of utilities required i.e. Power (UPS, Non UPS), Instrument air, Cooling water, steam for tracing, Nitrogen etc.

b) Location and estimated/actual requirement at each location. The requirement shall be listed as minimum/normal/maximum.

c) Incase of AC power, the In-rush current with duration and power factor shall also be indicated for each location.

d) In case of cooling requirement of any instrument/equipment, vendor shall provide the detail of pressure/flow requirement with location.

1.4.2.6 **Nozzle Elevation for Level Instruments**

Nozzle elevation for level Instruments represent the nozzle elevation, nozzle sizes and rating, requirement of stand-pipes, type of level instrument etc. for all the vessels, columns, exchangers and tanks.

1.4.2.7 **Purchase Requisition (PR)**

Purchase Requisition shall contain following information as a minimum but updated in line with the finally accepted offer of the successful vendor including:-

a) Instrument specifications including detailed instrument data sheet and special requirements, if any

b) Testing and Inspection requirements

c) Vendor data requirements

d) Other related documents like Standard Specifications, Quality Assurance requirements etc.

1.4.2.8 **Functional Schematics**

Functional Schematics details out the functionality of all the loops shown on the P&ID including their correlation. The schematic shows all the hardware necessary to configure a loop including their physical location, their interconnection and important software blocks as applicable to make a loop complete. Similar loops may be combined under the same functional schematic.

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1.4.2.9 **Logic Diagrams**

Logic diagram is a logic representation of process interlock and shutdown system and details out the functionality, in a schematic form, as either process cause and effect table shown on the P&ID or in a separate write-up. The schematic shall be prepared based on ISA S5.2 – A Binary Logic Diagrams for Process Operations and shall show the physical location of Input/output devices, their interconnection with functional blocks, bench status of all electrical devices etc. The schematic shall also be supplemented with operational requirements like startup and process bypasses, reset and shut down push buttons, selector switches, status lamp etc.

1.4.2.10 **Segment Drawing**

The FF segment drawing provides the complete segment design details indicating all the devices of a segment, the Tag names, device control/monitoring functional requirements, spur length, FF Junction box barriers connectivity, termination details, location of JB etc.

1.4.2.11 **Instrument Loop drawings**

Each loop shall have a separate Instrument Loop drawing which shall show each component from field device to final receiver including physical location; initiating device, its terminal number; junction box with its terminal number; cable number with pair number/polarity; receiver instrument terminals/cabinet terminals; system functional blocks of loop in simplified manner (without configuration details).

1.4.2.12 **Control Room Layout**

Control room layout drawing shall show the location of control panels, system cabinets, marshalling racks and other auxiliary cabinets, consoles with monitors, hard wired consoles, printers, non-system panels/cabinets including panels/cabinets for packages, LEL panel, fire alarms panels or any other equipment required to be installed in control room. The layout shall be prepared on control room architectural drawing and shall also show layout of equipment in engineering room/computer room etc.

1.4.2.13 **Panel Front Arrangement**

This drawing shall show the arrangement of panel mounted instruments like indicating instruments, alarm annunicator, indicating lamps, push buttons/switches etc. including their approximate sizes and their mounting locations.

1.4.2.14 **Configuration Diagram**

This drawing is a graphical representation of all major hardwares required in a configurable control system which are necessary to meet all the expected functional requirements.

1.4.2.15 **Dynamic Graphic Display Drawings**

These drawings provide a graphic representation of P&ID's arranged in a sequence which when displayed on the HMI, shall provide easy and logical operational views.

1.4.2.16 **Input/ Output Assignment**

This document indicates the physical assignment of various I/O modules and their respective channels to various physical inputs and outputs.

1.4.2.17 **Instrument Duct/ Tray/ Trench Layout**

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Instrument duct/tray trench drawing shows the routing of main instrument duct/tray trench in the unit/plant. The drawing shall be prepared on plot-plan/ Equipment layout and shall show the size, cross-section at various locations, general notes, symbols, reference drawings and the control room entry.

1.4.2.18 **Instrument Location Plans**

Instrument Location Plans shall show the location of instruments, location of tapping points, location of local panels, junction boxes, main cable trenches, instrument air distribution scheme etc. These drawings are prepared on equipment layout drawings in 1:50 or 1:100 scale depending on density of instruments.

1.4.2.19 **Instrument Cable Schedule**

The instrument cable schedule shall show all instrument and power cables required for complete instrumentation. The document shall show tag number, cable number, type, length and size of cables, type of junction box, identity of local panel, control room panel/cabinet location etc. The document shall also show the size of terminals considered for power junction boxes and the dimensions of cable considered by the contractor.

The cable schedule document shall include all single & multi pair cables indicating terminations of instruments, field junction boxes and respective termination in satellite rack room cabinets. The instrument cable schedule shall be prepared on EIL format.

1.4.2.20 **3D Modelling:**

Whenever 3D modeling is included in package vendor's scope, it shall include the following instrumentation items as a minimum:

a. Instrument Cable Duct.
b. Analyser shelter/ cabinet.
c. Local Control Panels.
d. Prefabricated Hook-ups
e. Gas Detectors
f. CCTV
g. Instrument Junction Boxes
h. Instrument Stanchions and Canopy

2.0 DESIGN PHILOSOPHY

2.1 Instrumentation shall be complete in every respect in accordance with latest approved P&IDs for the safe, efficient and easy operation, start up and shut down of the plant.

2.2 All instruments and equipments shall be suitable for use in a hot, humid and tropical industrial climate in which corrosive gases and/or chemicals may be present. As a minimum, all instruments and enclosures in field shall be metallic construction, dust proof and weatherproof to IP-65 as per IS/IEC-60529 and secure against the ingress of fumes, dampness, insects and vermin. All external surfaces shall be suitably treated to provide protection against corrosive plant atmosphere.

2.3 The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC 61000-4 'Electromagnetic compatibility for Industrial Process measurement and Control equipment.

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2.4 Instrument Requirements for Classified Area:

a) Certified Intrinsically Safe (IS) equipment as per IEC-60079-11 shall be used, in general, in hazardous area, for conventional loops.

b) Field instruments in fieldbus loops shall be designed and certified as per the hazardous area protection specified in Job Specification.

c) In case intrinsically safe equipment is not available, flameproof enclosures as per IEC-60079-01 may be considered.

d) Junction boxes, cable glands and accessories required for flameproof instruments shall also be certified flameproof.

e) All non flameproof panels and cabinets installed in classified area shall be purged as per requirements specified in NFPA-496, as a minimum.

f) Other type of protection specified in IEC-60079 shall not be used.

2.5 Statutory Approvals

a) Contractor shall be responsible for obtaining all statutory approvals, as applicable, for all instruments and control systems.

b) In addition, equipments/instruments/systems located in the hazardous area shall be certified by the local statutory authorities for their use in the area of their installation. In general following certification shall be given:

i) For all intrinsically safe/ FISCO/FINICO/ explosion proof/flameproof equipments/ instruments/systems or equipments with any other type of protection allowable as per this package which are manufactured abroad and certified by any statutory authority like Laboratorie Central Des Industries Electriques (LCIE), British Approval Service for Electrical Equipment in Flammable Atmospheres (Baseefa), Canadian Standards Association (CSA), Factory Mutual(FM), Underwriters laboratories(UL) etc. for compliance to ATEX directives or other equivalent standards. All these equipments/ instruments/systems shall additionally have the approval of Petroleum and Explosives Safety Organisation (PESO)/ Chief Controller of Explosives (CCE), Nagpur, if installed in INDIA and the same is mandatory.

ii) For all flame proof equipments manufactured locally (indigenously), the testing shall be carried out by any of the approved test house like Central Institute of Mining & Fuel research (CIMFR)/ Electronics Regional Testing Laboratory (ERTL) etc. The equipment shall in addition bear the valid approval from Petroleum and Explosives Safety Organisation (PESO)/ Chief Controller of Explosives (CCE), Nagpur and a valid BIS license.

iii) For all intrinsically safe equipment manufactured locally (indigenously), the testing shall be carried out by any of the approved test house like Central Institute of Mining & Fuel research(CIMFR)/ Electronics Regional Testing Laboratory(ERTL) etc. The equipment shall in addition bear the valid approval from Petroleum and Explosives Safety Organisation (PESO)/ Chief Controller of Explosives (CCE), Nagpur.

c) Approvals other than above shall neither be offered nor will these be acceptable.

2.6 Following units of measurement shall be applicable, unless indicated specifically otherwise:

Flow	Liquid	:	m^3/h
	Steam	:	kg/h

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	Gas & Vapour	:	Nm^3/h
Pressure/Vacuum	Gauge	:	kg/cm^2g
		:	mm of H2O
	Vacuum	:	kg/cm^2
		:	mm of H2O
Temperature		:	°C
Level		:	%
Analysis		:	%
		:	ppm
Conductivity		:	micro siemens
Viscosity		:	mPa.s (cP)

2.7 Local control loops shall be avoided. In case these are unavoidable, these shall be electronic field mounted manual loading station only.

2.8 Ranges for instruments shall be selected in general, such that in normal process operation the indication is between 35% to 65% of the range i.e. middle 30% of the full working range.

2.9 Field mounted direct actuated Flow and Temperature switches shall not be used. Instead, transmitters shall be used along with flow element/temperature element. Process switches shall not be considered unless its use is unavoidable and the same shall be subject to purchaser's approval. In case switch has been considered, same shall be provided with sealed micro switch contacts rated for the specified application. Also contacts shall be SPDT type unless otherwise specified. Contacts used in intrinsically safe applications shall be suitable for the application.

2.10 Intrinsically Safe System Requirements (for Non Fieldbus Instruments)

Following points must be considered while designing an intrinsically safe system;

a) All intrinsic safety barriers shall be active type isolating barriers only, with three port isolation.

b) Barriers must be selected based on entity concept. Cable parameters shall also be considered while matching entity parameters.

c) Each instrument in the hazardous area and the intrinsic safe barrier shall be certified for intrinsic safety by any statutory authority.

d) Each input and output in a loop shall have separate barrier. No barrier shall be shared between two loops or input/outputs.

e) Any device required to be connected to any intrinsically safe loop in the hazardous side permanently or temporarily shall also be certified intrinsically safe.

f) Configuration tools whenever required for any intrinsically safe item, which forms part of the intrinsically safe item, shall also be certified intrinsically safe.

2.11 Power Supplies and their Distribution

a) Power supply shall be made available at the following voltage levels, unless otherwise specified:

° For Instruments, Control Systems, Analyzers — 240V AC/110V AC

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°	Solenoid Valves, Relays, lamps	24V DC/110V DC ±10%/ 240 AC/ 110 V AC UPS
°	Input interrogation voltage	24V DC/110V DC ±10%
°	Panel/cabinets lighting	240V AC Non-UPS ± 10%

In case 24 V DC is required for Input interrogation, relays and lamps, any other vendor supplied instruments/ electronics), same shall be considered by the vendor using dual redundant power packs (110 V AC to 24 V DC converter). 24 V DC feeders shall not be provided by Purchaser unless indicated specifically in the job specifications.

b) All instruments, control systems (PLC and DCS) and analyser system shall be able to operate at the following UPS specification:

Voltage level : 240V AC/110V AC ± 10%

Frequency : 50 Hz ±3 Hz

Switch over time : 5 milli seconds.

c) Power feeders shall be supplied to the vendor at only one location. All further distribution within the package shall be taken care of by the vendor. Number and size of power feeders shall be informed during detail engineering. Vendor shall provide adequate number and size of terminals and cable glands required.

d) Instrument power circuits shall be individually protected and isolated from fault with the help of fuses and DPST switches. Power supply to the individual instrument shall be disconnected with the help of DPST switch and protected with the help of fuses. Miniature circuit breakers (MCB's) may be selected in place of switch fuse unit in case protection is provided for overload protection.

2.12 Alarm Philosophy

a) Alarms shall be provided to give audible and visual warning of any process and machine malfunction in the package.

b) All trips shall have a pre-trip warning alarm in addition to alarm at the trip condition.

c) Package alarms including pre-trip warning alarms and trip alarms (shutdown alarms) shall be annunciated on the local panel as per approved P&ID.

d) Rotating equipments shall have the status indication provided on the local panel as per approved P&ID.

e) 'Fail-safe' type with normally closed alarm contacts shall be used.

2.13 All line or equipment mounted instruments like control valves, pressure relief valves, thermo-wells, orifice flanges, level instruments etc., installed on pipes and vessels under IBR shall be certified by IBR or their authorized representative.

2.14 Location of process connections shall be from the side or from the top of the process equipment but not from the bottom. This requirement is applicable to both pipes and vessels. The location of lower side connection for level measurement when necessary shall be extended inside the equipment with the approval of purchaser to prevent plugging due to dirt or other suspended solids. In addition, the connections shall be short, vertical or horizontal and without any pockets.

2.15 Material of construction of instruments shall be as per the material selection chart, attached as Annexure I of this specification, as a minimum. However vendor is responsible to ensure that the selected material is consistent with temperature, pressure, corrosion conditions and other process requirements.

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2.16 Field Transmitters

2.16.1 SMART Field Transmitters:

2.16.1.1 The field transmitters in all conventional loops shall be smart type only unless specified otherwise. Field transmitters for flow, pressure, temperature, differential pressure and level applications shall be yoke mounted type unless specified otherwise. Meter electronics used for flow measurement etc. shall include all the associated items like pre-amplifier, converter, transmitter, integrator, integral output meter etc.

2.16.1.2 Field transmitter shall be intrinsically safe and meter electronics shall be intrinsically safe, in general. In case, intrinsically safe is not available from the approved vendor list enclosed with this MR/tender, flameproof enclosure is acceptable. In case sensor/ pick up coil is intrinsically safe, suitable barrier shall be provided and installed in flameproof enclosure.

2.16.1.3 These transmitters shall be 2 wire systems having 4 - 20 mA DC output with superimposed digital signal having simultaneous analog and digital communication with HART communication protocol, unless otherwise specified.

2.16.1.4 The transmitter shall be microprocessor based and it shall incorporate a non-volatile memory which shall store complete configuration data of transmitter and sensor characterization. All necessary signal conversions, including conversion to produce output with the required protocol shall be carried out in the transmitter electronics. The configuration data of the instruments shall be stored in a non-volatile memory such that this remains unchanged because of power fluctuations or power off condition. In case vendor standard instrument has battery backed RAM, vendor to ensure that battery drain alarm is provided as diagnostic maintenance message.

2.16.1.5 Transmitter shall also run complete diagnostic subroutines and shall provide diagnostic alarm messages for sensor as well as transmitter healthiness. In the event of detection failure, the output shall be driven to a predefined value, which shall be field configurable.

2.16.1.6 Universal hand held configurator / terminal for the configuration and maintenance of instruments with HART output shall be provided for all HART based smart instruments.

2.16.2 Fieldbus Field Transmitter and devices:

2.16.2.1 Fieldbus transmitters/ devices shall be provided, if specified, in fieldbus loops.

2.16.2.2 Field bus based transmitter/ devices shall meet the following requirements;

a) All instruments must satisfy the requirements of the fieldbus registration laboratory with applicable checkmark like foundation field bus, profibus etc as specified in Job Specification.

b) All instruments shall be polarity in-sensitive. Also transmitter shall be LAS capability. Line plugging detection facility shall be provided, whenever specified in data sheet.

c) All instruments shall have Analog Input (AI) block and Proportional, Integration and Differential (PID) control block, as a minimum.

d) All instruments must be interoperable and shall have valid interoperability test clearance like ITK latest version for foundation field bus or equivalent for profibus PA, as applicable.

e) The field bus instruments shall support peer to peer communication with two wire communication and bus powered supply.

f) All instruments shall support EDDL or FDT/DTM requirements.

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g) Internal software shall be configured by the vendor including the following information such as serial number, Device Tag (Tag Number) and Process description

h) All instruments shall be capable of supporting incremental Device descriptor (DD) for extra functionality and /or software revisions in device memory.

i) Soft copy of the Device Descriptor (DD) files for configuring the FF device parameters and common file format (CFF) files for integrating the device into the system shall be provided by the bidder for offline configuration by System vendor immediately after despatch.

j) Fieldbus based field indicator shall be able to indicate all signals available in the fieldbus segment, selectively.

2.16.2.3 The fieldbus / devices provided shall be able to communicate with latest universal fieldbus communicator.

2.16.3 Accuracy of transmitters (Pressure & Differential pressure), smart as well as fieldbus based shall be as follows:

Type of Transmitter	Range of Transmitter	Accuracy for the rangeability of 1:10
Direct	760 mm WC and above	Equal to or better than ±0.075%
Direct	Less than 760 mm WC	Equal to or better than ±0.15%
Diaphragm seal	500 mm WC and above	Equal to or better than ±0.25%
Diaphragm seal	Less than 500 mm WC	Equal to or better than ±0.5%

The accuracy is defined as the combined effect of repeatability, linearity and hysteresis.

2.16.4 Transmitter shall update the output at least 8 times a second unless otherwise specified.

Unless specified otherwise in purchaser's specification, transmitter response time shall be as follows:

a) For transmitter range of 760 mm WC and above, the response time shall be equal to or better than 500 milliseconds.

b) For transmitter range below 760mm WC, the response shall be equal to or better than 1 second.

The response time of the transmitter shall be considered as the sum of dead time and 63.2% step response time of the transmitter.

2.16.5 Unless specified otherwise, the over-range/static pressure protection of the transmitter shall be as follows;

Range of Transmitter	**Over range/ static pressure <N1>**	
	Pressure Transmitter (kg/cm²)	**Differential Pressure Transmitter (kg/cm²)**
0 < ® < 250 mm WC	20	20
250 < ® < 1000 mm WC	45	52
1000 < ® < 5000 mm WC	45	70

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5000 < ® < 10000 mm WC	45	160
1 < ® < 10 kg/cm²	52	160
10 < ® < 100 kg/cm²	160	210
> 100 kg/cm²	210	210

<N1> However if the Over range/ static pressure value specified above is less than the maximum/ design pressure of service conditions, offered instrument shall be suitable for the maximum/ design pressure.

2.16.6 Diaphragm seal DP transmitters in flow measurement with a DP of less than 250 mmWC shall be avoided and alternate type of flow meters shall be provided for such cases suitable to the process condition.

2.16.7 All transmitters shall have vent and drain facility and the same shall be provided with metallic plugs. All the cable entries shall also be provided with metallic plugs.

2.17 Instrument Connections

2.17.1 The connections of instruments installed on vessels, tanks, standpipes and piping shall be as per following EIL Standards.

a) 7-52-0001 Instrument Connections on Vessels and tanks.

b) 7-52-0002 Instrument connection on Piping.

2.17.2 Pneumatic instrument connections for signal and air supply shall be 1/4" NPT (F).

2.17.3 Electrical cable entry connection shall be 1/2" NPT (F)/ 3/4"NPT (F) as per the cable size. Suitable cable gland shall be used.

2.17.4 End connections shall meet the following, unless, otherwise specified:

a) Threaded end connection shall be NPT as per ASME B1.20.1.

b) Flanged end connection shall be as per ASME B16.5 or ASME B16.47B or AWWA C207 Cl D as per related Piping Specification.

c) When Flanges are Raised Face (RF) type, the face finish shall be as per ASME B 16.5 and shall be as follows:

125 AARH : 125 to 250 microinch AARH

63 AARH : 32 to 63 micro inch AARH

d) Grooves of ring type joint flanges shall be octagonal as per ASME B 16.20 and groove finish shall be as follows:

63 AARH : 32 to 63 micro inch AARH

2.18 Instrument Air Supply

2.18.1 Air supply at pressure specified elsewhere shall be made available to the vendor at the battery limit for distribution to the instruments.

2.18.2 Pneumatic Instruments shall operate on air supply of 1.4 kg/cm^2g and shall have transmission and output signal of 0.2 to 1.0 kg/cm^2g.

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2.18.3 Instrument air quality shall be as per ISA- S 7.0.01and free from corrosive, hazardous and toxic contaminants.

2.19 Interface with Main Control Room

2.19.1 Wherever applicable, instrument junction boxes shall be provided as interface between purchaser and vendor. Marshalling details between purchaser-vendor cabling shall be shown with corresponding junction box termination number allocated against appropriate purchaser's/vendor's instrument tag number in the format provided by purchaser.

2.19.2 Direct signals from package/package skid

All signals from package skid/battery limit to purchaser's control room shall be terminated in the junctions boxes located at the battery limit. Separate junction boxes shall be used for the following type of signals:

- Fieldbus based Signals
- Intrinsically Safe Analog Inputs/Outputs (4-20mA)
- Non -intrinsically Safe Analog Inputs/Outputs (4-20mA)
- Intrinsically Safe Thermocouple Inputs
- Intrinsically Safe RTD Inputs
- Intrinsically Safe contact Inputs
- Non-Intrinsically Safe contact Inputs
- Intrinsically safe contact Outputs
- Non-Intrinsically Safe contact Outputs

DCS and PLC signals shall be further segregated and shall in no case be mixed up.

2.19.3 Repeat Signals from Package Local Panel

a) Where signals as indicated in Clause 2.19.2 is less in number and do not justify separate junction boxes, all such signals may be routed via local control panel.

b) All such signals shall be terminated on separate terminal strips in the local control panel. The terminal strips shall be segregated as per Clause 2.19.2.

c) Intrinsically safe barriers for all such signals, wherever required, shall be provided.

The above shall only be considered with prior approval from purchaser.

3.0 SPARES PHILOSOPHY

3.1 Mandatory Spares

Unless specified otherwise, the following mandatory spares shall be provided by vendor.

3.1.1 **Predefined Mandatory Spares**

Mandatory spares shall be ware-house spares and shall be supplied as loose items.

3.1.1.1 Higher of 10% or minimum one of each type (range, type, material and rating) of complete instruments for commonly used instruments such as transmitter, gauges, temperature elements, switches, probes.

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3.1.1.2 For Control valve one set of packing and bonnet gasket with tag, one set of stem seal o-ring for each actuator and piston o-ring additionally for each piston actuated valve, line bolting (set of studs and nut) and set of gasket with each tag no.

3.1.2 **Commissioning Spares**

Vendor shall be responsible to supply all spares which are found necessary to replace while performing pre-commissioning and commissioning activities and this includes system oriented items (hardware / software).

3.1.3 **Consumable spares**

Vendor shall supply consumable spares for six months of normal operation.

3.1.4 **Engineering Spares**

3.1.4.1 For Control system, installed spare module of higher of 10% or minimum one of input/output modules (including termination panels, if applicable) to enhance the system functional requirements of control system.

3.1.4.2 For Hardwired console / Local control panel:

a) A minimum of 20% spare windows with alarm modules shall be provided in alarm annunciator.

b) A minimum of 20% spare status lamps / switches / pushbuttons / terminals or one no of each type, whichever is higher, shall be provided.

c) For pneumatic panels, 10% spare instrument air header branch lines and 15% spare bulkheads and tapping points shall be provided in each panel.

d) Control panels shall have additional spare-space as per clause 4.2.8 of this specification.

3.2 Spares for 2 years normal operation

Vendor shall supply a list of recommended spare parts for each instrument and system required for two (2) years of normal operation. These spares shall be quoted separately.

4.0 GENERAL SPECIFICATION OF INSTRUMENTS

4.1 Panel Board Instruments

4.1.1 Alarm Annunciator shall either be solid state type or microprocessor based programmable type with plug in modules and integral power supply. Window display shall be back lighted incandescent lamps or cluster LED type integral power supply. For window display with back lighted incandescent lamps two numbers of incandescent lamps of minimum 5 watt each shall be provided for each window. For cluster type LED display, the number of LED's in the cluster matrix windows shall be sufficient to provide illumination level of at least 150 lumens. The circuit shall be designed in such a way that removal/failure of one lamp or LED from a window/ cluster shall not hamper functioning of that particular window/display. The annunciator lamps shall be replaceable from the front of the enclosure panel. In general, dedicated alarm logic module shall be used for each alarm input. However, when micro processor based alarm Annunciator is offered failure of one microprocessor shall not affect more than four alarm windows.

Intrinsically safe annunciator circuit, when used, shall have power supply unit in a safe area. Annunciator alarm sequence shall be as per F3A of ISA.

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The design of the alarm annunciator system shall be such that transient alarms of less than 330 milliseconds duration shall be automatically rejected.

4.2 Panel Design

4.2.1 All panels shall be supplied in pre-tubed/pre-wired condition and shall be completely tested at manufacturer's works prior to dispatch.

4.2.2 Panels shall be free standing type. Panels with instruments mounted on the front shall be fabricated from 3 mm thick cold rolled steel sheet. If the same is not available, 4 mm thick hot rolled steel sheet shall be used. All other panels shall be fabricated from 2mm thick cold rolled steel sheet. Angle iron framework shall use a minimum section of 50 x 50 x 4 mm angle. Panel painting procedure shall include blast cleaning, grinding, chemical cleaning, surface finishing by suitable filler and two coats of high grade lacquer with wet blasting wherever required. Two coats of paint in the panel colour shall be provided for non-glossy high satin finish. Final coat shall be given after assembly at site.

Unless otherwise specified, exterior/interior portion of all panels and closed cabinets shall have a colour as per RAL-7035. Channel base shall be of black colour.

4.2.3 Panel shall be enclosed cubicle type with each section of typically 2100 mm high, 1200 mm wide and 800 mm deep mounted on 100 mm channel base.

4.2.4 Enclosed cubicle panels shall have removable hinged doors for easy maintenance and accessibility of the instruments. Doors shall be double leaved type with handle and shall be provided with lock and key. Adequate illumination shall be provided inside the panel. All light fittings shall be suitable for 240 V, 50 Hz AC. Power supply greater than 240 V shall also not enter the control panel.

4.2.5 All cable entries to the panel shall be from panel bottom only using cable glands of adequate size. Cable gland plate thickness shall be a minimum of 3 mm cold rolled cold annealed (CRCA) as a minimum. All unused cable entries must be plugged.

4.2.6 Space heater shall be provided where condensation is expected. The space heater provided shall be with temperature cut off and manual control.

4.2.7 The design of panel shall incorporate provision for expansion by installing adequate spare capacity. Each panel shall be designed to accommodate the following additional equipment, as a minimum:

a) 20% of panel front/inside mounted instruments including lamps, push buttons, switches, relays etc.

b) 20% additional power feeders each provided with switch fuse assembly.

c) 20% additional spare windows in alarm annunciators.

d) 20% spare cable entry points.

4.2.8 Panel layout shall be designed considering ease of operation. No push button or hand switch shall be located below 600 mm. Instrument mounting heights, in general, shall be as follows:

a)	Electronic Instruments	Bottom row	1100 mm
		Middle row	1350 mm
		Top row	1600 mm
b)	Annunciators	-	1950 mm
c)	Electric push buttons/	-	700 mm

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switches, lamps etc.

4.2.9 The internal panel layout shall be designed considering proper approach for instruments, terminals and other accessories for maintenance, easy removal and online calibration. No instrument, terminals, power distribution box etc shall be mounted on the panel side plates inside the panel.

4.2.10 All lamps, status as well as alarm, shall be provided with lamp test facility. One single lamp test push button shall be used for each panel. Logic for lamp test shall not be implemented through relay logic in the panel.

4.2.11 **Colour Scheme**

a) Status Lamps

On/Open/Permissive	:	Green
Off/Close/Emergency	:	Red

b) Alarms

Normal/Pre-trip alarms	:	Amber
Shutdown alarms	:	Red

c) Push/Pull buttons

On/Open	:	Green
Off/Close	:	Red
Emergency shut-down (ESD) (Push-button with cover/ Mushroom push button)	:	Red

4.2.12 **Panel Piping and Tubing**

4.2.12.1 The instrument air header shall be adequately sized with 1/2" branches, SS packless isolation valves and shall be complete with suitable dual filter-cum-air reducing station.

4.2.12.2 Panel tubing from the bulk head to the panel instruments and instrument air supply to the panel instruments shall be of 6 mm x 1mm thick SS 316L tubing.

4.2.12.3 The tubing shall be laid in plastic slotted ducts. Panel air header and tube fittings shall be of SS 316.

4.2.12.4 Each tube shall be identified at both the terminating ends.

4.2.13 **Panel Wiring**

4.2.13.1 Open terminals shall generally be avoided. Terminal strips shall preferably be mounted in an enclosure. Fused terminal may be used wherever necessary. All terminals shall be of mechanical screw clamp/screwless type with pressure plates as per the job specification. Self-insulating crimping wire lugs shall be used for all terminations on terminal blocks, whereas forked tongue type or lug with eyehole type shall be used for termination on screwed terminals such as on relays, push buttons, lamp etc. Terminal blocks shall be rated for 600 V.

4.2.13.2 A minimum of 1 mm^2 multi stranded PVC insulated copper conductor shall be used in general. All wiring shall be laid in the PVC troughs. No trough shall be more than 70% full.

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4.2.13.3 Wires carrying measurement signals associated with thermocouples, resistance thermometers and other low level signals shall be routed in separate troughs/wire ways and not alongwith power cables. Power wiring and control wiring shall be separated by not less than 150 mm. The crossing, if unavoidable, shall be as close to right angles as possible.

4.2.13.4 Extension cables/wires shall be used for all thermocouple inputs. These wires shall be routed in separate troughs/wire-ways.

4.2.13.5 All intrinsically safe wires shall be routed in separate wire ways from non-intrinsically safe and power wiring. Intrinsically safe wiring and terminals shall be light blue in colour and shall be separated from non-intrinsically safe terminals atleast by 50 mm.

4.2.13.6 All incoming power feeders shall be terminated on separate terminals suitable for the incoming feeder size. These shall be located at the bottom of the panel and shall be suitably covered for protection against accidental shorting and for human safety.

4.2.13.7 Power supply shall be made available at one point. Further power distribution network shall be designed such that a single power fault in any instrument branch system shall not cause a trip of the entire system. Each consumer shall be provided with a separate switch and fuse for isolation and protection of the system.

4.2.14 Electrical Wiring

All the cabinets, consoles and panels shall be completely wired. Interconnections shall preferably be done with the help of pre-tracked cables. Vendor may follow their standard wiring practices, however the requirements specified herein must be complied.

a) All wiring shall conform to API RP 552- Transmission Systems. Different signal level cables shall be routed with separation distances as recommended by code.

b) All wiring inside racks, cabinets, and back of the panels shall be housed in covered, non-flammable plastic raceways arranged to permit easy assembly to various instruments for maintenance, adjustments, repair and removal.

c) All wiring in the raceways shall be properly clamped. All incoming cable shall be terminated by vendor at marshalling rack with cable glanding including supply of cable glands. Total wiring cross-sectional area shall not exceed 50% of the raceway cross sectional area.

d) Separate wiring raceways shall be used for power supply wiring, DC and low level signal wiring, and intrinsically safe wiring. Parallel runs of AC and DC wiring closer than 300mm shall be avoided.

e) Vendor can alternately offer prefabricated cables for interconnection between different cabinets and panels.

f) Wire termination shall be done using self-insulating crimping lugs. More than two wires shall not be terminated on one side of single terminal. The use of shorting links for looping shall not be done.

g) No splicing is allowed in between wire / cable straight run.

4.2.15 Terminals and Terminal Blocks

a) Terminals shall be non-hygroscopic type made up of unbreakable, fire-retardant, safe extinguishable, halogen free polyamide compound.

b) Terminals shall be suitable for wires up to 2.5 sq. mm base solid or stranded conductor in general. For power cables, higher size terminals shall be used.

c) The metal parts of terminals shall be of high quality (pure electrolytic) copper and shall be tin or nickel plated (of thickness up to 15 micron).

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d) The spring material for all terminals shall be chrome nickel spring steel of high tensile strength and of excellent corrosion résistance. All terminal / terminal blocks shall be DIN Rail mounted type and shall be easily removable. The size of the terminal blocks / terminals of different types shall be consistent and identical.

e) All terminal blocks shall be mounted on suitable anodised metallic or plastic stand-off.

f) Terminal strips shall be arranged group-wise for incoming and outgoing cables separately. Terminal blocks for intrinsically safe wiring shall be separate. 20% spare terminals shall be provided, as a minimum, preferably in each terminal strip.

4.2.16 Following design philosophy shall be followed while deciding the internal layout of panels, as a minimum;

a)	Distance between terminal strip and side of the panel upto 50 terminals	:	100 mm (min.)+ trough width
b)	Distance between two adjacent terminal strips	:	100mm (min.)+trough width
c)	Distance between gland plate and bottom of the strip	:	300mm (min.)
d)	Distance of terminal strip from instrument/trough/panel top	:	100mm (min.)

4.3 Local Control Panel (LCP)

4.3.1 Local control panel for the package units shall be installed within the battery limit of the package considering operational and maintenance requirements and accessibility. In case of skid mounted packages, panel shall be located away from the skid.

In case local control panel is housed outdoor i.e. not in a local control room, it shall be designed to meet IP-55 requirements. In addition, panel must be provided with a rain cum sun shade/canopy.

4.3.2 Local control panel/panels shall be totally enclosed cubicles. Panel sizing shall be carried out based on equipment being installed keeping in view the maintenance clearances and easiness of operation. Although the panel dimensions shall be guided by the actual requirements, typical dimensions shall be 2100 mm height x 1200 mm width x 1000 mm depth. In any case, vendor shall not proceed with panel manufacturing before getting prior approval from the purchaser.

4.3.3 Local control panels located in the hazardous area shall either be purged type or flame proof Ex'd' or weather proof with Ex'd' components such as lamps, push buttons, switches etc. as specified in job specification. In case pressurized panels are specified the same shall be purged and pressurized as per NFPA 496 requirements to render space within the panel non hazardous. For panels located in IEC Zone 2, hazardous area type Z purging shall be used with a purge fail alarm in main control room. In case, panels are located in Zone 1, the power shall be cut off on perssurisation failure as per x-purge requirements of NFPA-496.

An alarm shall be provided on local panel and a contact shall be provided for remote annunciation, whenever the panel pressurization falls below 2.5 mm of H2O. A protective device to protect the panel from over pressure must be provided.

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4.3.4 Panel pressurisation with start-up panel purging scheme shall be fully automatic however it shall be started manually from a push button. Solenoid valves and differential pressure switch required for panel purging shall be flameproof, however other items like relays, switches/pushbuttons, timers etc. shall be located in a flameproof housing. Other items like valves, restriction orifice plates, dual filter regulators, pressure gauges, rotameters etc required for pressurization shall also be located in the non-pressurized section of the panel.

4.3.5 It shall be possible to switch off incoming power to panel from panel front. All such power on/off switches shall be flameproof type.

In addition, all those devices and terminals, which cannot be powered off from on/off switches shall also be located inside flameproof enclosures.

4.3.6 All hinges, screws and other non-painted metallic parts shall be of stainless steel material.

4.3.7 All other requirements as specified in clause 4.2 of this specification shall also be applicable for local control panels.

4.3.8 Whenever weatherproof local panel is provided by vendor for classified area, the Alarm Annunciator shall be intrinsically safe and push button, lamps; selector switches shall be flame-proof "Exd" type mounted on LCP. IS Barriers/ relays for IS alarm annunciator shall be supplied by vendor along with IS annunciator and potential free non-flameproof contact for the same shall be considered from the PLC / DCS/ control systems. The IS power supply module for alarm annunciator shall be installed in a flameproof box in local panel by bidder. For Lamps, wet contact shall be considered from the PLC/ control system and the lamp test logic shall be realised in PLC/ control system. The Power supply distribution box inside the Local Panel shall also be flame-proof "Exd'. IS PCs for display of loop powered indicators shall be used in weather-proof local panels in case no. of tag local display more than Five tags. The same IS PC can also be used for local display of vibration and temperature monitoring system parameters at field instead of separate display unit at field. For 5 or less number of tags for local indication, normal IS loop powered indicators shall be provided on weather proof local panel.

Intrinsically Safe (IS) type with minimum 15" Display (Remote interactive PC terminal) unit certified suitable for the hazardous area shall be mounted on the panel front of local control panel of the package, wherever IS PC is considered. All local control panel mounted field remote output indicators, wherever required as per approved P&IDs, shall be displayed in this remote PC. Single serial interface (RS 485 with Modbus RTU protocol) corresponding to these signals from control system shall be considered and vendor's scope shall include all necessary converters, power supply module, connectors at both ends along with serial communication cables for connecting to serial interface cards.

The PC terminal shall be equipped with necessary keyboard suitable for specified hazardous area.

4.4 Local Gauge Board

4.4.1 Local gauge board shall be used to install skid-mounted instruments like pressure gauges, temperature gauges and transmitters.

4.4.2 Location of local gauge boards, when provided, shall be decided to allow easy access at the rear and front for all instruments and accessories for maintenance and operation.

4.4.3 Gauge board shall be constructed from 3 mm stainless steel sheet with other necessary SS supporting structure.

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4.4.4 Local gauge board shall be supplied with all instruments installed and completely in tubed/wired condition before shipment.

4.4.5 All pressure transmitters and gauges shall be provided with block and bleed valves securely fastened. Identification tags shall be securely fastened for easy identification. Wherever local temperature indicator is required with temperature transmitter, Loop powered indicator shall be provided.

4.5 Temperature Instruments

4.5.1 Thermowells

a) All temperature elements shall be provided with thermowells fabricated out of bar stock of minimum SS 316 material as per EIL Standard 7-52-0035. The base of the thermowells shall be chosen to fit the instrument without air gap for minimizing measurement lag.

b) Built-up thermowells shall be used in low pressure and low velocity services like in fired heaters and also where thermowell immersion lengths greater than 500 mm are required.

c) Immersion length of thermowells shall be as follows:

Line Size	Immersion length
From 4" to 6"	280 mm
From 8" to 20"	320 mm
>20" and Vessels / columns	400 mm

In special applications, not covered above, vendor shall decide the immersion length based on actual requirements. Immersion length is based on 200 mm length between flange face and outer wall of pipe and 200 mm length between flange face and outer wall of the vessel.

d) Any pipe line less than 4" nominal bore shall be blown to 4" size to install thermowell.

e) Thermowell flange and well material shall be as per material selection chart.

f) The vibration analysis shall be carried out as per PTC 19.3 TW:2010 (latest version) and corrective measures shall be taken as necessary.

4.5.2 **Temperature Gauges**

a) Local temperature gauges shall be in general bimetallic type. The temperature bulb shall be of stainless steel construction. The gauge connection shall be all angles adjustable. Gas filled type shall be used when measuring range is beyond the limits of Bimetallic gauge or thermowell length exceeds 550 mm or in applications involving excessive vibrations. Mercury filled type temperature gauge shall not be used.

b) All local temperature gauges shall have 150 mm dial size. The bulb size shall be selected to suit the thermowell.

c) Cases shall be minimum 304 SS and weatherproof to IP-65 as per IS/IEC-60529.

d) Temperature gauges shall have accuracy of ±1% URV (upper range value).

e) Bimetallic type dial thermometers shall be avoided where excessive vibrations are encountered, such as reciprocating compressor discharge. Only filled type with

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capillary extension shall be used in such cases. Capillary tubing shall be a minimum of 304 SS with stainless steel flexible armouring, and PVC covering over armour. Filled type gauges shall be manufactured as per relevant SAMA class.

f) Thermometer stem adjustable gland with union connection and bushing shall be suitable for 1/2" NPTF connection.

4.5.3 **Temperature Elements**

a) For remote temperature indication/recording/control/switch etc., resistance temperature detector (RTD) shall be used upto 400 deg C (operating) and above 400 deg C (operating) thermocouples shall be used. Elements shall be spring loaded, mineral insulated and shall have stainless steel sheath as a minimum.

c) Thermocouple assemblies shall be furnished with weatherproof screw type heads as per EIL Standard 7-52-0036.

d) Thermocouples shall be as per IEC-60584-2 and shall have a wire size of 18 AWG for single and 20 AWG for duplex thermocouples. These shall be magnesium oxide (MgO) filled grounded type, unless necessary otherwise. The type of thermocouple shall be selected based on temperature. The selection of type shall be as per following guidelines:

Copper-Constantan (ISA-Type-T)	:	(-) 200 to 200^{O}C
Chromel-Constantan (ISA-Type-E)	:	(-) 200 to 600^{O}C
Iron- Constantan (ISA-Type-J)	:	0 to 600^{O}C
Chromel-Alumel (ISA-Type-K)	:	600 to 1200^{O}C
Platinum Rhodium-Platinum (ISA Type-S)	:	600 to 1600^{O}C

d) The design of thermocouple assemblies shall be such that replacement on line is possible.

e) RTD (Resistance Temperature Detecter) shall be platinum element 3 wire type with 100 ohms resistance at 0^{O}C calibrated as per IEC 60751. RTD shall be used within a temperature range of -200 to 650^{O}C. Three-wire system shall be adopted in connecting the element.

f) RTD shall be used where accuracies of the order of 0.25% or better and smaller measuring spans are required.

g) Duplex element sensors shall be supplied. Two separate cable entries shall be provided with plugs.

4.5.4 **Temperature Transmitter**

a) Temperature transmitters shall have a built-in linearising function to produce an output linear to temperature range.

b) The Temperature transmitters with RTD shall have an accuracy of 0.075% of URV as a minimum for range above 350^{0} C, 0.15% of URV for temperature range 350^{0} C to 150^{0} C and 0.25% for calibrated range below 150^{0} C.

The Temperature transmitters with cold junction compensation for thermocouple shall have an accuracy of 0.25% of URV as a minimum for range above 350^{0} C, 0.5% of URV for temperature range between 350^{0} C to 150^{0} C and 0.75% for calibrated range below 150^{0} C.

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c) Transmitters shall be provided with dual compartment.

4.5.5 Burn out protection must be provided with temperature transmitters. Upscale or downscale protection shall be decided based on its application to ensure fail-safe operation.

4.6 Pressure Instruments

4.6.1 Pressure Gauges

a) Pressure gauge dial shall be white with black figures. The dial face shall be marked with pressure element material. Pointers shall have micrometer adjustment.

b) Pressure gauges shall be weatherproof with dial size of 150 mm and shall have features like over range protection (at least 130% of max. operating pressure) and blowout discs. Glass shall be shatter proof. Pressure gauge sensing element shall be of SS 316 and movement of SS 304, as a minimum.

c) Pressure gauges shall have an accuracy of ±1% of URV as a minimum. Differential pressures gauges, diaphragm seal pressure gauges and draft gauges may have an accuracy of ±2% of URV.

d) Over range protector and pulsation dampener, whenever used, shall be of SS 304, as a minimum. Pulsation damepner shall be used for all pulsating services. It shall be floating pin type, externally mounted and externally adjustable.

e) Pressure gauges with range 0-100 kg/cm^{2}g and more shall have safety type solid front case.

f) Connection shall normally be 1/2" NPTM bottom.

g) Cases shall be minimum 304 SS and weatherproof to IP-65 as per IS/IEC-60529.

h) Ranges shall be so specified that the gauge normally operates in the middle third of the scale and shall conform to IS-3624 standard dials, wherever possible.

i) Diaphragm seals shall be furnished where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be of the clean out type with flushing connection.

j) Where vibrations and pressure fluctuations are expected, glycerin filled type and snubber shall be used.

k) Receiver pressure gauges for local transmitter output indication shall have 100 mm dial with stainless steel element and 1/4" NPTM connection.

l) The pressure element shall be bourdon, diaphragm or bellows depending upon process condition. Single diaphragm type Differential pressure gauges shall not be considered, Instead double diaphragm type or bellows shall be considered.

4.6.2 Pressure/Differential Pressure Transmitters

a) Pressure/differential pressure transmitter shall have electronic state-of-art capacitance or any other type of sensor meeting all functional specifications as per clause 2.16. Element material for transmitters shall be 316 SS, as a minimum.

b) All transmitters shall have an integral output meter. Remote mounted meters may be provided if required in addition.

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c) Diaphragm seal element with capillary shall be used for congealing, corrosive and highly viscous services.

4.6.3 **Pressure Switches**

a) Process switches shall not be considered unless its use is unavoidable and the same shall be subject to purchaser's approval

b) Pressure switches shall have either diaphragm or bellow type of process element with SS 316 material of construction as a minimum. Switch type shall be sealed micro-type with contact rating suitable for specific application. Also contacts shall be SPDT type unless otherwise specified. Contacts used in intrinsically safe applications shall be suitable as per the process condition.

c) Pressure switches shall be blind type with 1/2 NPTF process connection and shall be operative in full-specified range. The switch differential shall be selected as per operating conditions.

d) Pressure switches shall have repeatability of ±0.5% of URV, as a minimum. Pressure switch shall have over range protection of at least 130% of maximum working pressure. The set pressure shall fall in the middle third (between 35% to 65%) of the adjustable range in general. Set point shall be field adjustable.

4.7 Level Instruments

4.7.1 **Level gauges**

a) All gauge glasses shall be steel armoured reflex or transparent type with body and cover material of forged carbon steel as a minimum and shall have tempered borosilicate glass with asbestos or other suitable gasket. Transparent type of gauges shall be provided with integral illuminators operating at 240 V 50 H z supply and shall be suitable for electrical area classification specified. All gauge glasses must have a rating equal to or more than the vessel design pressure and temperature.

b) Reflex type will be used for clean and colourless liquids, except liquids level interface. For low temperature, low boiling point service, large chamber type will be used. Transparent type will be used on acid, caustic, dirty or viscous, coloured liquids and liquid interface. Transparent type with Mica or Kel-F shields shall be used for treated water, boiler and condensate services, and for corrosive liquids, which will attack glass. Tubular gauge glasses shall, in general, not be used in Hydrocarbon/hazardous services. They may be used for non-hazardous services at ambient temperature and low pressures (less than 10 kg/cm^2g operating).

c) Large chamber gauges with frost shields shall be provided for cold services below 0^{O} C. Heating jacket shall be provided for viscous liquids with 1/2" flanged connection.

d) All gauges shall have top and bottom chamber connections, unless otherwise specified. However side-side chamber connection is acceptable where nozzle installation is a constraint. In addition each gauge shall be provided with ball check valves and pipe union.

e) The visible range of level gauge shall be selected to cover the complete operating level as well as measuring range of the other level instruments provided for the same purpose. In general, the visible length and C to C distance of the top and bottom level gauges shall be selected from the following:

Visible length	Centre to Centre Length

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220	470
470	720
720	970
980	1230
1230	1480
1490	1740

For side-side level gauge C to C distance shall be 10 mm less than visible length.

f) For level gauging in very viscous, corrosive liquids, liquids with crystals and high pressure service, float operated magnetic gauges with 2" (50 mm) flanged end connections, shall be used. C to C length of single magnetic level gauge shall not be more than 2500mm.

4.7.2 **Level Transmitter**

a) Guided Wave Radar type instruments with external cage and side-side connections shall normally be used for level and for interface level measurement upto 2400 mm.

b) Guided wave radar inst shall have ±3mm accuracy.

c) Differential pressure transmitter shall be used for level measurement above 2400 mm, for services requiring purge or where liquid might boil in external portion.

d) Differential Pressure transmitters for use on corrosive or fouling service shall generally be diaphragm wafer with extended filled capillary type. Flush or extended diaphragm type differential pressure transmitter shall be considered for special applications only. Diaphragm material shall normally be stainless steel or any other special alloy.

e) For sump levels, Guided wave radar or non- contact type radar level instrument shall be used depending on the application within accuracy ± 3mm.

f) Generally for top mounted level transmitters, internal guided wave radar type instruments shall be used for level measurement upto 3000mm. Above that non-contact type radar shall be used.

g) Level transmitters shall meet all requirements specified in clause 2.16.

4.7.3 Other Special types of level instruments like ultrasonic, hydrostatic, nucleonic, capacitance, conductivity type shall be used as necessitated by application requirements.

4.7.4 For high pressure steam drum application at least one number conductivity type (Hydrastep or equivalent) level instrument shall be provided. Also level gauges shall be of bi-color type for such application.

4.7.5 For solid level measurement, type of instrument shall be ultrasonic/ electromechanical/capacitance/nucleonic/non-contact type radar as per the process condition. The actual type selection shall be carried out based on the provenness of the selected type for similar type of application.

4.8 Tank Level Instruments

a) Each tank shall be provided with minimum 2 types of tank level instruments operating on different principles like one servo and other one radar (Antenna) type.

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b) Radar type transmitter shall be provided with ±3 mm accuracy for storage tanks and ±1 mm for custody transfer. Whenever ±3.0 mm accuracy is required, process connection on vessel/ tank/ equipment for non-contact radar gauge can be 4" with 4" Carbon Steel / Stainless Steel (depending on the pipe schedule requirement) still well. However wherever ±1.0 mm accuracy is required (e.g. in custody application), process connection on vessel/ tank/ equipment for non-contact radar gauge shall be 8" with 8" Carbon Steel / Stainless Steel (depending on the pipe schedule requirement) still well. For viscous service, nozzle connection shall be 24".

c) Servo type instruments shall have 6" process connection with 6" diameter still well, with accuracy ±3 mm for storage tanks and ±1 mm for custody transfer. Raising or lowering of displacer for calibration shall be possible on-line with the design of still-well.

d) The wetted material like float, displacer, tape, wire etc. shall generally be 316 SS.

e) The accessories for servo-controlled level gauge shall include isolation ball valves for pressurized tanks and calibration/maintenance chamber for all tanks. Each calibration chamber shall be provided with a viewable window of blast proof glass. The calibration chamber can be either integral to the instrument or separate. Whenever calibration chamber is separate i.e. not integral to the tank level instrument, the material of construction of calibration chamber shall be stainless steel. The calibration chamber shall also permit insertion / removal of displacer for maintenance without removing the instruments.

f) Servo and Radar type instruments shall be capable of providing serial output as per vendor standard protocol or field bus protocol as per IEC-61158 in addition to analog 4-20 mA DC current output. These instruments shall also be capable of accepting input from multi element tank temperature sensors (thermocouple/ RTD), water cut probes and transmit the same as a part of serial signal from the transmitter. Multi-element tank temperature sensors when used shall be provided with 3" stillwell and 3" process connection.

4.9 Flow Instruments

The selection of flow measurement instruments shall be based on the requirement of accuracy, repeatability, location, physical properties of the flowing fluids handled, pressure drop and ease of maintenance.

In-line flow instruments shall have a direction of flow indication clearly marked and easily visible in the final installed position.

Flow switches shall not be used without prior approval from the purchaser.

4.9.1 Orifice Plates

a) Flow measurement shall normally be carried out by using thin square edged concentric orifice plate mounted between a pair of weld neck flanges of minimum 300 pounds ANSI rating for line size 2" and above. Flange taps shall be used for line sizes upto 14" while D-D/2 taps shall be used for line sizes more than 14". The material of the orifice plates shall be normally 316 SS, as a minimum.

Quadrant edge or quarter circle orifice plates shall be used for highly viscous liquids and for pipe Reynold number below 10,000.

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Conical entrance type of orifice plates shall preferably be used for very highly viscous liquids upto throat Reynolds number of 250. These plates shall be fabricated as per Flow Measurement Hand Book by RW Miller.

Vent and Drain holes shall be provided for bore dia above 25.4 mm.

b) Sizing of orifice plate shall be carried out in accordance with ISO-5167 (Latest Edition). For orifice plates not covered in ISO 5167, sizing methods shall be ASME MFC-14M (latest Edition) or AGA Report No. 3 or 'Flow measurement-Engineering Handbook' by RW Miller.

d) Honed metering runs or integral orifice type transmitter shall be used in line size with 1.5" (40 mm) nominal diameter or below.

e) Upstream and downstream straight length shall be provided based on maximum d/D ratio of 0.75, in general. Where it is difficult to meet this requirement, the actual d/D ratio can be considered for reducing the straight length as permitted by the codes. Flow straighteners are to be considered, where straight runs are difficult to achieve otherwise.

f) Meter taps shall be horizontal for liquids, condensible vapours and steam. The taps shall be on top for gas, non-condensible vapour, or liquids which boil at or below the maximum design ambient temperature at operating pressure. Where piping clearances are a factor, taps may be located upto 45 degree below the horizontal center line for condensible vapour and liquid. The taps may be located upto 60 degree from vertical for gas, non-condensible vapour and steam.

4.9.2 **Venturi Flowmeters**

a) Venturi shall be designed and constructed as per ISO 5167-4 (Latest Edition) or ASME MFC-3M.

b) The Venturi Flow element shall be classical, machined, non truncated type.

c) Impulse piping connection for venturi tubes shall be provided with 1/2" NPTF connection, unless otherwise specified in the data sheet.

d) Venturi tube shall be forged/cast construction in general. However fabricated construction shall also be acceptable, wherever allowed as per ISO-5167.

e) Venturi tube shall be provided with Annular chamber / Piezo-metric Ring. Material of construction of Annular chamber / Piezo-metric Ring shall be same as material of Venturi tube.

f) Material of construction of Venturi tube shall be SS316 as a minimum. Material of construction for Throat, Divergent section and Convergent section shall also be SS316 as a minimum. Flanges shall be provided as per the material specified in the datasheet.

g) Flow calibration for those Venturi tubes, which are necessitated due to their installations outside the limits as defined in ISO 5167 for D (Pipe Inside Diameter), beta and Reynolds numbers shall be considered in the base quote

4.9.3 **Averaging Pitot Tube**

Averaging pitot tube in general shall not be considered unless specifically required by the purchaser. Averaging pitot tube shall meet the following requirements:

a) The flow sensor shall be continuous averaging velocity head producing type of pitot tube with four or more equal averaging pitot tube sensing ports or continuous slots to

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suit line velocity profile. The sensor shall also incorporate a rear port for the measurement of line static pressure.

b) Averaging pitot tube shall be of 3" flanged connection with isolation ball valve.

c) The insert retract mechanism shall be provided to allow on line removal and insertion of the average Pitot tube under maximum pressure and flow condition.

d) Vibration analysis for each averaging pitot tube element shall be done for the indicated flow condition to ensure that the averaging pitot tube is of sufficient thickness and strength to withstand the vibration effects created due to Karman vortex shedding in the fluid stream.

e) The free end of the averaging Pitot tube shall be pressure supported at the pipe wall. However, for the large pipe sizes and where vibration analysis recommends the requirement of end support, the end support/weld cap support shall be provided.

f) The offered averaging pitot tubes shall have ±1% accuracy of actual value and repeatability of ±0.1% of actual value.

4.9.4 **Variable area Flow Meters**

Variable area flow meters or rotameters shall be provided as per the P&ID or where rangeability in flow precludes the use of an orifice. Variable area flow meters shall be as per ISA-RP 16.1, 16.2, 16.3, 16.4, 16.5 and 16.6. Metal tube rotameters shall be used for all fluids. External devices for indicating or transmitting shall be magnetically coupled to the float or extension.

Glass tube rotameters shall not be used unless it is necessitated for low range or for low pressure utility services for local indication and where line size is 1-1/2" (40mm) or less with the approval of purchaser.

Reducer shall be considered, in case the size of the flowmeter is less than the line size.

4.9.5 **Mass Flow Meters**

The mass flow meters shall meet the following requirement:

a) Flow meter shall be of in-line mounting design and shall be of flanged body construction with stainless steel as minimum material of construction.

b) The mass flow meter shall be provided with the external flow tube housing. In all such cases, the flow tube housing shall have provision to monitor housing pressure continuously.

c) The mass flow meter shall have high vibration immunity.

d) The meter electronics shall be protected against transients induced by lighting and power supply surges. Transient protection electronics shall preferably be provided in the terminal block.

e) Flow meter electronics shall be microprocessor based and shall include pre-amplifier, converter, transmitter electronics and integral output meter. The indication on the output meter shall be digital with engineering units.

f) The mass flow meter shall be capable of computing field density and shall incorporate temperature sensor flow fluid temperature measurement. Whenever required, the flow meter electronics shall have capability to compute volumetric flow rates.

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g) The meter electronics shall be protected against transients induced by lightning and power supply surges. Transient protection electronics shall preferably be provided in the terminal block. The transient protection shall meet the requirements specified in IEC-60587.

h) Unless specified otherwise in the job specification, the performance requirements for the mass flow meter shall be as follows:

i.	Flow meter accuracy:	± 0.2% of mass flow rate for liquid service.
		± 0.5% of mass flow rate for gas / vapour service.
ii.	Flow meter repeatability:	± 0.1% of mass flow rate for liquid service.
		± 0.25% of mass flow rate for gas / vapour service.

The performance requirements specified above excludes the effect of zero stability of the flow meter on these parameters.

Flow accuracy shall be maintained between the minimum and maximum flow. Where only normal flow is specified, the maximum and minimum flows considered for the purpose of sizing shall be:

Maximum flow = 1.4 times the normal flow

Minimum flow = 0.4 times the normal flow

When only maximum flow is specified minimum flow shall be considered as 0.2 times the maximum flow for sizing the meter.

The maximum pressure drop at meter maximum shall not exceed the allowable pressure drop across the meter specified in the data sheet.

The meter shall be selected such that both accuracy and allowable pressure differential across the meter are complied.

4.9.6 Ultrasonic flowmeter

Ultrasonic flow measurement shall be considered where non-intrusive flow measuring is required.

The Ultrasonic flow meter shall be based on transit time technology.

The design used shall provide maximum reliability, maximum on-line performance and minimum maintenance. It shall be immune to other impurities in the fluid stream.

Ultrasonic flow meters and the meter runs/flow conditioners shall be rated for the maximum design pressure.

Spool piece type Ultrasonic flow meters shall have flanged end connections. Weld joints, if any, shall be of radiographic quality.

Meter Sizing:

Selected meter size shall ensure that flow meter operates within 85% of their standard range considering density and viscosity of the fluid. Extended range shall not be referred for the meter selection.

Vendor to ensure the velocity in the Ultrasonic flow meter and meter run shall not exceed maximum permissible velocity.

4.9.7 Target meters shall be considered for highly viscous hydrocarbon streams such as asphalt, tar, polymers etc.

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4.9.8 Vortex meter shall be considered where high rangeability is the prime requirement.

4.9.9 Differential Pressure type flow transmitter shall meet all the requirements specified in clause 2.16.

4.9.10 Wedge flow meter shall be considered in slurry services or where powder deposits may form. However, Diaphragm seal type DP transmitter shall be provided along with wedge flow meter duly calibrated with both sensor and the transmitter.

4.10 Control Valves

4.10.1 Control valves shall normally be globe type. Other valve types like butterfly, ball, rotary plug, angle or 3way etc., shall be selected as per service and process requirements.

4.10.2 Control valve sizing shall be carried out as per ISA S75-01. The valve shall permit upto 150% of normal flow or 110% of maximum flow, whichever is higher. In general, control valves shall be sized so that the valve opening is as noted below:

At max. flow	:	about 90% open
At normal flow	:	about 75% open
At minimum flow	:	about 20% open.

4.10.3 Flanged control valves shall be used. Body material, body rating and flange rating shall be as per piping specifications. However body and flange rating shall be minimum 300#.

4.10.4 Minimum control valve body size shall be 1" in general. Reduced trims can also be considered.

4.10.5 For globe valves trim characteristics shall be equal percentage type unless required otherwise. Control valve plugs shall be heavy top guided for single seated valves. Cage guiding may be used in clean applications.

4.10.6 Anti-cavitation trim shall be selected wherever cavitation is expected in the valve. For flashing services and hardened trim shall be used and anti-cavitation trim shall not be provided.

4.10.7 Noise from control valve during operation shall be limited to OSHA specified level or better. The maximum allowable noise is 85 dBA SPL (Sound Pressure Level). Source treatment for noise may be performed by using special trims like low noise trims, in case noise exceeds the specified level. Other methods based on merit are also permissible.

4.10.8 Valve seat leakage shall be minimum class IV as per ANSI/FCI 70.2 unless tight shutoff requirement is required as per the P&ID.

4.10.9 Flanged bolted type gland packing boxes shall be used. Packing shall normally be PTFE on liquid and gas service up to 200^{O}C (design). Graphite/grafoil shall be used above 200°C(design) temperature. Asbestos based packing material shall not be used.

4.10.10 Bellows seal shall be used where it is required to isolate the packing from the process fluid or where no leakage to atmosphere can be tolerated like toxic, explosive and precious fluids.

4.10.11 Material used for trim shall be minimum SS 316, with guide bushing of hardened stainless steel like 440 C, 17-4 PH. For higher pressure drops (more than 10 kg/cm^2) or erosive and slurry services and in general for all steam services, flashing and cavitating services, plug and seat shall be stellited.

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Special cases may require 17-4 PH seat ring and 440 C solid plugs or other materials like Hastelloy, Monel etc.

4.10.12 Valve actuator shall be pneumatic spring opposed diaphragm type, in general. Piston type actuators may be used for very high shut off pressure requirements. Additional equipment including volume bottle necessary to meet fail safe condition shall also be included in case double acting piston type actuator is selected. In either case, actuator shall be able to withstand maximum shut-off pressure (1.5 times of design pressure) with the minimum instrument air pressure specified.

4.10.13 Whenever limit switches are specified as inductive proximity type, these shall meet NAMUR (DIN-19234) requirements.

4.10.14 Solenoid valves, wherever used, shall be universal and continuous rated type with class H coil insulation. These shall be SS body as a minimum.

4.10.15 Self-actuating regulators for flow, pressure and temperature shall be used where loads are constant and requirements of precision and accurate controls are not stringent.

4.10.16 The actuator shall be painted as below:

Direct action (open on air failure) valves	-	Green
Reverse acting (close on air failure) valve	-	Yellow
Actuator for shutdown valves	-	Red

Items like air volume tanks etc., supplied as an accessory along with the actuators, shall be painted as per corresponding actuator.

4.11 ON-OFF VALVE

4.11.1 On-off valves shall have flanged end connections integral to the valve body. Top entry valve design shall not be offered unless specifically indicated. Body rating of valve shall be minimum 300#.

Whenever flangeless on-off valve body design is specified, following shall apply:

a) Wafer type or lug type body design for butterfly type on-off valves body size up to 6 inches.

b) Lug type body design for butterfly type of on-off valve body size more than 6 inches.

4.11.2 For on-off valves with fire safe design, flanged body construction shall only be acceptable.

4.11.3 For all services where full port valves are specified, following shall apply:

a) Port size shall be equal to line size for rating up to ASME Class 1500.

b) Port size shall not be less than one size than the line size for rating ASME Class 2500 and above.

4.11.4 For steam jacketed valves, the body and port size shall be one size lower than the on-off valve end connections.

4.11.5 On-off valve body, bonnet, bottom flange, line flanges and other pressure containing assemblies shall be of the same material of construction as specified for valve body.

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4.11.6 In case of ball-type of on-off valves;

a) The valve design shall ensure valve seat and body protection against thermal expansion of the entrapped fluid when the on-off valve is fully close.

b) For size up to 4" and rating up to ASME Class 300, the on-off valve shall have floating ball design. For ratings ASME Class 600 and above, floating ball is acceptable for sizes less than 2". For higher sizes trunion mounted ball design shall be provided.

4.11.7 Rotary type on-off valves like Ball valves, butterfly valves etc. shall have blow out proof shaft guiding design.

4.11.8 Guide bushing shall be of a sufficiently hard material to resist side thrust on the plug or shaft.

4.11.9 Vendor shall be responsible for trim design and selection of the on-off valve. However, it must meet the following minimum requirements:

a) The valve characteristics shall be quick-opening (on-off) type.

b) Vendor shall select proper material pairs, surface finish, hardness and clearances to avoid galling.

c) Valves operating under extreme temperature conditions, vendor shall consider increased clearances at room temperature and seal welding of threaded seat rings etc whenever required. Hard facing of trim including guide bushing shall be considered for all valves operating at high temperatures (i.e. temperature more than 200°C). For very low temperature application, material used shall have adequate cold impact strength.

d) For all on-off valves including 3-way type of valves, stem and plug shall be detachable and shall be attached together by suitable threaded design secured with a pin to avoid plug rotation during operation.

4.11.10 Trim material and actuator colour shall be as specified for the control valve.

4.11.11 Leakage class of on-off valves shall be as specified in data sheet, where no class is specified it shall be Class IV.

4.11.12 For on-off valves specified with Class VI / bubble tight (as per API) leakage class, vendor shall select the soft seat (elastomer) material suitable for the process conditions i.e., shut off pressure, maximum temperature and process fluid. Metal seated on-off valves meeting the leakage class shall also be acceptable.

4.11.13 For application in vacuum service, vendor to provide inverted packing design suitable for vacuum service. For pressure-cum-vacuum service, the on-off valve shall have dual packing design suitable for the application. Dual packing design shall also be provided for on-off valves in toxic service, with a facility to connect inert fluid between the packings.

4.11.14 Valve actuator shall be designed to move the valve to the failure position as specified. For failure position specified as 'fail-locked', vendor shall provide air reservoir with all required accessories to meet the fail lock position of the valve.

4.11.15 Whenever double acting springless type of actuator is unavoidable, all accessories like pilot valves, booster relays, non-return valve, pressure gauge, volume tank etc. shall be provided to ensure desired action on air failure.

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4.11.16 The volume tank shall be of carbon steel construction and sized as per ASME Section VIII with design pressure of 10kg/cm^{2}g as a minimum. Each volume bottle shall be sized for a minimum of 3 valve strokes

4.11.17 The actuator casings and diaphragms shall be designed for minimum twice the maximum pneumatic operating pressure of the on-off valve.

4.11.18 Vendor shall be fully responsible for sizing and selection of correct actuator, while sizing the actuator vendor shall consider minimum actuator thrust equal to two times (2) the total force induced by shut off condition and the force required to overcome packing friction.

4.11.19 Wherever the valves are indicated as fire safe, they shall be tested for fire safe as per BS 6755 (Part-2) when the valves are supplied with metal-to-metal seats and shall be tested as per API 607 latest edition when the valves are provided with soft seats.

4.11.20 Wherever fire safe actuator and controls have been asked for, actuators and all accessories such as solenoid valves, air volume bottles etc. shall meet the fire proof requirement to ensure normal valve operation even during and after exposure to fire. Vendor shall clearly define the schemes they propose to achieve the above requirements and ensure that the proposed schemes shall meet the requirement in terms of type of exposure and exposure time of the testing procedure given in BS 6755/API 607.

4.11.21 Vendor shall furnish type test certificate duly witnessed by third party inspection agency like M/S LRIS,BV,DNV,TUV etc. for fire safe testing of valve, actuator and controls for the offered models.

4.12 Smart Type and Field Bus Type Positioners

Digital smart positioners or field bus type of positioners with diagnostic capabilities shall be provided as per job specific requirement. These shall meet the following minimum requirements:

a) The positioner sensor and sensing mechanism shall be rugged and shall not be affected by the line/valve vibration. The performance of the positioners shall be immune to above vibration.

b) The positioner's output and input range shall be field adjustable without any hardware modification. The output from the positioners shall be available for both single acting as well as double acting actuator.

c) Each positioner shall be operable, configurable and accessible through HART compatible hand held configurator/field bus configurator as applicable. Smart positioners shall also have dedicated buttons for the above functions.

d) Control valve's operating signatures in the form of hard copy and soft copy for each control valve provided with smart positioners shall be supplied. The necessary software for advanced control valve diagnostics like seat ring condition, gland packing condition, actuator leakage etc. shall also be included.

e) Fieldbus positioner shall have the capability to perform functions like PID etc.

f) All positioners shall have metallic casing and cover.

4.13 Pressure Relief Valves and Rupture Discs

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4.13.1 **Pressure Relief Valves**

4.13.1.1 All pressure relieving devices shall be designed in accordance with ASME code for 'Boilers and Pressure Vessels', API-521 and Indian Boiler Regulations. The pressure relief valve sizing shall be as per API 520. For mixed phase fluids, sizing shall be as per Leung-Omega method (or Diers) sizing shall be followed. The orifice sizing, area and designation, valve size and rating shall be as per API RP 526.

4.13.1.2 Pressure relief valves shall be full nozzle full lift type except for thermal relief valves.

4.13.1.3 Conventional valves shall be specified for constant back pressure while bellows seal type valves shall be specified for variable back pressure. Pilot operated pressure relief valves shall be used when Back pressure is greater than 50% of set pressure or when the difference between operating pressure and set pressure is within 10% of the set pressure.

4.13.1.4 Lifting lever shall be specified for steam, air or water above 65 degree service. Open bonnet shall be used for steam service.

4.13.1.5 The percentage accumulation in case of pressure relief valves/safety valves shall be as follows:

a)	Steam Service	
	- ASME SEC I(steam generation/consumption)	3%
	- IBR (Before steam let-down station)	5%
	- IBR (Distribution & utilities) and ASME Section VIII	10%
b)	Gas, Vapour or liquid for process service	10%
c)	Liquid for thermal Relief	25/ 10% (as per Process requirement)
d)	Fire exposure on unfired vessels	21%

4.13.1.6 3/4" x 1" threaded (NPT) modified nozzle type valves with typically 0.38 cm^2 orifice size shall be specified for thermal relief. However, if discharge is connected to flare or with variable back pressure more than 10% of set pressure, 1D2 flanged valves as per API-526 as a minimum to be provided.

4.13.1.7 The body material shall, as a minimum, be as per piping specifications. Nozzle and disc material shall be SS 316 as a minimum with machined stainless steel guide and spindle. Whenever semi nozzle designs are unavoidable, body material shall be atleast same as nozzle and disc material.

4.13.1.8 The spring material of pressure relief valves shall be as follows unless otherwise necessary because of process conditions;

(-)29^{O}C to 230^{O}C	:	Carbon steel with weather protective coating.
above 230^{O}C	:	Tungsten alloy steel.
Below (–)29^{O}C	:	316 Stainless Steel

4.13.1.9 Flanged connection shall be for standard sizes 1" or larger.

4.13.1.10 Where permissible, screwed connections shall be used on sizes 3/4" and below.

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4.13.2 **Rupture Disc**

4.13.2.1 Rupture discs shall be reverse buckling type, in general and shall be supplied in pre-torqued holder assembly, which shall fit inside the inner diameter of the bolt circle of standard flanges. Disc material shall be compatible with the vessel contents and shall be consistent with the bursting requirements. Inconel discs shall be used above $100^{O}C$ if compatible with the process fluid.

4.13.2.2 When rupture disc is used upstream of a pressure relief valve, a pressure gauge shall be provided on the downstream of the disc to indicate any rupture of the disc in addition to an excess flow check valve. In addition combination capacity factor of 0.9 shall be used for sizing unless the combination has been tested and approved for any other combination capacity factor.

4.13.2.3 The bursting tolerance of the rupture disc shall be 5% of the specified bursting pressure or less, unless otherwise specified.

4.13.2.4 Vendor shall consider 5 nos. rupture discs (1 for testing + 1 for installation + 3 nos. spare) of the same specifications.

4.14 Interlock and Shutdown System

4.14.1 Interlock and Shutdown System shall be an independent system with its own dedicated primary element except for orifice flow measurement. For orifice flow element, separate set of tapping for each flow transmitter for shut down / interlock shall be considered.

4.14.2 The system shall be designed fail safe and shall meet the following requirements, as a minimum:

a) All initiating contacts shall be close (except limit switches for which contact shall close when the limit reaches) under normal conditions and shall open under abnormal conditions.

b) All relays and solenoid valves shall be energised under normal conditions and shall de-energize under abnormal conditions.

c) If desired, because of operational or maintenance requirements, adequate trip by-pass facilities are to be provided with warning lights to indicate that the trip has been bypassed. Trip bypass alarms shall be provided ~~in local as well as in remote location~~. All such by-pass switches shall be key-operated type.

4.14.3 Each shutdown circuit and solenoid valve shall be provided with a switch-fuse unit separately.

4.15 **Instrumentation for Rotating Equipments**

Rotating Equipment vendor shall be completely responsible for providing adequate instrumentation for safe and efficient operation of the machine. The commonly used instruments are being detailed out in the following clauses, however this does not absolve the vendor of providing additional instrumentation, if required.

4.15.1 **Anti surge and performance control system (ASC)**

a) Vendor shall be fully responsible for the complete design of Anti surge/performance control system (ASC) including selection of type of flow element, controller Algorithm, type of explosion protection, type and operating timings of final control element. Vendor shall guarantee the performance of machine with the offered ASC system. Wherever required, ASC system shall be designed in such a way that it is capable of correcting the

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compressor operating point so as to avoid surge in order to protect machine from possible damage, to minimize process upsets and to minimize recirculation.

b) ASC system shall typically consist of but not limited to flow element, flow transmitter, differential pressure transmitter, ASC controller, control valve and other accessories as felt necessary by the vendor.

c) Vendor shall supply all the hardware and software related to the operation and safety of the equipment. This shall include but not limited to the following;

i. Design and operation of surge control loop scheme based on offered equipment performance.

ii. Supply of all hardwares in antisurge control loop including dedicated controller, transmitters, measuring elements, final control element etc.

iii. Fast response transmitter and control valve etc. as required.

iv. Algorithm required for antisurge/ Performance control application.

d) The ASC shall be a dedicated single loop controller on proprietary Hardware Platform or single/multi loop controllers of common hardware platform such as PLC. The single loop controller shall be dedicated controller for each Anti-surge or Performance control application/Tag. Dedicated panel mounted facia shall be provided. The ASC system when provided on common hardware platform shall be with redundant configuration as minimum viz-dual processor, dual input/output, redundant communication & dual power supply system. The multiloop controller/system shall be dedicated for Anti-surge/Performance applications/Tags of each machine/each machine tag. Unless specified otherwise dedicated panel facia for each application shall be provided to mount on hardwired console in control room

e) It should be able to accept 4-20 mA signal from field or from HIC at purchaser DCS or at LCP as a manual override to anti-surge control system with bump less transfer.

f) Auto-manual operation with bump less transfer shall be provided.

g) The controller response time (total time to read input, processing time and output) shall be as per the machine dynamics and safety and shall be of the order of max. 40-milisec. Any faster response required based on machine dynamics shall be considered by vendor. The input sampling interval shall be as per machine dynamics within the controller response time as above. The processor cycle time shall be considered to meet the overall response time.

h) The ASC shall be field proven, specific to the make of machine and for the similar application in hydrocarbon industries. Vendor shall provide the proven track record for the offered ASC meeting the above.

i) The anti surge/performance control algorithm shall be implemented using standard firmware in the controller/processor system.

j) The algorithm developed by vendor shall be specific for given application, surge control, performance, load sharing etc. and shall be field proven for the compressor make.

k) The algorithm implemented in the system shall be protected against any modifications/changes.

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l) The configuration shall be stored in non-volatile memory or battery back-up for configuration shall be provided (minimum 48 hours) in case of volatile memory along with battery drain indication.

m) In case of ASC on common hardwired platform separate configurator with necessary hard ware/ soft ware shall be provided for application programming.

n) Anti surge controller shall not be used for performing any other machine related inter locks/logics.

o) All the instruments (transmitters, Positioner and temperature elements and / or transmitters) connected with anti-surge control loop shall be flame proof "EExd" type suitable for the area as specified. The suitability of smart transmitter/ Positioner shall be confirmed by vendor and to be provided accordingly.

p) The ASC system vendor shall be fully responsible for the sizing and selection of the anti-surge valve. Vendor to provide the sizing calculations duly vetted by ASC system manufacturer.

4.15.2 **Machine Monitoring System (MMS)**

Machine Monitoring system shall be provided for continuous monitoring and indication of machine parameters like vibration & axial displacement, bearing and winding temperature, key-phasor etc.

4.15.2.1 Vibration and displacement monitoring system shall be as per API-670. The extent and type of monitoring shall be as defined elsewhere. However, vendor shall furnish any additional requirements for monitoring deemed essential by them with reasons. Two probes at 90 degree apart for each location shall be provided and connected to same dual channel monitor for vibration monitoring.

4.15.2.2 The machine monitoring system shall be provided with preferably built in intrinsically safe barrier and shall be duly mounted in separate panel. However, separate terminal blocks shall be provided for terminating the field cables for maintenance purpose. Direct cable termination on modules shall not be considered.

4.15.2.3 For MMS the display unit shall be provided at local control panel with necessary statutory certification. Alternatively purged enclosure is also acceptable with necessary certification.

4.15.2.4 The sensing probe shall be accessible for adjustment, repair and replacement without dismantling the machine.

4.15.2.5 Vendor shall provide hardwired Voted contact output of each parameter for Pre trip and trip alarms for alarms/ interlock in purchaser's control system. The alarms/trips of the channels within each monitor/ Module can be grouped together and common pre-trip alarm and common trip contact for each monitor/ Module shall be provided. 4-20 mA signals from Vibration & Temperature Monitoring System racks to DCS system are not required separately, unless specified and vendor to ensure that all the parameters are available through serial interface. For multi racks, vendor shall provide common serial interface through multi drop link.

4.15.2.6 In addition to this, it shall be provided with necessary hardware (communication gateway module) including the cable for serial data communication from monitoring system to purchaser's DCS for machine monitoring through purchaser's DCS via redundant serial data interface. This serial link shall be RS 422 / RS 485 with MODBUS RTU protocol. Vendor shall furnish all details like pin configuration and tag number wise MODBUS address mapping list etc. for smooth interfacing of this communication link with DCS.

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Vendor shall also provide necessary hardware and software for providing raw data to conditioning monitoring system for each rack.

4.15.2.7 Vendor shall also supply one common laptop based configuration unit for the package unit with required configuration software (refer clause 4.17) and hardware for configuration of MMS system including the serial communication cable required between configuration unit (laptop) & MMS monitors.

4.15.2.8 **Key Phasor**

Key phasor system shall be provided by vendor for performing analysis of vibration signals to determine machine malfunctions. It shall consist of a proximity probe and transmitter, extension cable etc. and other accessories to make the system complete. Vendor shall provide necessary reference on the shaft to determine one-per-turn occurrence.

4.15.2.9 **Vibration and Axial Displacement Monitoring**

Monitors shall be four channel types and shall meet the following specifications as a minimum:

a) Continuous channel monitoring with each channel input from one probe. Readout scale shall read higher of the sensors.

b) Each channel shall have two independent alarm levels one for pre trip alarm and one for each trip and that can be set continuously over measurement range. Two relay contacts for each pre-trip alarm and trip alarm per channel shall be provided.

c) Broken sensor failure detection without causing shut down.

d) LED lamps on monitor front for each channel to indicate pre-trip alarm, trip-alarm and circuit fault conditions.

e) Selector switches on monitor front to read vibration/ displacement pre-trip alarm and trip set points for each channel shall be provided.

4.15.2.10 **Bearing & Winding Temperature Monitoring**

a) Sensor shall be three wires RTD element of platinum having 100 ohms resistance at $0^{O}C$.

b) The temperature sensor, cables, terminal heads, junction boxes etc. shall be capable of withstanding the mechanical vibration and environment of a rotating machinery atmosphere.

c) Bearing and Winding temperature shall be monitored by means of a temperature monitor. It shall meet following requirements:

i. Accept RTD inputs (platinum, 100ohm at $0^{O}C$).

ii. Continuous six channel monitoring with each channel input from each RTD. Read out scale shall read higher of the six temperatures.

iii. Each channel shall have two independent alarm levels one for pre-trip alarm and one for trip alarm and that can be set continuously over measurement range.

iv. Broken sensor failure detection without causing shut down.

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v. Selector switches on monitor front, to read temperature, pre-trip alarm and trip set points for each channel shall be provided.

vi. Analog output 4-20 mA DC isolated signals shall be provided for each channel for remote indication, if specified.

4.15.2.11 Wherever MMS is not specified, vendor shall provide suitable transmitter for all the vibration and axial displacement, temperature, key phasor to provide 4-20mA signal to purchaser's control system.

4.15.3 **Speed Governor System**

4.15.3.1 Digital microprocessor based system mounted in standalone cabinet and located in rack room shall be provided. Fault tolerant triple modular redundant (TMR) system shall be supplied unless otherwise specified in Job Specification.

4.15.3.2 HMI for operator interface shall be supplied loose with all mounting accessories for mounting this HMI in purchaser's hardwired console in general. This shall include all basic features of governor to enable operator to do all control and monitoring operations from console itself.

4.15.3.3 This shall include features like assignable speed range, adjustable speed set point, remote speed set point input, digital speed indication, adjustable speed ramp, override for testing the external over speed trip system etc.

4.15.3.4 It should be able to accept 4-20 mA signal from HIC at purchaser's DCS or LCP as a manual override to governor and pass on the same, after a bump less auto / manual selection and local / remote selector switches configured in speed governor (shall be possible through HMI) to governor valve as manual control.

4.15.3.5 Vendor shall provide all hardware & software in the system (including the cable for serial data communication from system to purchaser's DCS) for serial communication link for all data transfer from governor to purchaser's DCS. This serial link shall be RS 422 / RS 485 with MODBUS RTU protocol, vendor shall furnish all details like pin configuration and tag number wise MODBUS address mapping list etc. For smooth interfacing of this communication link with DCS.

4.15.4 **Accumulator of Lube Oil System**

4.15.4.1 If accumulators are used with nitrogen for lube oil dampening at the desired pressure to meet the system requirement the following instrumentation with the accumulator to be provided by vendor:

a) Accumulator shall have charge kit with isolation valves and connection hoses.

b) Standard nitrogen cylinders available in India are at pressure of 140 kg/cm^2g with standard connection sizes. Vendor shall provide the complete regulator system with protection for charging nitrogen from nitrogen cylinder to accumulator at the desired pressure. Regulator shall be suitable for the inlet pressure variation of 140 to 150 kg/cm^2g while charging with suitable inlet connection to match the Nitrogen cylinder connection. Regulator system shall have pressure indicator, regulator, relief valve, needle valve etc. as a minimum. Material of construction shall be stainless steel.

4.15.5 The compressor loading-unloading scheme for reciprocating compressors shall be provided as per the minimum requirements specified in the job specifications. Manual as well as automatic schemes shall be provided.

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4.15.6 Emergency switch shall be provided in the local panel/local. All such switches shall have a protective cover to avoid inadvertent shutdown.

4.15.7 Vendor shall provide the following common alarms for purchaser:

a) Common machine pre-trip alarms.

b) Common machine trip alarm.

4.16 System Cabinets, Racks and Consoles

4.16.1 All system cabinets, marshalling racks and hardwired consoles shall be free standing and enclosed cubicles type. All these items shall have bottom cable entry.

4.16.2 Cabinets shall be fabricated from cold rolled steel sheet (CRCA) of minimum 2.0mm thickness suitably reinforced to prevent warping and buckling. Doors shall be fabricated out of 1.6 mm thick CRCA sheet. Cabinets having modular construction and with basic frame structure of heavy duty aluminium shall also be acceptable.

4.16.3 Cabinet/Console finish shall include sand blasting, grinding, chemical cleaning, surface finishing by suitable filler and two coats of high-grade lacquer with sanding between coats. Two coats of paint in the cabinet colour and a final coat after assembly at site, shall be given for non-glossy high satin finish.

4.16.4 In order to remove dissipated heat effectively vent louvers backed by wire fly screen shall be provided. Further, ventilation fans shall be provided wherever required. High temperature annunciation shall be provided on operator console.

4.16.5 Illumination shall be provided for all cabinets by fluorescent lamps, which shall be operated by door switch.

4.16.6 All cabinets/racks/consoles shall be adequately sized to avoid any congestion. Wiring shall be done as per guidelines provided in clause 4.2.14 of this specification.

4.16.7 The height and colour of the cabinets shall be inline with other equipments being installed in the control room.

4.17 System software / License

Systems (like PLC, ASC, Speed Governor etc.) software shall include the operating system and application program. The application program shall include software for performing functions like interlock and shutdown logic, programming/program modification, documentation etc. Two copies of application program and two sets of licensed system software shall be supplied. The program language shall be English.

The licenses and application program shall allow:

- Monitoring of system program for troubleshooting purpose.
- Carrying out any modifications to the PLC/system program if need arises (engineering license with proper validity)
- Troubleshooting of any system related failures.
- Monitoring of the system healthiness

The system shall be supplied with programming tools and related accessories.

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5.0 LIST OF DOCUMENTS ATTACHED

7-52-0001	Instrument connections on vessels, standpipes and tanks
7-52-0002	Instrument connections on piping.
7-52-0035	Thermowell
7-52-0041	Orifice Plates and Flanges -Dimensional details.
7-52-0254	Duct Fabrication – Bolted Construction Details

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PART II

SPECIFICATION FOR MATERIAL, INSTALLATION, TESTING AND COMMISSIONING

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1.0 INSTALLATION MATERIALS

1.1 Vendor shall ensure and supply all erection hardware required for the installation of complete instrumentation which form a part of the package unit. This includes items like cables, cable glands, junction boxes, instrument valves and manifolds, mounting accessories, impulse piping/tubing, pipe/tube fittings, pneumatic signal tubes, air line pipes and fittings, filter regulators, steam/electrical tracing, insulation materials, cable duct and trays, conduits, prefabricated canopies for instruments, identification tags, structural material required for instrument supports and trays etc.

1.2 Clause 1.1 above broadly covers the items required for any typical plant, however vendor shall supply all necessary items to make the installation and commissioning work complete in all respect, irrespective of whether these have been explicitly included in their scope or not.

1.3 Salient feature and minimum requirement for some of the main installation materials is being described in the following paragraphs. For items for which no specification has been provided, vendor may follow their own specifications and prevailing international standards.

1.4 Cables

1.4.1 All cables shall have PVC insulated primary insulation of cable shall be 85^{O}C Polyvinyle Chloride type as per IS-5831 and inner and outer sheath of cable shall be flame retardant made of extruded PVC Type ST-2 at 90^{O}C as per IS-5831. Oxygen index of PVC shall be over 30% at 27 ^{O}C$\pm$2 ^{O}C and temperature index shall be over 250^{O}C. However, Polyethylene (PE) insulation shall be provided in IIC area classification.

1.4.2 In general cables shall be flame retardant as per standard IEC 60332 Part 3 Cat.A. However, cables with fire-safe valves shall be fire resistant also as per the following.

1.4.2.1 The insulation grade shall be 650 V/1100 V as a minimum and shall meet insulation resistance, voltage and spark test requirements as per BS-5308 Part-II.

1.4.2.2 All cables shall be twisted and armoured. Armour over inner jacket shall be of galvanised steel wire/flat as per IS-1554 part I.

1.4.3 For signal and control cables, inner jacket colour shall be black. Outer jacket colour shall be light blue for intrinsically safe application and black for others. For thermocouple extension cables the inner and outer jacket colour shall be as per IEC.

1.4.4 Maximum DC resistance of the conductor of the completed cable shall not exceed the following:

a) 12.3 ohms/km at 20^{O}C for cables with 1.5 mm2 conductor.

b) 39.7 ohms/km at 20^{O}C for cables with 0.5 mm2 conductor.

1.4.5 The mutual capacitance of the pair or adjacent cores shall not exceed 250 pF/m at a frequency of 1 kHz whereas the same shall not exceed 100 pF/m for PE insulated cables. The capacitance between any core and screen shall not exceed 400 pF/ m at a frequency of 1 kHz.

1.4.6 L/R ratio of adjacent cores shall not exceed 40 μH/Ω for cables with 1.5 mm^2 conductor and 25 μH / Ω for cables with 0.5 mm^2 conductor.

1.4.7 The drain wire resistance including shield shall not exceed 30 ohms/km.

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1.4.8 A pair of communication wire shall be provided for multipair/multitraid cables. Each wire shall be 0.5 mm^2 of plain annealed single or multi-strand copper conductor with 0.4 mm thick 85^{O}C PVC insulation. Insulation shall be green and red colour coded.

1.4.9 Each multipair cables shall have 20% pairs as spare.

1.4.10 Running length of the cable shall be printed on the outer sheath at least at every 5 metre interval.

1.4.11 **Signal Cables**

a) Single pair shielded signal/alarm cables shall be used between field instruments and junction boxes/local control panels.

b) Multipair individually and overall shielded signal/alarm cables shall be used between junction boxes/local control panels and control room, in general.

c) The single pair and triad cables shall be of 1.5 mm^2 conductor size made of electrolytic copper conductor of 7 strands with each strand of 0.53 mm diameter, multipair cables with 0.5 mm^2 conductor size shall have 16 strands of annealed electrolytic grade copper conductor with each strand of 0.2 mm diameter, multi triad cable or multi pair cable with 1.5 mm^2 conductor shall have 7 strands with each strand of 0.53 mm diameter, as per the job specification.

d) Shield shall be aluminium backed mylar/polyester tape bonded together with the metallic side down helically applied with either side having 25% overlap and 100% coverage. The minimum shield thickness shall be 0.05 mm in case of single pair/traid and 0.075 mm incase of multipair/triad cable.

e) Drain wire shall be provided for individual pair and overall shield which shall be 0.5 mm2 multi stranded bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminium side of the shield.

f) All multi pair cables shall have 6 pair/12 pairs only while multitriad cable shall have 6 triads/8 triads only.

1.4.12 **Control Cables**

a) Single pair control cables shall be used between field mounted solenoid valves and junction boxes/local control panels and shall meet the requirements specified in para 1.4.11 above.

b) Multipair control cables shall be used between junction boxes/local control panel and control room mounted devices in general. These cables shall have only overall shielding.

c) These control cables shall have 1.5 sq mm conductor size with 7 stranded conductors of annealed electrolytic grade copper, with each strand of 0.53 mm diameter.

1.4.13 **Fieldbus Cables**

a) Fieldbus cables shall be 16AWG (1.31 mm^2) for trunk and 18 AWG (0.82mm^2) for spur twisted in pair individually and overall shielded with aluminium mylar tape with drain wire and armoured. Other parameters shall be as per Type A defined in IEC-61158-2.

b) Fieldbus cables shall be single pair or two pairs.

c) Field bus cable shall be field proven for FF applications.

d) Fieldbus cable shall comply with H1 cable test specification FF 844.

e) Outer jacket color shall be orange with 3 longitudinal blue stripes for spur cables and black stripes for trunk cables.

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1.4.14 **Thermocouple Extension Cables**

a) Single pair shielded thermocouple extension cables shall be used between thermocouple head and junction boxes/ transmitters/local control panel mounted instruments.

b) Multipair individually and overall shielded thermocouple extension cables shall be used between junction boxes and control room mounted devices.

c) The type of thermocouple extension cables shall be compatible with thermocouple used. In addition the colour coding of the primary insulation shall be as per IS-8784-1987 (R2004).

d) The cable shall have 16 AWG and 20AWG solid conductors for single and multipairs respectively.

e) All thermocouple extension cable shall be matched and calibrated in accordance with IEC-60584-2.

f) Shield shall be aluminium backed by mylar/polyester tape bonded together helically applied with the metallic side down with either side having 25% overlap and 100% coverage. Minimum shield thickness shall be 0.05 mm for single pair and 0.075 mm for multipair cable. Drain wire shall be similar to individual pair and shall be in continuous contact with the aluminium side of the overall shield.

g) Inductance shall not exceed 4mH/Km. However for J-type thermocouple inductance could be 8 mH/km.

h) Electrostatic noise rejection ratio shall be over 76dB.

i) All multi-pair cables shall have 6 pairs/12 pairs only.

1.4.17 **Power Supply and Other Cables**

a) All power supply cables shall be as per IS-1554 Part I and shall have copper/aluminium conductors depending on conductor size. Minimum conductor size shall be 2.5 mm^2 of copper conductor. For higher sizes (above 16 mm^2), aluminium conductor can be considered. All these cables shall be PVC insulated and armoured.

1.4.18 Any other special cable required for instruments shall also be supplied as per the requirement. Vendor shall ensure that these cables are armoured type and shall meet all other requirements specified in para 1.4.1 through 1.4.10, as applicable.

1.5 Cable Glands

a) Vendor shall supply all cable glands required for glanding the above mentioned cables at field instrument side, local control panel side, junction boxes side and at control room side.

b) All cables glands shall be of nickel-plated brass and shall be double compression type suitable for armoured cables.

c) Flame proof glands wherever required shall be supplied with Ex (d) certification.

d) PVC Cable shrouds shall be provided with all the cable glands.

1.6 Junction Boxes (Non-Fieldbus loops)

a) Vendor shall supply junction boxes as per the cables selected, wherever required. These shall be of die cast aluminium alloy (min. LM-6) body and shall be weather proof to IP65 as a minimum.

b) These boxes shall have terminals suitable for minimum 4.0 mm^2 cable termination mounted on rails. 20% spare terminals shall be supplied in each junction box.

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c) Telephone sockets and plugs shall be provided in junction boxes.

d) Flame proof junction boxes shall be used in explosion proof/ flame-proof instruments circuits and supplied with Ex (d) certification. All such boxes shall be weatherproof also.

e) Each junction box shall have a minimum 12 numbers of entries with 20% or 2 Nos. as spare entries for branch cable and minimum 2 numbers of entries for multipair cable with 1 No. spare. All entries shall be provided with suitable plugs.

f) Suitable 3-way power junction box shall be considered for higher size of incomer power cable, which is not matching with the terminals provided in the control panel.

1.7 Junction Boxes for Fieldbus Loops

1.7.1 For Fieldbus segment, junction box shall be used for mounting the wiring/ terminal blocks to terminate the trunk and spurs in the fieldbus networks.

Unless otherwise specified, vendor must use the following type of terminal blocks:

For all FISCO signals	:	Weatherproof terminal blocks
For all safe signals	:	Weather proof terminal blocks
For all Explosion proof signals	:	Explosion proof/Flameproof terminal blocks

1.7.2 Junction box for Fieldbus field barrier concept:

Fiedbus junction boxes with field barrier assembly/ assemblies shall be provided. Not more than 12 spurs shall be considered in one junction box. Each junction shall not have more than two segments and no. of field barrier assemblies shall be considered accordingly. Field barrier assemblies in a segment shall be multidropped (shall not be daisy chained in a trunk). Only one closed loop can be considered per segment. Remaining spur connections in the segment can be used for open loop. For multi field barrier assembly in a junction box, Field barrier assemblies shall be DIN rail mounted. Vendor shall terminate the spare pair of trunk cable in DIN rail mounted terminal in junction box. One field barrier assembly shall contain:

a) Isolation facilities (EEx de) for isolating the field barrier assembly from fieldbus trunk.

b) Not more than 6 spur / barriers connections and Not more than one field device in each spur connection.

c) Internal short circuit protection for each spur (short circuit current <= 45 mA)

d) LED indicator for each spur short circuit.

e) Each spur shall be galvanically isolated from trunk.

f) Fieldbus terminator for each segment shall be inside junction box.

1.7.3 Housing of the fieldbus junction boxes shall be electropolished type SS 316.

1.7.4 Surge protectors on the field side shall be provided whenever specifically mentioned in job specification either within the FFJB or along with the instrument.

1.7.5 Sufficient spacing shall be provided inside the Junction Boxes for mounting of field barrier assemblies, termination and routing of Trunk/ Spur cables to the barrier/Megablocks, sufficient space shall be provided for installing terminator etc. inside the Junction Box.

1.7.6 For spur and trunk cables, 20 % addition cable entries must be provided. Unused entries shall be plugged.

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1.7.7 Each junction box shall be provided with sufficient entries with weatherproof, flameproof plugs, as required. Trunk and spur entries shall be from the bottom.

1.8 Instrument Valves and Manifolds

a) Vendor shall supply instrument valves (miniature type) and valve manifolds wherever required.

b) The hydrostatic test pressure for instrument miniature valves shall be 153 Kg/cm^{2}g for pipe class upto 600 and whereas for Instrument air lines, it shall be 41 Kg/cm^{2}g. All valves and manifolds shall be forged type only.

c) Valve body and trim material shall be 316 SS unless otherwise specified. Superior trim material shall be selected as required by process conditions. Packing material in general shall be of PTFE.

1.9 Impulse Piping/Tubing

a) Vendor shall supply 1/2" OD x 0.065" thick ASTM A 269 TP 316 L stainless steel seamless tubes as a minimum for impulse lines.

b) Where the pressure (operating) exceeds 70kg/cm2g or if piping is specified as impulse line, seamless pipes of size ½" NB of required thickness shall be supplied with material as per piping class.

c) Seamless tubes shall have a hardness of max 80 RB as typical.

d) Steam tracing shall be 10 mm OD copper tubes of electrolytic grade copper.

e) Instrument air tubing shall be 6 mm SS316L.

1.10 Pipes and Tube Fittings

a) Vendor shall supply flareless compression type of tube fitting and of three piece construction.

b) The fitting/ferrule hardness shall not be less than RB 90 so as to ensure a minimum hardness difference of 5 to 10 between tube and fittings. The fitting/ferrule shall be of SS316 material.

c) Socket-weld type forged pipe fittings of suitable material and rating shall be supplied for pipe fittings as per Piping Material Specification. The minimum rating shall be 3000 Lbs. Weld neck fittings shall be used where socket weld type are not allowed by piping class.

d) Brass fittings, wherever used as per job specification, shall be suitable for use on copper tubes conforming to ASTM B68 /B68M hardness not exceeding RB 50. All fitting parts shall be manufactured from Brass as per IS-319 bar stock or equivalent and shall be nickel plated.

e) All threaded fittings shall have NPT threads as per ANSI/ASME B 1.20.1 only.

1.11 Pneumatic Signal Tubes

a) Vendor shall supply 6mm OD x 1mm thick SS316L tube for pneumatic signal tubes.

b) Vendor shall avoid use of intermediate connections and shall estimate single length for each instrument location.

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1.12 Instrument Air Lines Fittings and Valves

a) Seamless galvanised, inside and outside, carbon steel pipes used for instrument air distribution shall be as per IS 1239 class Heavy. In view of difficulty in bending such pipes, elbows shall be used wherever bending is expected or A106 Gr B pipe shall be supplied.

b) Galvanised forged screwed carbon steel screwed fittings of 2000 lbs rating fittings shall be used.

c) Isolation valves on instrument air service shall be packless gland type full bore ball valves.

1.13 Air Filter Regulators

a) Instrument air filter regulator of suitable size, range and capacity shall be supplied for each pneumatic instrument.

b) The body of the filter shall be anodised aluminium.

c) The filter shall have 5 micron sintered bronze filter element and shall be provided with manual drain and 2" nominal size pressure gauge.

1.14 Cable Trays and Cable Ducts

a) All cables on the main pipe rack shall be laid in cable duct. Cable ducts shall be of galvanised mild steel with SS bolts and shall be fabricated as per 'Duct Fabrication-bolted Construction Details' standard No. 7-52-0254.

b) All branch cables/tubes shall run on cable trays.

c) These cable trays shall be made out of galvanised mild steel sheets of 2.5 mm thickness. Ladder trays shall be of galvanised mild steel. 50 mm x 50 mm x 6mm thick angle shall be used as a minimum.

d) The width shall be so selected that 50% of tray space is available for future use.

e) Suitable SS wire cable clamps shall be supplied for binding the cables/tubes at every 500 mm. Nuts/Bolts used for cable trays fixing shall be SS.

f) FRP cable trays shall be provided when specified.

1.15 Instrument Support/Structural Steel

a) Vendor shall supply instrument stands, stanchions and other structural steel material required for supporting the cable trays, impulse lines and instruments.

1.16 Heat Tracing and Insulation

a) Heat tracing and insulation of line mounted instrument impulse lines shall be carried out as per line specifications. Similar philosophy shall also be followed for equipment mounted instruments. However, impulse lines for instruments/level instrument in congealing, viscous services shall also be stream traced even though the pipe/equipment not traced.

b) Instruments mounted on jacketed lines and jacketed equipments shall be jacketed only. In case the jacketing of any particular instrument item is not possible, heat tracing may be selected after intimation to Owner/ Owner Representative before proceeding ahead.

c) For all steam traced lines and steam jackets, a suitable type of steam trap must be provided for proper and efficient tracing. Separate dedicated steam trap shall be used for each instrument. Steam trap shall preferably be located on ground level with its

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outlet connected to drain funnel or as advised elsewhere in the package. Each instrument to be traced shall be provided with steam isolation valve.

d) Wherever electric tracing is shown in the approved P&ID and selected for instruments and instrument lines, this must be suitable for the line temperature rating.

e) Steam tracing shall be avoided inside any room/ or shelter. The heat tracing required for analyzers shall be carried out by electrical tracing using prefabricated tube tracers.

f) Insulation of all in-line instruments like control valves, safety valves etc. shall be done as per the line requirements. Also all direct equipment mounted instruments like level gauge, displacer/float type instruments etc. shall be properly insulated as per insulation requirements of the equipment on which these are installed.

g) The insulation with 25 mm dia. Sodium silicate inhibited ceramic fiber rope (fiber glass / SS wire braided) by spiral winding in position, wrapping the rope around piping so as to cover the piping completely without leaving any gap, application of two layers of self adhesive aluminum foil tape (min 0.1 mm thick) spirally wound over the rope surface with the joints in two layers staggered. Ceramic fibre rope shall be of minimum density 250 kg/m^3 shall be made up of ceramic fibre insulation with other properties of ceramic fibre rope confirming to 3.2.3 (1) of specification "6-44-0002 for hot insulation" work.

h) Steam tracing shall be considered for instrument impulse line for cryogenic services (i.e. operating temperature is less than 0° C).

2.0 INSTALLATION

2.1 Vendor shall be completely responsible for installation of all instruments within their battery limit, in line with the installation standards (typical) furnished alongwith package specification.

2.2 Whenever installation is beyond the scope of vendor/contractor, purchaser shall install the instruments as per the details/documents/drawings provided by the vendor/contractor. However, in such a case it must be ensured that complete installation materials shall be supplied.

2.3 All direct mounted instruments like thermocouples, thermowells, temperature gauges, pressure gauges, pressure switches etc. shall be installed in such a way that they have good readability and accessibility.

2.4 The capillary of all capillary type instruments shall be supported properly and shall be protected against mechanical damage.

2.5 All pressure/differential pressure instruments shall be provided with block and bleed/ by-pass, drain/vent valves etc as per the installation standards, and shall have accessibility.

2.6 All primary piping/tubing (impulse lines) shall have a slope of 1 in 12 on the horizontal run.

2.7 All welding shall be carried out as per the relevant codes with proper electrodes. Any testing (non destructive) like DP test and radiography on root weld and final weld shall be carried out as applicable. All consumables shall be part of vendor's scope of supply. Any pre/post weld treatment as required by the relevant codes shall be carried out.

2.8 All threaded joints shall be joined by PTFE tapes only.

2.9 All impulse lines shall be supported at regular intervals.

2.10 Instrument drain/vent connections shall be piped to safe area like oily water sewer or above pipe racks to avoid accumulation of hazardous fluid in the plant atmosphere.

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2.11 Steam tracing wherever required shall be carried out by 10 mm OD x 1 mm thick coper tubes and condensate traps shall be provided to collect all the condensate and shall be piped to the nearest pipe drain funnels.

2.12 All tubes/cables shall be properly laid on cable trays, which shall be supported at regular intervals.

2.13 Separate routing or physical separation shall be maintained between signal, shut down and power cables.

2.14 Wherever intrinsically safe system cabling is employed, the minimum separation of 150 mm shall be adhered between IS (intrinsically safe) and non- IS signal cables.

2.15 The cases of instruments shall be earthed by earthing wire to the nearest earth bus bar for safety reasons.

2.16 In case the cables are to be buried or laid in concrete trench the same shall be carried out by vendor. In case civil work is carried out by purchaser, requirement of trenches shall be provided with prior intimation to client.

2.17 Painting of angle trays, instrument supports and all structural supports shall be painted as under :-

a) The surface to be painted shall be thoroughly cleaned with brush and sand paper to remove all scales. After cleaning, one coat of red oxide zinc chromate primer shall be given conforming to IS-2074 and allowed to dry. One coat of final paint shall be applied.

Second and final coats of paint of final colour shall be given before handing over the plant/ commissioning.

2.18 Installation of Systems (MMS, Analysers etc.)

2.18.1 The system as applicable shall be installed by the system vendor who would be responsible for installation and termination of interconnecting cables in the system racks/cabinets. All interconnecting cables shall be identified and the individual cores/wires shall be properly identified using ferrules. Direct-cross ferruling method shall be used for identification.

2.18.2 All system communication cables shall be laid in covered GI (galvanised iron) trays away from power cables. Prefabricated cables shall be avoided for interconnection if these are to be routed out side the cabinets. If unavoidable these should be laid in covered GI trays.

2.18.3 All panels/cabinets shall be properly leveled and secured firmly with the base supporting structure. However, the consoles and printer stands need not be secured to base structure.

2.18.4 **Grounding**

a) Each cabinet, console and other equipment supplied as a part of system shall have earthling lugs which shall be secured to the 'AC mains earthing bus'.

b) All circuit grounds, shields and drain wires shall be connected to the 'system ground' bus which is isolated from 'AC mains earth'. This bus shall typically be 25 mm wide and 6 mm thick of copper.

The total resistance of system ground shall be less than 5 ohms unless otherwise recommended by system manufacturer.

c) Safety barriers, if used, shall be secured to 'Safety ground' which shall have typically ground resistance of less than 1 ohm. The bus shall be designed considering a fault level of 0.5 A at 250V r.m.s. per barrier.

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2.18.5 All other installation guidelines as recommended by system manufacturer shall be followed.

3.0 TESTING AND CALIBRATION

3.1 All impulse lines shall be tested hydrostatically at 1.5 times the design pressure / maximum operating pressure. Ensure that instrument and vessel/piping is isolated during this test.

3.2 In case of special instruments/items where hydrotesting is not permitted due to service conditions, the impulse lines testing shall be carried out by using air or nitrogen.

3.3 After pressure testing, all these impulse lines shall be drained and dried with dry air for 15 minutes to remove any traces of moisture, oil and dust.

3.4 Instrument air lines shall be duly tested for any leak after pressurising and isolating the main root valve by soap solution and bubbler unit. After isolation, the rate of fall in pressure shall be less than 1 kPa for every 4.4 metre (1 psi for each 100 feet) of tubing for a test period of 2 minutes.

3.5 All instrument cables shall be tested for continuity and insulation. While meggering the cables for insulation testing, ensure that all instruments and barriers are isolated at both ends. The megger testing at site is not required to be carried out for the field bus cables and thermocouple extension cables. However, for field bus cables and thermocouple extension cables, the loop resistance and capacitance shall be checked by the contractor before and after the completion of cable laying.

3.6 All instruments supplied by the vendor shall be calibrated using proper test equipment.

3.7 All instruments shall be calibrated for 0%, 25%, 50%, 75%, 100% and vice versa.

3.8 All temperature gauges shall be calibrated using temperature baths.

3.9 All thermocouple activated instruments shall be calibrated by generating millivolts by a potentiometer.

3.10 All transmitters shall be calibrated as per instrument ranges.

3.11 All displacer type level transmitters shall be calibrated with water or suitable fluids and corrected for specific gravity.

3.12 All alarm and trip switches shall be calibrated over the entire range, finally set and checked for alarm/trip points and reset points as per the alarm/trip set point schedule. After setting, these shall be sealed.

3.13 All control valves, prior to stroke checking, shall be externally cleaned thoroughly. The full stroke of valve shall be checked for opening and closing. Any adjustment required for obtaining full stroke and reducing hysteresis shall be carried out. The hysteresis shall not be more than 1% URV (upper range value) with positioners and 5% URV without positioners.

3.14 Solenoid valve shall be checked functionally for its operation and also compatibility with respect to barrier.

3.15 Safety valves and relief valves shall be set/ tested by using dry air/nitrogen. Leakage if any shall be removed by proper lapping of seat and disc.

3.16 All electronic/pneumatic receiver instruments shall be calibrated as per the manufacturer's instructions. Controllers shall be aligned properly.

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3.17 All special instruments like analyzer shall be checked and calibrated as per manufacturer's instructions. Prior to testing, all analyzer sample lines shall be thoroughly cleaned by carbon tetra chloride or any other cleaning liquid. After cleaning, these lines shall be thoroughly purged with dry nitrogen.

3.18 No oil should be used in oxygen and chlorine service lines.

3.19 The accuracy of overall loop shall be within 1% for electronic and 1.5% for pneumatic loops.

3.20 After performing the calibration of all instruments, the entire loop shall be checked for proper operation.

3.21 The entire shutdown scheme shall be simulated from the process trip switches/ control system and the scheme shall be tested for its proper operation prior to start up of the unit.

3.22 If no instrument air is available vendor shall provide necessary nitrogen cylinders with suitable regulators to carry out the above activity.

3.23 Testing Of Systems

3.23.1 All the system functions shall be checked thoroughly for proper functioning. These shall include but not limited to the following tests:

a) Visual and mechanical.

b) Complete system configuration loading.

c) Demonstration of all system functions.

d) Checking of all systems displays.

e) Checking of correct functioning of all keyboards.

f) Demonstration of all system diagnostics.

g) Checking of proper functioning of all printers, hardcopy unit, and printing of all reports.

h) Checking of all disc drives.

i) Complete checking of logic system, loading of user's program and checkout of results.

j) Checking of correct changeover of the back-up/redundant units in case of failure of main units.

Vendor shall also carryout the system checks as per respective items specifications wherever provided along with package.

3.23.2 The input signals shall be simulated by disconnecting the field wires for all inputs. Wherever control room mounted Transmitters/Converters/Receiver switches are used, the functioning of same shall also be checked.

3.24 Loop Checking

3.24.1 Loop checking shall be carried out by vendor, which shall include proper functioning and interconnection of all items in the loop.

3.24.2 All input signals shall be generated in the field and corresponding reading shall be checked at all corresponding displays.

All the outputs shall be checked in the field, by physical verification of valve stroke or operation of solenoid valve/pick-up of electrical contactor.

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3.24.3 After loop checking is completed, vendor shall connect back any terminals and connections removed during loop checking.

3.24.4 For fieldbus loops the segment verification shall be carried out by DCS vendor. Any field side modifications required shall be carried out by vendor.

4.0 COMMISSIONING

4.1 This activity shall be carried out in a systematic manner so as to avoid any accident to plant and operating personnel.

4.2 During the plant start up all the instruments calibration, controller alignment, trip point settings shall be trimmed so as to meet the operation requirements.

4.3 Prior to guarantee run of any package unit, the vital instruments as required by vendor have to be recalibrated and the results recorded.

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1.0 GENERAL

1.1 Material selection chart defines the base material requirements for major instrument items. The materials have been specified as per 'piping class' in which these instruments are installed. Additional requirements like stelliting etc. shall be selected based on process conditions.

1.2 Although materials as specified in Material Selection Chart shall be acceptable, in general, this does not absolve vendor of the responsibility of proper selection of material as per the fluid being handled and process conditions.

1.3 For all instruments in sour service requiring NACE as per Piping class, all materials of construction shall meet the requirements specified in NACE MR 01-03 latest edition. In addition, any other requirements if specified in respective piping class, shall also be complied.

1.4 Impulse pipe material shall be as per the corresponding piping class. However, for Impulse tubing material shall be 316L SS, as a minimum. Better material shall be selected wherever required.

1.5 This gives details of selection criteria for most of the common EIL Piping Classes. However, variations may exist from these in jobs and also new piping classes may arise. In those circumstances, the material selection shall be based on the relevant job piping classes and evaluation of actual requirements.

1.6 For testing requirement like Radiography, IBR, NACE, Hydrogen testing, Post weld heat treatment, etc shall be followed as per piping material specification for the respective piping class.

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SL. NO	PIPING CLASS	CONTROL VALVE		PRESSURE RELIEF VALVE		
		Body	Trim	Body / Bonnet	Nozzle / disc	Bellow
1.	A1A, A3A, A5A, A6A, A8A, A9A, A10A, A14A, A19A, A22A, A28A, B1A, B5A, B6A, B9A, B13A, B19A, B28A	A216 Gr. WCB	SS 316	A216 Gr. WCB	SS 316	SS 316L
2.	A16A, A23A, A26A, A68A, B16A, B23A, B24A, B26A, B68A	A216 Gr. WCB *	SS 316L*	A216 Gr. WCB *	SS 316L *	Inconnel *
3.	D23A, D26A	A216 Gr. WCB *	SS 316L Stellited*	A216 Gr. WCB *	SS 316L *	Inconnel *
4.	A2A, B2A, B21A, D1A, D9A, D19A, D2A, D5A, E1A, E2A, F1A, F2A, F5A	A216 G.r. WCB	SS 316 Stellited	A216 Gr. WCB	SS 316	SS 316L
5.	A4A, B4A, D4A	A352 Gr. LCB	SS 316	A352 Gr. LCB	SS 316	SS 316L
6.	A1B, B1B, D1B, D2B	A217 Gr. WC1	SS 316 Stellited	A217 Gr. WC1	SS 316 stellited	SS 316L
7.	A1D, B1D, B5D, D1D, D2D, F2D	A217 Gr. WC6	SS 316 Stellited	A217 Gr. WC6	SS 316 stellited	SS 316L
8.	A4F, B3F, B4F	A217 Gr. C5	SS 321	A217 Gr. C5	SS 321	SS321
9.	A4G, B4G	A217 Gr. C12	SS 321	A217 Gr. C12	SS 321	SS 321
10.	D4G	A217 Gr. C12	SS 321 Stellited	A217 Gr. C12	SS 321	SS 321
11.	A1H, B1H, D1H	A352 Gr. LC3	SS 316 Stellited	A352 Gr. LC3	SS 316 stellited	SS 316L
12.	A1K, A2K, A3K, A22K, B1K, B2K, D2K	A351 Gr. CF8	SS 316	A351 Gr. CF8	SS 316	SS 316L
13.	D2K	A351 Gr. CF8	SS 316 Stellited	A351 Gr. CF8	SS 316	SS 316L
14.	B25K	A351 Gr. CF3	SS 316L Stellited	A351 Gr. CF3	SS 316L stellited	SS 316L
15.	B18K, D18K	A351 Gr. CF8	SS316	A351 Gr.CF8	SS316	SS 316L
16,	A1M, B1M	A351 Gr. CF8M	SS 316	A351 Gr. CF8M	SS 316	SS 316L
17.	A1N, B1N, B6N	A351 Gr. CF3M	SS 316L	A351 GrCF3M	SS 316L	SS 316L
18.	A26N	A351 Gr. CF3M*	SS 316L*	A351 GrCF3M*	SS 316L*	Inconnel *
19.	D26N	A351 Gr. CF3M*	SS 316L Stellited*	A351 GrCF3M*	SS 316L*	Inconnel *
20.	B4K, B5K	A351 Gr. CF10M	SS 304H Stellited	A351 Gr. CF10M	SS 316	SS 316L
21.	A70M, A74M, B70M, B74M	A351Gr. CF8C	SS 321	A351Gr. CF8C	SS 321	SS 321
22	D25M	A351Gr. CF8C	SS 347 Stellited	A351Gr. CF8C	SS 347 Stellited	SS 347
23.	A11K, B11K	A351Gr. CF3	SS316L	A351Gr CF3	SS316L	SS 316L

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S. NO	PIPING CLASS	ORIFICE/SENIOR ORIFICE		FIELD TRANSMITTER	
		Flange/Body	Plate	Body	Sensor
1.	A1A, A3A, A6A, A8A, A9A, A10A, A14A, A19A, A22A, B1A, B21A, B6A, B9A, B13A, B19A, D1A, D9A, D19A, E1A, F1A,	A105	SS 316	SS 316	SS 316L
2.	A16A, A23A, A26A, A68A, B16A, B23A, B24A, B26A, B68A, D23A, D26A	A105 *	SS 316L*	SS 316*	SS 316L*
3.	A2A, B2A, D2A, E2A, F2A,	A105	SS 316	SS 316	SS 316L
4.	A4A, B4A, D4A	A350 GrLF2	SS 316	SS 316	SS 316L
5.	A1B, B1B, D1B, D2B	A182 GrF1	SS 316	SS 316	SS 316L
6.	A1D, B1D, B5D, D1D, D2D, F2D	A182 GrF11	SS 316	SS 316	SS 316L
7.	A4F, B3F, B4F	A182 GrF5	SS 321	SS316	SS321 or Hastelloy-C
8.	A4G, B4G, D4G	A182 GrF9	SS 321	SS316	SS321 or Hastelloy-C
9.	A1H, B1H, D1H	A350 GrLF3	SS 316	SS 316	SS 316L
10.	A1K, A2K, A3K, A22K, B1K, B2K, D2K	A182 GrF304	SS 316	SS 316	SS 316L
11.	B25K	A182 GrF304L	SS 316L	SS 316	SS 316L
12.	B18K, D18K	A182 GrF304	SS 316	SS 316	SS 316L
13.	A1M, B1M	A182 GrF316	SS 316	SS 316	SS321 or Hastelloy-C
14.	A1N, A26N*, B1N, B6N, D26N*	A182 GrF316L	SS 316L	SS 316	SS 316L
15.	A5A, B5A, D5A, F5A, F25A Note-1	A105	SS316	SS 316	SS316L with gold plated
16.	B4K, B5K	A182 GrF304H	SS 316	SS 316	SS 316L
17.	A70M, A74M, B70M, B74M	A182GrF321	SS321	SS316	SS321 or Hastelloy- C
18.	D25M	A182GrF347	SS347	SS316	SS316L with gold plated
19.	A11K, B11K	A182GrF304L	SS316L	SS316	SS316L

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S. NO	PIPING CLASS	THERMOWELL		LEVEL INSTRUMENT
		Flange	Well	Cage/ Chamber
1.	A1A, A3A, A6A, A8A, A10A, A14A, A19A, A22A, B1A, B21A, B6A, B9A, B13A, B19A, D1A, E1A, F1A, A5A, B5A, D5A, D9A, D19A, F5A	A105	SS 316	A106 Gr. B
2.	A16A, A23A, A26A, A68A, B16A, B23A, B24A, B26A, B68A, D23A, D26A	A105 *	SS 316L	A106 GrB*
3.	A2A, B2A, D2A, E2A, F2A	A105	SS 316	A106 GrB
4.	A4A, B4A, D4A	A350 GrLF2	SS 316	A333 Gr6
5.	A1B, B1B, D1B, D2B	A182 GrF1	SS 316	A335 GrP1
6.	A1D, B1D, B5D, D1D, D2D, F2D	A182 GrF11	SS 316	A335 GrP11
7.	A4F, B3F, B4F,	A182 GrF5	SS 321	A335 GrP5
8.	A4G, B4G, D4G	A182 GrF9	SS 321	A335 GrP59
9.	A1H, B1H, D1H	A350 GrLF3	SS 316	A333, Gr3
10.	A1K, A2K, A22K, A3K, B1K, B2K, D2K	A182 GrF304	SS 316	A312 GrTP304
11.	B25K	A182 GrF304L	SS 316L	A312 GrTP304L
12.	B18K, D18K	A182 GrF304	SS 316	A312 GrTP304
13.	A1M, B1M	A182 GrF316	SS 316	A312 GrTP316
14.	A1N, B1N, B6N, A26N*, D26N*	A182 GrF316L	SS 316L	A312 GrTP316L
15.	B4K, B5K	A182 GrF304H	SS 304H	A312 GrTP304H
16	A70M, A74M, B70M, B74M	A182 GrF321	SS321	A312 GrTP321
17.	D25M	A182 GrF347	SS347	A312 GrTP347
18.	A11K, B11K	A182 GrF304L	SS316L	A312 GrTP304L

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SL. NO	PIPING CLASS	LEVEL GAUGE			PRESSURE, DIFFERENTIAL PRESSURE AND VACUUM GAUGE	
		Chamber	Cock Body	Cock Trim	Sensing Element / Socket	Diaphragm
1.	A1A, A3A , A6A, A8A, A10A, A14A, A19A, A22A, B1A, B6A, B9A, B13A, B19A, B21A, D1A, D9A, D19A, E1A, F1A, A5A, B5A, D5A, F5A	A105	A105	SS 316	SS 316	SS 316
2.	A16A, A23A, A26A, A68A, B16A, B23A, B24A, B26A, B68A, D23A, D26A	A105*	A105*	SS 316L*	SS 316*	SS 316L*
3.	A2A, B2A, D2A, E2A, F2A	A105	A105	SS 316	SS 316	SS 316
4.	A4A, B4A, D4A	A350 GrLF2	A350 GrLF2	SS 316	SS 316	SS 316
5.	A1B, B1B, D1B, D2B	A182 GrF1	A182 GrF1	SS 316	SS 316	SS 316
6.	A1D, B1D, B5D, D1D, D2D, F2D	A182 GrF11	A182 GrF11	SS 316	SS 316	SS 316
7.	A4F, B3F, B4F	A182 GrF5	A182 GrF5	SS 321	SS 316	SS 321 or Hastelloy or Inconel
8.	A4G, B4G, D4G	A182 GrF9	A182 GrF9	SS 321	SS 316	SS 321 or Hastelloy or Inconel
9.	A1H, B1H, D1H	A350 GrLF3	A350 GrLF3	SS 316	SS 316	SS 316
10.	A1K, A2K, A22K, A3K, B1K, B2K, D2K	A182 GrF304	A182 GrF304	SS 316	SS 316	SS 316
11.	B25K	A182 GrF304L	A182 GrF304L	SS 316L	SS 316	SS 316
12.	B18K, D18K	A182 GrF304	A182 GrF304	SS 316	SS 316	SS 316
13.	A1M, B1M	A182 GrF316	A182 GrF316	SS 316	SS 316	SS 321 or Hastelloy or Inconel
14.	A1N, B1N, B6N, A26N*, D26N*	A182 GrF316L	A182 GrF316L	SS 316L	SS 316	SS 316L
15.	B4K, B5K	A182 Gr. F304H	A182 GrF304 H	SS 304H	SS 316	SS 316
16.	A70M, A74M, B70M, B74M,	A182Gr. F321	A182Gr F321	SS321	SS 316	SS 321 or Hastelloy or Inconel
17.	D25M	A182Gr. F347	A182Gr F347	SS347	SS 316	SS 347 or Hastelloy or Inconel
18.	A11K, B11K	A182Gr. F304L	A182Gr F304L	SS316L	SS 316	SS 316L

Notes:

* Material shall be hardness controlled and shall comply with NACE MR-0103 latest edition.

1. For Hydrogen service wetted part material for switches, transmitters shall be SS 316L gold plated, base material Hastelloy shall be avoided

2. SS 316L, SS 316Ti are also acceptable in place of SS316.

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ANNEXURE-II

1. Format of Instrumentation Index
2. Format of Point Data Base
3. Format for Functional Schematics
4. Format For cable Schedule (Non-FF)
5. Format For cable Schedule (FF)
6. Format for Logic Diagram
7. Format for Electrical/Instrumentation interface
8. Format for FF instrument details

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Instrument Index

Tag no.	Fluid	Description	Location-Line No. Equipment No.	P&ID No.	Data Sheet No.	P.R. No.	Inst. Loc. Drawing No.	Installation Std. No.	Tubing Hook up No.	Steam Tracing Std. No.	Bill of Material No.	Functional / Loop Schematic No.	Remarks

	ENGINEERS INDIA LIMITED NEW DELIHI	PLANT:- UNIT:- CLIENT:-						DRAWING NO.
			REV.	DATE	BY	CHKD	APPD	

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POINT DATA BASE FOR

LOCATION : LOOPTYPE :

Tag Number													SET POINT FOR ALARM				TEMP SENSOR						
Tag_Number	System Tag	PID	Service	System	MCC	INPUT SIGNAL TYPE	Loop Type	Min Inst Range	Max Inst Range	Engg Unit	Control Action	Fail Position	HIGH	LOW	HIGH_HIGH	LOW_LOW	Type	Burnout Status	Contact_Status on Actuation	FS/ LOGIC DWG	IS/ NON-IS	Interlock No.	REMARKS	Note ID

NOTES:

ENGINEERS INDIA LIMITED NEW DELHI	PLANT :	DIVISION : ENGINEERING					DRAWING NO. A545-110-16-51-PD01 REV. A
	CLIENT :	DEPT : INSTRUMENTATION	REVISION	DATE	PREPARED BY	CHECKED BY	APP. BY SHEET OF

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SV2FS1

REV.	DATE				

FIELD

CONTROL ROOM

TAG NUMBER	AL	AH	ALL	AHH	REMARKS

ENGINEERS INDIA LIMITED
NEW DELHI

PLANT –
UNIT–
CLIENT–

DRAWING NUMBER
FUNCTIONAL SCHEMATIC
SHEET 1 OF 1

REV

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REV.	DATE				

FIELD

CONTROL ROOM

TAG NUMBER	AL	AH	ALL	AHH	REMARKS

SV2FS1

ENGINEERS INDIA LIMITED
NEW DELHI

PLANT –	DRAWING NUMBER	REV
UNIT–	FUNCTIONAL SCHEMATIC	
CLIENT–	SHEET 1 OF 1	

POINT DATA BASE FOR

LOCATION : LOOPTYPE :

Tag Number		PID	Service	System	MCC	INPUT SIGNAL TYPE	Loop Type	Min Inst Range	Max Inst Range	Engg Unit	Control Action	Fail Position	SET POINT FOR ALARM				TEMP SENSOR		Contact_Status on Actuation	FS/ LOGIC DWG	IS/ NON-IS	Interlock No.	REMARKS	Note ID
Tag_Number	System Tag												HIGH	LOW	HIGH_HIGH	LOW_LOW	Type	Burnout Status						

NOTES:

ENGINEERS INDIA LIMITED NEW DELHI	PLANT :	DIVISION : ENGINEERING					DRAWING NO.	REV.
	CLIENT :	DEPT : INSTRUMENTATION					A545-110-16-51-PD01	A
			REVISION	DATE	PREPARED BY	CHECKED BY	APP. BY	SHEET OF

Signal/Alarm/Control Cable Schedule

Junction box location Col.- Grid-
Ref. Inst. Location Plan No.-

Multicable _____ Length _____ Type _____ Size _____ Overall Dia. _____

Drum No. _____ Colour _____

Local					Multi Cable Pair No.	Control Room / Satellite Rack Room												Remarks
						Barrier/Marshalling Cabinet No.			I/O Cabinet No.			HW Console / HW Panel No.			System Cabinet No.			
From	To	Jn.Box Terml	Type	Length m		Terml. No. (H)	Barrier No.	Terml. No. (S)	Terml. No. (I)	Module No.	Terml. No. (O)	Terml. No.	Inst. No.	Terml. No.	Terml. No.	Module No.	Pre Fab Cable No.	

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NEW DELHI

PLANT-

CLIENT- UNIT-

REV	DATE	BY	CHK`D	APPD		DRAWING NO.

EIL-165[illegible]-1851 REV.1 A4-210X297 PTU-13-0125/4-5 SHT OF

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INSTRUMENTATION CABLE SCHEDULE
ALL FIELD BUS CABLES

Project	Testing Job No.	**Client**	EIL
Unit	Test Unit	**Job No.**	**Unit No.** 0

JB DESC.		JB TAG NO	
		JB ITEM CODE	
LOCATION	L9(Side# 1)	CONTROL ROOM	

JB TO CONTROL ROOM CABLE DESCRIPTION

CABLE DESC		CABLE TAG NO	
		LENGTH (m)	
		CABLE ITEM CODE	

FROM TAG NO	TAG TO JB CABLE	LENGTH (m)	JB TERMINAL NO.	PAIRED / TRIAD / QUAD NO.

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EIL – 1641–505 A3–297 x 420

TAG NO.	ACTUATING DEVICE					LOGIC DESCRIPTION	FINAL CONTROL ELEMENT					
	SERVICE ABNORMAL CONDITION	LOCATION	CONTACT STATUS BENCH	CONTACT STATUS NORMAL	SYMBOL		SYMBOL	ELEMENT	ACTION	LOC.	SERVICE	TAG NO.

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DRAWING NO.	REFERENCE DRAWING	PLANT:– / UNIT:– / CLIENT:–	NO.	DATE	REVISIONS	BY	CH.	APPROVALS

LOGIC DIAGRAM

DRAWING NO.	REV.

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

ELECTRICAL INSTRUMENTATION INTERFACE DETAILS

Document No.

Unit No.

S.No.	Equip. No.	Interlock No.	Manual Operation						Auto Operation					Emergency Stop					Status Indication of Equipment /MOV					Analog Signal as per P&ID for monitoring & control	
			LCP		Control Room			Any Other Location	Auto Start	Auto Stop	Auto Start & Stop	Start Permissive	Location	Field	LCP	Control Room	Any other Location		LCP	Control Room		Any other Location		Electrical to Instrumentation	Instrumentation to Electrical
			Start	Stop	HWC Start | Stop	DCS Start| Stop		Locaton / Tag No.									Location	Tag No.		HWC	DCS	Location	Tag No.		

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Sl.No	Make (Vendor Name)	Model no	Device ID	Device Tag	Node Address	Device Type	Device Class	Device Revision	DD Revision	CFF Revision	PID function required (yes/no)	FF transducer HI	FF transducer LO	FF transducer Unit	L- Type	Downloadable file
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Note : - **Node Address data will be communicated to the Device vendor after finalization of segment loading.It is Device Vendor's responsibility to incorporate this data in the device before Supply**

Device Type :- Manufacturer's model number associated with the resource - used by interface devices to locate the DD file for the resource

Device Revision :- Manufacturer revision number associated with the resource - used by an interface device to locate the DD file for the resource

DD Revision : - Revision of the DD associated with the resource - used by an interface device to locate the DD file for reference.

L-Type : - Determines if the values passed by the transducer block to the AI block may be used directly **(Direct)** or if the value is in different units and must be converted linearly **(Indirect)** , or with square root **(IND Sqr Root)**, using the input

Transducer HI,LO Scale & Unit :- The high and low scale, engineering units code, and the number of digits to the right of the decimal point used with the value obtained from the transducer for a specified channel.

अचल कार्बन डाई ऑक्साइड अग्नि शामक पद्धति हेतु मानक विनिर्देश

STANDARD SPECIFICATION FOR FIXED CO_2 FIRE EXTINGUISHING SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
3	24.08.18	REVISED AND ISSUED AS STANDARD SPECIFICATION	GAURAV	GYAS	RS	RKT
2	19.08.10	REVISED AND ISSUED AS STANDARD SPECIFICATION	RBT	VM/RKS	RBB	ND
1	01.09.98	REVISED AND ISSUED AS STANDARD SPECIFICATION	PKS	NK	MMK	AS
0	09.09.88	ISSUED AS STANDARD SPECIFICATION	NK	PCS	HVR	RCPC

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Abbreviations:

AC	:	Alternating Current
AH	:	Ampere Hour
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing and Materials
CO_2	:	Carbon Dioxide
CCOE	:	Chief Controller of Explosives
DC	:	Direct Current
F&G	:	Fire and Gas
FM	:	Factory Mutual
IS	:	Indian Standard
LPC	:	Loss Prevention Council
NFPA	:	National Fire Protection Association
PESO	:	Petroleum Explosive Safety Organisation (Formerly known as CCOE)
psi	:	Pounds per Square Inch
RCC	:	Reinforced Cement Concrete
SMPV	:	Static and Mobile Pressure Vessels
UL	:	Underwriters Laboratory
VdS	:	Verband der Sachversicherer

Structural Standards Committee

Convenor: Mr. Rajanji Srivastava

Members:
Mr. Anurag Sinha
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjit Singh (Proj.)
Mr. Ravindra Kumar (Const.)

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1.0 SCOPE

This specification covers the general description, material of construction and test for the fixed type auto actuated carbon dioxide fire extinguishing system.

2.0 REFERENCE CODE

NFPA 12	Carbon Dioxide Extinguishing System
NFPA 70	National Electrical Code
NFPA 72	National Fire Alarm Code
NFPA 72E	Standard for Automatic Fire Detectors

SMPV (Unfired) Rules by PESO (Formerly known as CCOE)

3.0 GENERAL DESCRIPTION OF SYSTEM

3.1 The CO_2 system shall be designed and supplied strictly as per the requirements of NFPA-12 and having design concentration as per NFPA-12 **for the single largest risk area** to be protected and the criteria given herein below:

3.2 The system shall be a high pressure (850psi) at 21 ^{0}C and shall be such that it is

a. Extremely quick in action
b. Non poisonous
c. Non-corrosive, non-damaging and non-deteriorating
d. Safe and Clean

3.3 Fire shall be extinguished by the total flooding of the space with CO_2 gas to render the atmosphere inert and non-supporting to combustion.

3.4 CO_2 gas cylinder's capacity provided shall be sufficient to discharge CO_2 gas, equivalent to 50 per cent of the cubical content of the space involved, depending on the floor area of the enclosure. Consideration of extra requirement due to opening in the enclosure shall also be given.

3.5 System operation shall be by listed or approved mechanical, electrical or pneumatic means as per NFPA-12. Where multiple cylinders are required for one hazard area, a common manifold shall be used. Each cylinder shall discharge through the manifold through common piping and discharge nozzles. All cylinders supplying a common manifold shall be interchangeable and of one standard size. Two (2) cylinders in each bank shall be provided with control heads if a total of 3 or more cylinders are required. Where pilot cylinder is used, actuation of the control heads on the "pilot" cylinders shall pneumatically actuate the remaining cylinders.

3.6 A 100 % reserve supply equal to primary supply shall be provided. It shall provide protection during the period the main supply is out of service for re-charge.

3.7 Hydraulic calculations for each system shall be based upon two-phase flow equations for unbalanced piping systems with regardless if a single nozzle or balanced piping network is used. A complete set of hydraulic calculations shall be submitted for each carbon dioxide system.

3.8 The Manual Release Station (MRS) and Manual Release Inhibit station (MRI) shall be located at major points of egress. In addition auto/manual selector switch shall also be provided. The MRS shall provide a means of manually discharging the automatic fire extinguishing system when used in conjunction with the control panel. The MRS switch shall be of the "dual-action" type, to prevent accidental operation. The switch shall remain in the

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operated position until reset by means of a key. Supervision of automatic systems and Lock-out valves shall be provided as per NFPA requirements.

3.9 The system shall be auto actuated through fire detection system. As a safety measure a time delay relay unit shall be provided. On detection of fire an audible alarm shall sound & CO_2 discharge shall take place after some time to allow for any personnel in the building to evacuate. A manual change over switch shall be provided at entry point of building allowing the system to be put in manual mode at any point of time for prolonged human entry.

3.10 Pre-discharge alarms and electrical/mechanical discharge delays shall be provided. These shall be of sufficient duration to warn personnel of an impending discharge of carbon dioxide and allow for hazard area evacuation and preparation. Warning signs shall be provided at each entrance to the hazard area.

3.11 The design shall be in accordance with the requirements of NFPA-12. The duration of discharge and minimum liquid discharge time shall be as per NFPA-12. The discharge period shall be lengthened as appropriate by considerations such as deep-seated type fires.

3.12 Upon entering the alarm mode, audible indication shall be supplied by the steady sounding of an alarm electronic sounder. This unit shall be polarized for full supervision and shall be UL listed. It shall have an output of 86-90 DBA at 24V DC. The sounder shall be provided with a red finish. All field wiring connections shall be made to terminal strips or wire leads on the device.

3.13 All the mandatory requirements of NFPA-12 shall be fully complied.

3.14 The vendor shall fill the required data in the Technical data sheet (Annexure- 1)

4.0 SYSTEM COMPONENTS AND HARDWARES

4.1 All the system components used in the system shall be in accordance with NFPA-12. Only listed and new materials and devices shall be installed.

i) Cylinder

- CO_2 cylinders shall be designed as per ASME code for boiler & pressure vessels section-VIII OR as per IS 7285 Part 2 to hold CO_2 at ambient temperatures. Cylinder shall be of approved type and freshly imported/ manufactured. CO_2 cylinders along with cylinder valves shall be FM/UL/VDS/LPC listed/ approved. In addition CO_2 cylinders shall also be PESO approved. The cylinders shall be equipped with differential pressure valves. No replacement parts shall be necessary to recharge the Carbon Dioxide containers
- Cylinder filling density for high pressure system shall be as per NFPA-12.
- Cylinder shall be shipped with maintenance record card and shipping cap attached.
- Cylinder shall have serial number, along with the full and empty weight capacities, stamped near neck of cylinder.
- The cylinder shall be seamless, brand new (date of manufacturing of cylinders shall not be older than 1 year from the date of bid opening) never retested and month & year of manufacture shall be latest (or as specified in the requisition).
- Cylinder shall bear the mark of manufacturer, serial number, single test certificate and shall be duly approved by competent authority of the country of origin (FM/UL/Vds/LPC) and PESO. A reliable means of indication shall be provided to determine the pressure in refillable cylinders. PESO Approval of the

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cylinders along with cylinder valve is a must irrespective of the country of Origin. Cylinders without approval shall not be accepted.

ii) Cylinder Assembly

- Carbon Dioxide storage cylinders shall be provided with a safety rupture disc. An increase in internal pressure due to high temperature shall rupture the safety disc and allow the contents to vent before the rupture pressure of the container is reached. The contents shall not be vented through the discharge piping and nozzles.
- Cylinder valve shall contain safety pressure relief device shall be provided as per NFPA-12.
- For system installations consisting of 3 or more cylinders, a framing arrangement for supporting the cylinders and manifold shall be provided.
- Weight of Cylinder shall be monitored by Pressure Transmitter/ Switch along with local pressure indicator for each cylinder. All local pressure indicators in a bank of cylinders (main / stand by) shall be connected in a signal loop and shall give a common indication/signal of loss of pressure in that particular bank in the Control Panel.
- Operation devices shall be listed or approved electrical or pneumatic means as per NFPA-12. Each Carbon Dioxide system shall utilize a solenoid operated releasing device (control head) which causes discharge of all storage containers in the system. Each releasing device shall be separately series supervised and operated directly from the control panel.
- The releasing device (control head) shall be easily removable from the cylinder without emptying the cylinder. While removed from cylinder, the releasing device shall be capable of being operated, with no replacement of parts required after operation.
- The releasing device shall also be capable of direct mechanical actuation, providing a means of discharge in the event of total electrical malfunction. The device shall be provided with a manual lever and a faceplate with clear instructions on how to mechanically activate the system.
- The storage cylinders shall be located in the building.

iii) Distribution Piping for high pressure system

- All Pipe, fittings and valve shall be provided and installed per NFPA-12 requirements.

iv) Discharge Nozzles

- Nozzles shall be listed and approved type design as required by the type of hazard being protected and shall provide flow rates in accordance with system design hydraulics. Nozzle spacing shall be in accordance with the listed or approved coverage for each nozzle type.

v) Electric Actuator

- Electrical actuation of agent cylinder to be accomplished by an electric actuator/solenoid valve interfaced through F &G panel.

vi) Manual/Pneumatic Actuator

- Manual/Pneumatic Actuator shall be provided for manual/pneumatic actuation of cylinder valve. Manual actuation shall be accomplished by pulling hand lever on the actuator. Pneumatic actuation shall be accomplished by a remote pressure device UL listed /FM approved. It shall consist of a nitrogen cylinder mounted

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at the entrance of each protected area. Pneumatic tubing shall be connected up to the cylinder actuator valve.

vii) Supports and Hangers

- The supports and hangers shall be of a reputed make and subject to Company approval. However listed supports and hangers are acceptable.

4.2 All pipe work shall be identified / banded at a minimum of 3 m and where it passes through the wall.

4.3 The laying of fittings at branch connection or other fixed point of the system shall be such, as to allow provision of movement without causing undue stress on the pipe work. Pipe work shall be arranged to reduce the strain due to expansion on all equipment.

4.4 All sleeves shall be built into the structure by the contractor in such a manner as to maintain the integrity of the structure and the fire barriers. Non combustible matter shall be used for sealing the opening.

5.0 CHARACTERISTICS OF FIXED INSTALLATION

5.1 The time to reach the specific concentration of CO_2 shall be clearly mentioned. The system shall be interlocked with the air conditioning/ ventilation system wherever applicable. In case of CO_2 injection into the rooms, the relevant air-handling units shall be automatically shutoff.

5.2 The distribution piping shall have to clear the RCC beams and ribs which criss cross the ceiling, path of air ducts and electrical conduits. All supports, hangers and clips etc. required for supporting the distribution piping, cylinders, manifolds etc. shall also be supplied with the system.

6.0 CHARGING

Each CO_2 cylinder shall be equipped with a valve permitting refilling of cylinder. The cylinder shall be sealed with a puncturable diaphragm and shall be provided with a safety pressure relief for abnormal pressure formation.

7.0 DISCHARGE HEADS

Each cylinder of CO_2 battery shall be equipped with a discharge head for automatic piercing of the sealing diaphragm. One or two cylinders in the multiple cylinder discharge group shall have discharge heads operated directly from the control panel and the others shall be operable by the gas pressure discharged from the first one or two.

8.0 MANIFOLDS WITH CONNECTIONS TO DISCHARGE HEADS

The pressure manifold shall be designed in such a way that it shall collect the gas from all the cylinders and discharge collected quantities of the gas in the main manifold which shall be connected with the discharge of outlets in the rooms.

9.0 CO_2 SYSTEM CONTROL PANEL

9.1 The control panels shall be located in building / shed and shall be wall mounted type. The control panels shall be provided for manual actuation and shall be designed to accommodate relays, auxiliary switches, pilot and signal lamps. The control panels shall be also be provided with the facility of audio alarm and on receipt of fire alarm signal from fire alarm panel, audio alarm shall be initiated from CO_2 control panel with necessary signal to shut off air conditioning / ventilations system, if any. Manual push button for discharge of CO_2, in each

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protected area (after audit alarm and 30 seconds time delay) shall be provided near exit of the room.

9.2 Sign boards, caution boards, illumination board, alarm, given as per requirements of NFPA-12 shall be provided in and around building protected with CO_2 system.

10.0 MATERIAL SPECIFICATIONS

Material for cylinder body, valve, cylinder body nozzles, spray nozzles, piping and CO_2 gas quality shall conform to NFPA-12.

11.0 STATUTORY APPROVAL

Approval from PESO for cylinders along with cylinder valve assemblies & for handling, storage, disposal of CO_2 shall be taken by contractor.

12.0 APPROVAL OF INSTALLATION

All equipment and devices used for CO_2 Fixed system such as cylinder, cylinder assembly, valves, nozzles etc. shall have FM/UL marking and listings.

13.0 INSPECTION AND TESTING

13.1. The completed system shall be inspected and tested to meet the approval of Owner. Only listed or approved equipment and devices shall be used in the systems. To determine that the system has been properly installed and will function as specified, all the requirements of NFPA-12 shall be complied with.

13.2. Tests shall demonstrate that the entire system functions as intended. All circuits shall be tested: Automatic discharge, manual discharge and equipment shutdown and alarm devices. In addition, supervision of each circuit shall be tested.

13.3. All test procedures and discharge tests shall be performed in accordance to NFPA-12. Tests shall be conducted by the contractor, equipment manufacturer, or equipment manufacturer's representative in the presence of the Owner's representative. Such tests shall be made only after the control system has tested satisfactorily. Carbon Dioxide shall be used as the test agent. Contractor shall include the price of full discharge test for each location in his quoted price.

13.4. Test containers shall be filled to the designed weight. The amount of gas shall be certified by the contractor.

13.5. The contractor shall provide all necessary test apparatus and instrumentation including gas to be expended.

13.6. Gas analyzers capable of automatically monitoring three (3) sampling points simultaneously shall be provided. Concentration measurements shall be recorded every 5 seconds on separate strip charts. Sampling probes shall be placed at 3 different heights in different sections of the protected area. In no case will a probe be placed higher than the highest anticipated combustible hazard.

13.7. The contractor shall correct all defects and make additional tests, at no cost to owner, until the system complies with all contract requirements.

13.8. Upon acceptance by the Owner, the complete system shall be reconditioned, containers refilled and/or replaced, and the system placed in operation.

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13.9. As a condition of final acceptance, the contractor shall provide operational training to the Owner's personnel. The training sessions shall include emergency procedures, system control panel operation, trouble procedures, and safety requirements.

13.10. System shall be warranted for parts and labor for not less than a period of one (1) year from date of installation. Contractor shall specify the maintenance to be performed during the warranty period to maintain warranty conditions.

13.11. All material test certificates and inspection release notes shall be submitted before dispatch of the system.

13.12. Contractor to note that acceptance of any equipment or system during factory acceptance test shall in no way absolve the vendor of their responsibility for the performance of the system.

13.13. It shall be Contractor's responsibility to modify and/or replace the hardware if the specified functions are not achieved during testing and factory acceptance.

14.0 PAINTING AND MARKING

Painting of piping, nozzles, CO_2 cylinders, supports, etc. shall be done as per standard practice including supply of all paints and consumables and other items required for carrying out painting.
Each cylinder shall be clearly and permanently marked with the following information:

a. Manufacturer's name and trade mark.
b. Year of manufacture.
c. Marking as per code

15.0 MANDATORY SPARES

The bid must include in the quoted price, the mandatory spares to be supplied with the CO_2 system.

1.	CO_2 Cylinders	Minimum one or 5% of total cylinder (i.e. main cylinders + 100% standby cylinders), whichever is more, shall be supplied with filled in Clean Agent gas. These are in addition to 100% standby filled up cylinder
2.	Automatic and Manual release system	One of each type/ size used in the system supplied
3.	Cylinder Valve with safety pressure relief device	One of each type / size used in the systems supplied.
4.	Nozzles	10% of total nozzles used in each size / type with minimum drill holes.
5.	Release Push Buttons	10% of total used of each type etc.

16.0 RECOMMENDED SPARES

In addition to the above spares, vendor shall also furnish the list of spares required for two years trouble free operation with unit rates and quantity along with the offer.

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TECHNICAL DATA SHEETS — ANNEXURE-1

(BIDDER TO FURNISH DATA/DETAILS MARKED "V")

1.0	Type of system	:	Fixed CO_2 Fire Extinguishing System
2.0	Design code / standard to which design/ Manufacture / testing conforms.	:	NFPA-12 and SMPV Rules for cylinders
3.0	System designed to protect risks in the building as specified.	:	V
3.1	Design Concentration	:	V
3.1.1	Amount of gas required. (Attach separate sheet, if required). (List out gas supplied, no. of cylinders etc. for working and standby requirements, risk wise.)	:	V
3.2	CO_2 storage cylinder details		
	a) Manufacturer	:	V
	b) Design Code	:	V
	c) Capacity in litres	:	V
	d) Gas Holding Capacity (Kg)	:	V
	e) Total Number supplied	:	V
	f) Certificates from approving Agency FM/UL/ LPC/ VdS	:	V
	g) Certificate from PESO	:	V
	h) Working pressure (kg/cm^2)	:	V
	i) Design Pressure (kg/cm^2)	:	V
	j) Dimension of Cylinder Dia x length x thickness	:	V
3.3	Pipes, valves and fittings.		
	a) Manufacturers		
	i. Pipes	:	EIL approved vendor
	ii. Fittings	:	EIL approved vendor
	iii. Valves	:	EIL approved vendor

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b) Material of Construction

i.	Pipes	:	V
ii.	Fittings	:	V
iii.	Valves	:	V

c) Design Code

i.	Pipes	:	As per NFPA-12
ii.	Fittings	:	As per NFPA-12
iii.	Valves	:	As per NFPA-12

d) Type of joints : As per NFPA-12

e) Hydraulic test Pressure of manifold/supply lines(kg/cm^2) as per NFPA-12 : V

f) Discharge Nozzles

i.	Manufacturer and Type	:	V
ii.	Material of Construction	:	V
iii.	Number Supplies	:	V
iv.	Approved by FM / UL / VdS	:	V

3.4 Painting of piping, nozzles, cylinder supports included (primer and synthetic enamel) : V

3.5 Operating Devices

3.5.1 Push Button Station

i.	Type	:	V
ii.	Manufacturer	:	V
iii.	Model, numbers offered	:	V
iv.	Overall dimensions	:	V

3.5.2 Control Cables

i.	Manufacturer	:	V
ii.	Code/ Standard	:	V
iii.	Type	:	V
iv.	Size	:	V
v.	Rating	:	V

3.6 Main Control Panel

i.	Manufacturer	:	V
ii.	Mounting Detail	:	V
iii.	Number of entries	:	V
iv.	Sheet Thickness	:	V
v.	Cable Entry	:	V
vi.	Total heat load predicted for air conditioning, if any.	:	V

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vii. No. of AC/DC feeders and their rating. : V

3.6.1 Additional Requirements for Control Panel

a) Whether housing all the necessary relays indicating lamps, push buttons, switches, etc. for the efficient operation of the system (Yes / No) : V

b) Input power supply requirement for operation of panel. (AC/DC Volts) : V

c) Panel Signal Voltage(AC/DC Volts) : V

d) Type/AH Capacity of the battery : V

e) Interconnecting cabling between battery and panel. : V

f) Power supply unit incorporated in the panel. (Yes/No). : V

g) Audio visual alarm on panel provided Battery low conditions (Yes/ No) : V

h) Change over from AC Main supply to standby power supply fully automatic in either direction (Yes / No). : V

i) Following push buttons provided

i) Alarm : V
ii) Reset : V
iii) Test (Yes/ No) : V

j) Audio visual indication for AC supply failure provided (Yes/No). : V

k) Pilot lamp for system 'ON' supply (Yes/No) : V

l) Dual tone hooter for fire/fault alarm Provided & range of the same (Yes/No) : V

m) Painting (External/Internal) : V

4.0 Material of Construction selected in accordance with NFPA-12 (Yes/No) : V

5.0 Inspection and Testing

a) Visual inspection of installed system & hazard area : V

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b)	Check of labeling of devices	:	V
c)	Check for mechanical tightness of piping & associated equipments	:	V
d)	Non-destructive operational tests for all devices included.	:	V
6.0	Weighing system	:	V

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बोलीकर्ता से गुणवत्ता प्रबंधन प्रणाली अपेक्षाओं हेतु विनिर्देश

SPECIFICATION FOR QUALITY MANAGEMENT SYSTEM REQUIREMENTS FROM BIDDERS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
					Approved by	
1	12.03.15	General Revision	QMS Standards Committee	QMS Standards Committee	MPJ	SC
0	04.06.09	Issued as Standard Specification	QMS Standards Committee	QMS Standards Committee	SCT	ND

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Abbreviations:

CV	-	Curriculum Vitae
ISO	-	International Organization for Standardization
MR	-	Material Requisition
PO	-	Purchase Order
PR	-	Purchase Requisition
QA	-	Quality Assurance
QMS	-	Quality Management System

QMS Standards Committee

Convener: Mr. M.P. Jain

Members:
Mr. A.K. Chaudhary (Insp.)
Mr. S.K. Kaul (C&P)
Mr. R.K. Trivedi (Engg.)
Mr. Ravindra Kumar (Const.)
Mr. Tilak Raj (Projects)
Mr. Vinod Kumar (CQA)

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1.0 SCOPE

This specification establishes the Quality Management System requirements to be met by BIDDER for following purpose:

- QMS requirements to be met by suppliers/contractors after award of work/ during contract execution.

2.0 DEFINITIONS

2.1 Bidder

For the purpose of this specification, the word "BIDDER" means the person(s), firm, company or organization who is under the process of being contracted by EIL / Owner for delivery of some products (including service). The word is considered synonymous to supplier, contractor or vendor.

2.2 Project Quality Plan

Document tailored from Standard Quality Management System Manual of BIDDER, specifying how the quality requirements of the project will be met.

2.3 Owner

Owner means the owner of the project for which services / products are being purchased and includes their representatives, successors and assignees.

3.0 REFERENCE DOCUMENTS

6-78-0002	Specification for Documentation Requirements from Contractors
6-78-0003	Specification for Documentation Requirements from Suppliers

4.0 QUALITY MANAGEMENT SYSTEM – GENERAL

Unless otherwise agreed with EIL / Owner, the BIDDER proposed quality system shall fully satisfy all relevant requirements of ISO 9001 "Quality Management Systems – Requirements." Evidence of compliance shall be current certificate of quality system registration to ISO 9001 or a recent compliance audit recommending registration from a certification agency. The quality system shall provide the planned and systematic control of all quality related activities for execution of contract. Implementation of the system shall be in accordance with BIDDER'S Quality Manual and PROJECT specific Quality Plan.

5.0 QUALITY SYSTEM REQUIREMENTS

5.1 BIDDER shall prepare and submit for review / record, Project Quality Plan / Quality Assurance Plan for contracted scope / job. The BIDDER'S Quality Plan shall address all of the applicable elements of ISO 9001, identify responsible parties within BIDDER'S organization, for the implementation / control of each area, reference the applicable procedures used to control / assure each area, and verify the documents produced for each area. The Project Quality Plan shall necessarily define control or make reference to the relevant procedures, for design and engineering, purchase, documentation, record control, bid evaluation, inspection, production/manufacturing, preservation, packaging and storage, quality control at

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construction site, pre-commissioning, commissioning and handing over (as applicable) in line with contract requirement and scope of work.

5.2 BIDDER shall identify all specified or implied statutory and regulatory requirements and communicate the same to all concerned in his organization and his sub contractor's organization for compliance.

5.3 BIDDER shall deploy competent and trained personnel for various activities for fulfillment of PO / contract. BIDDER shall arrange adequate infrastructure and work environment to ensure that the specification and quality of the deliverable are maintained.

5.4 BIDDER shall do the quality planning for all activities involved in delivery of order. The quality planning shall cover as minimum the following:

- Resources
- Product / deliverable characteristics to be controlled.
- Process characteristics to ensure the identified product characteristics are realized
- Identification of any measurement requirements, acceptance criteria
- Records to be generated
- Need for any documented procedure

The quality planning shall result into the quality assurance plan, inspection and test plans (ITPs) and job procedures for the project activities in the scope of bidder. These documents shall be submitted to EIL/Owner for review/approval, before commencement of work.

5.5 Requirements for sub-contracting / purchasing of services specified in contract / tender shall be adhered to. In general all outsourced items will be from approved vendors of EIL. Wherever requirements are not specified, or approved sub vendors do not exist, the sub-contractor shall establish and maintain a system for purchasing / sub-contracting to ensure that purchased product / service conforms to specified requirements. Criteria for selection of sub-contractor, evaluation, re-evaluation, maintenance of purchasing data and verification of purchased product (sub-contractor services), constitute important components of this requirement.

5.6 BIDDER shall plan and carry production and service provision under controlled conditions. Controlled conditions shall include, as applicable

a) the availability of information that describes the characteristics of the product
b) the availability of work instructions
c) the use of suitable equipment
d) the availability and use of monitoring and measuring devices
e) the implementation of monitoring and measurement
f) the implementation of release, delivery and post-delivery activities

5.7 BIDDER shall validate any processes for production and service provision where resulting output cannot be verified by subsequent monitoring and measurement. This includes any process where deficiencies become apparent only after the product is in use or service has been delivered.

5.8 BIDDER shall establish a system for identification and traceability of product / deliverable throughout product realization. Product status with respect to inspection and testing requirements shall be identified.

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5.9 BIDDER shall identify, verify, protect and safeguard EIL / Owner property (material / document) provided for use or incorporation into the product. If any Owner / EIL property is lost, damaged or otherwise found to be unsuitable for use, this shall be reported to the EIL / Owner.

5.10 BIDDER shall ensure the conformity of product / deliverable during internal processing and delivery to the intended destination. Requirements mentioned in the tender shall be adhered to.

5.11 BIDDER shall establish system to ensure that inspection and testing activities are carried out in line with requirements. Where necessary, measuring equipments shall be calibrated at specified frequency, against national or international measurement standards; where no such standard exists, the basis used for calibration shall be recorded. The measuring equipments shall be protected from damage during handling, maintenance and storage.

5.12 BIDDER shall ensure effective monitoring, using suitable methods, of the processes involved in production and other related processes for delivery of the scope of contract.

5.13 BIDDER shall monitor and measure the characteristics of the product/deliverable to verify that product requirement has been met. The inspection (stage as well as final) by BIDDER and EIL / Owner personnel shall be carried out strictly as per the ITPs forming part of the contract. Product release or service delivery shall not proceed until the planned arrangements have been satisfactorily completed, unless otherwise approved by relevant authority and where applicable by Owner / EIL.

5.14 BIDDER shall establish and maintain a documented procedure to ensure that the product which does not conform to requirements is identified and controlled to prevent its unintended use or delivery

5.15 All non-conformities (NCs) / deficiencies found by the BIDDER'S inspection / surveillance staff shall be duly recorded, including their disposal action shall be recorded and resolved suitably. Effective corrective and preventive action shall be implemented by the BIDDER so that similar NCs including deficiencies do not recur.

5.16 All deficiencies noticed and reported by EIL / Owner shall be analyzed by the BIDDER and appropriate corrective and preventive actions shall be implemented. BIDDER shall intimate EIL / Owner of all such corrective and preventive action implemented by him.

5.17 BIDDER should follow the standards, specifications and approved drawings. Concessions/Deviations shall be allowed only in case of unavoidable circumstances. In such situations Concession/deviation request must be made by the BIDDER through online system of EIL eDMS. URL of EIL eDMS is http://edocx.eil.co.in/vportal.

5.18 BIDDER shall have documented procedure for control of documents.

5.19 All project records shall be carefully kept, maintained and protected for any damage or loss until the project completion, then handed over to EIL / Owner as per contract requirement (Refer Specification Nos. 6-78-0002 - Specification for Documentation Requirements from Contractors and 6-78-0003 - Specification for Documentation Requirements from Suppliers), or disposed as per relevant project procedure.

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6.0 AUDITS

BIDDER shall plan and carry out the QMS audit for the job. Quality audit programme shall cover design, procurement, construction management and commissioning as applicable including activities carried out by sub-vendors and sub-contractors. This shall be additional to the certification body surveillance audits carried out under BIDDER'S own ISO 9001 certification scheme.

The audit programmes and audit reports shall be available with bidder for scrutiny by EIL / Owner. EIL or Owner's representative reserves the right to attend, as a witness, any audit conducted during the execution of the WORKS.

In addition to above EIL, Owner and third party appointed by EIL/Owner may also perform Quality and Technical compliance audits. BIDDER shall provide assistance and access to their systems and sub-contractor / vendor systems as required for this purpose. Any deficiencies noted shall be immediately rectified by BIDDER.

7.0 DOCUMENTATION REQUIREMENTS

BIDDER shall submit following QMS documents immediately after award of work (Within one week) for record / review by EIL / Owner.

- Organization chart (for complete organization structure and for the project)
- Project Quality Plan/Quality Assurance Plan
- Job specific Inspection Test Plans, if not attached with PR
- Job Procedures
- Inspection/Test Formats

In addition to above QMS documents, following documentation shall be maintained by the BIDDER for submission to EIL / Owner on demand at any point of time during execution of the project.

- Quality Manual
- Certificate of approval for compliance to ISO: 9001 standard
- Procedure for Control of Non-conforming Product
- Procedure for Control of Documents
- Sample audit report of the QMS internal and external audits conducted during last one year
- Customer satisfaction reports from at least 2 customers, during the last one year
- Project QMS audit report
- Technical audit reports for the project
- Corrective action report on the audits

Documents as specified above are minimum requirements. BIDDER shall submit any other document/data required for completion of the job as per EIL/Owner instructions.

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SPECIFICATION FOR DOCUMENTATION REQUIREMENTS FROM SUPPLIERS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committe Convener	Standards Bureau Chairman
					Approved by	
1	12.03.15	General Revision	QMS Standards Committee	QMS Standards Committee	MPJ	SC
0	04.06.09	Issued as Standard Specification	QMS Standards Committee	QMS Standards Committee	SCT	ND

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Abbreviations:

DCI	-	Document Control Index
eDMS	-	Electronic Document Management System
FOA	-	Fax of Acceptance
HOD	-	Head of Division / Department
IC	-	Inspection Certificate
IRN	-	Inspection Release Note
ITP	-	Inspection and Test Plan
LOA	-	Letter of Acceptance
MOU	-	Memorandum of Understanding
MR	-	Material Requisition
PO	-	Purchase Order
PR	-	Purchase Requisition
PVC	-	Polyvinyl Chloride
QMS	-	Quality Management System
TPIA	-	Third Party Inspection Agency
URL	-	Universal Resource Locator

QMS Standards Committee

Convener: Mr. M.P. Jain

Members:
Mr. A.K. Chaudhary (Insp.)
Mr. S.K. Kaul (C&P)
Mr. R.K. Trivedi (Engg.)
Mr. Ravindra Kumar (Const.)
Mr. Tilak Raj (Projects)
Mr. Vinod Kumar (CQA)

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Attachments

Format for completeness of Final Documentation : Format No. 3-78-0004

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1.0 SCOPE

This specification establishes the Documentation Requirements from Suppliers.

All documents/data against the PO / PR / MR shall be developed and submitted to EIL/Owner by the suppliers for review / records, in line with this specification.

2.0 DEFINITIONS

2.1 Supplier

For the purpose of this specification, the word "SUPPLIER" means the person(s), firm, company or organization who is under the process of being contracted by EIL / Owner for delivery of some products (including service). The word is considered synonymous to bidder, contractor or vendor.

2.2 Owner

Owner means the owner of the project for which services / products are being purchased and includes their representatives, successors and assignees.

3.0 REFERENCE DOCUMENTS

6-78-0001	Specification for Quality Management System Requirements from Bidders

4.0 DOCUMENTATION REQUIREMENTS

4.1 Documents/Data to be Submitted by the Supplier

4.1.1 The Supplier shall submit the documents and data against the PO/PR/MR as per the list given in respective PO/PR/MR.

4.1.2 Review of the supplier drawings by EIL would be only to review the compatibility with basic designs and concepts and in no way absolve the supplier of his responsibility/contractual obligation to comply with PR requirements, applicable codes, specifications and statutory rules/regulations. Any error/deficiency noticed during any stage of manufacturing/execution/installation shall be promptly corrected by the supplier without any time and cost implications, irrespective of comments on the same were received from EIL during the drawing review stage or not.

4.1.3 Unless otherwise specified, submission of documents for Review/Records shall commence as follows from the date of Fax of Intent / Letter of Intent/ Fax of Acceptance (FOA)/ Letter of Acceptance (LOA):

QMS	- 1 week
Drawing/Document Control Index	- 2 weeks
Other Documents/Drawings	- As per approved Drawing/Document Control Index/Schedule

4.1.4 Documents as specified in PO/PR/MR are minimum requirements. Supplier shall submit any other document/data required for completion of the job as per EIL/Owner instructions.

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4.2 Style and Formatting

4.2.1 All Documents shall be in ENGLISH language and in M.K.S System of units.

4.2.2 Before forwarding the drawings and documents, contractor shall ensure that the following information are properly mentioned in each drawing:

Purchase Requisition Number
Name of Equipment / Package
Equipment / Package Tag No.
Name of Project
Client
Drawing / Document Title
Drawing / Document No.
Drawing / Document Revision No. and Date

4.3 Review and Approval of Documents by Supplier

4.3.1 The Drawing/Documents shall be reviewed, checked, approved and duly signed/stamped by supplier before submission. Revision number shall be changed during submission of the revised supplier documents and all revisions shall be highlighted by clouds. Whenever the supplier require any sub-supplier drawings to be reviewed by EIL, the same shall be submitted by the supplier after duly reviewed, approved and stamped by the supplier. Direct submission of sub-supplier's drawings without contractor's approval shall not be entertained.

4.4 Document Category

4.4.1 Review Category

Following review codes shall be used for review of supplier Drawings/Documents:

Review Code 1	-	No comments. Proceed with manufacture/ fabrication as per the document.
Review Code 2	-	Proceed with manufacture/fabrication as per commented document. Revised document required.
Review Code 3	-	Document does not conform to basic requirements as marked. Resubmit for review
R	-	Document is retained for Records. Proceed with manufacture/fabrication.
V	-	Void

4.5 Methodology for Submission of Documents to EIL/Owner

4.5.1 Document Control Index (DCI)

Supplier shall create and submit Document Control Index (DCI) for review based on PO/PR/MR along with schedule date of submission of each drawing/document on EIL eDMS. The DCI shall be specific with regard to drawing/document no. and the exact title. Proper sequencing of the drawings/documents should be ensured in schedule date of submission.

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4.5.2 **Submission of Drawings/Documents**

Drawings/documents and data shall be uploaded on the EIL eDMS Portal as per DCI. The detail guidelines for uploading documents on EIL eDMS Portal are available on following URL

http://edocx.eil.co.in/vportal

4.5.3 **Statutory Approvals**

Wherever approval by any statutory body is required to be taken by Supplier, the Supplier shall submit copy of approval by the authority to EIL.

4.5.4 **Details of Contact Persons of Supplier**

After placement of order supplier shall assign a Project Manager for that order. The details are to be filled online through the portal. The details include e-mail address, mailing address, telephone nos., fax nos. and name of Project Manager. All the system generated emails pertaining to that order shall be sent to the assigned Project Manager.

4.5.5 **Schedule and Progress Reporting**

Supplier shall submit monthly progress report and updated procurement, engineering and manufacturing status (schedule vs. actual) every month, beginning within 2 weeks from FOA/LOA. In case of exigencies, EIL/Owner can ask for report submission as required on weekly/fortnightly/adhoc basis depending upon supply status and supplier shall furnish such reports promptly without any price implication. Format for progress report shall be submitted by the Supplier during kick off meeting or within one week of receiving FOA/LOA, whichever is earlier.

4.5.6 **Quality Assurance Plan/Inspection and Test Plan**

Inspection and test plans (ITP) attached if any, to the MR/PR are to be followed. However for cases wherein ITPs have not been attached with MR/PR, Supplier shall submit within one week of receiving FOA/LOA, the Quality Assurance Plan for manufacturing, covering quality control of critical bought out items/materials, inspection & testing at various stages of production, quality control records and site assembly & testing as may be applicable to the specific order and obtain approval from concerned Regional procurement Office of EIL/third party inspection agency, as applicable.

For Package equipment contracts, the supplier shall prepare a list of items/ equipments and their inspection categorization plan for all items included in the scope of supply immediately after receipt of order and obtains approval for the same from EIL. The items shall be categorized into different categories depending upon their criticality for the scope of inspection of TPIA and/or EIL.

4.5.7 **Inspection Release Note (IRN)/ Inspection Certificate (IC)**

IRN/ IC shall be issued by EIL Inspector/ third party inspection agency on the basis of successful inspection, review of certificates as per specifications & agreed quality plan (as applicable) and only after all the drawings/documents as per DCI are submitted and are accepted under review code-1 or code R. Supplier shall ensure that necessary documents/manufacturing and test certificates are made available to EIL/TPIA as and when desired.

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Note: Non fulfilling above requirement shall result into appropriate penalty or with-holding of payment as per conditions of PO/PR/MR.

4.5.8 Transportation Plan

Transportation Plan for Over Dimensional Consignments (ODC), if any, shall be submitted within 2 weeks of receiving FOA/LOA, for approval. Consignment with parameters greater than following shall be considered as over dimensional.

Dimensions: 4 meters width x 4 meters height x 20 meters length

Weight : 32 MT

4.6 Final Documentation

4.6.1 As Built Drawings

Shop changes made by Supplier after approval of drawings under 'Code 1' by EIL and deviations granted through online system , if any, shall be marked in hard copies of drawings which shall then be stamped 'As-built' by the supplier. These 'As-built' drawings shall be reviewed and stamped by EIL Inspector/ TPIA also. Supplier shall prepare scanned images files of all marked – up 'As – built' drawings. Simultaneously Supplier shall incorporate the shop changes in the native soft files of the drawings also.

4.6.2 As Built Final Documents

As built final documents shall be submitted as listed in PO/PR/MR.

4.6.3 Packing/Presentation of Final Documents

Final Documents shall be legible photocopies in A4, A3 size only. Drawings will be inserted in plastic pockets (both sides transparent, sheet thickness minimum 0.1 mm) with an extra strip of 12 mm wide for punching so that drawings are well placed.

Final Documentation shall be bound in Hard board Plastic folder(s) of size 265 mm x 315 mm ($10^{1}/_{2}$ inch x $12^{1}/_{2}$ inch) and shall not be more that 75 mm thick. It may be of several volumes and each volume shall have a volume number, index of volumes and index of contents of that particular volume. Where number of volumes are more, 90mm thickness can be used. Each volume shall have top PVC sheet of minimum 0.15 mm thick duly fixed and pressed on folder cover and will have 2 lever clip. In case of imported items documents, 4 lever clip shall also be accepted. All four corners of folders shall be properly metal clamped. Indexing of contents with page numbering must be incorporated by supplier. Spiral/Spico bound documents shall not be acceptable. As mentioned above, books should be in hard board plastic folders with sheets punched and having 2/4 lever clips arrangement.

Each volume shall contain on cover a Title Block indicating package Equipment Tag No. & Name, PO/Purchase Requisition No., Name of Project and Name of Customer. Each volume will have hard front cover and a reinforced spine to fit thickness of book. These spines will also have the title printed on them. Title shall include also volume number (say 11 of 15) etc.

4.6.4 Submission of Soft Copies

Supplier shall submit to EIL, the scanned images files as well as the native files of drawings/documents, along with proper index.

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In addition to hard copies, Supplier shall submit electronic file (CD-ROM) covering soft copies of all the final drawings and documents, all text documents prepared on computer, scanned images of all important documents (not available as soft files), all relevant catalogues, manuals available as soft files (editable copies of drawings/text documents, while for catalogues/manuals/proprietary information and data, PDF files can be furnished).

All the above documents shall also be uploaded on the EIL eDMS portal.

4.6.5 **Completeness of Final Documentation**

Supplier shall get the completeness of final documentation verified by EIL/TPIA and attach the Format for Completeness of Final Documentation (Format No. 3-78-0004) duly signed by EIL Inspector or TPIA as applicable to the document folder.

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COMPLETENESS OF FINAL DOCUMENTATION

Name of Supplier/Contractor	:	
Customer	:	
Project	:	
EIL's Job No.	:	
Purchase Order No./ Contract No.	:	
Purchase Requisition No./ Tender No.	:	Rev. No. :
Name of the Work/ Equipment	:	
Tag. No.	:	
Supplier's/ Contractor's Works Order No.	:	

Certified that the Engineering Documents/ Manufacturing & Test Certificates submitted by the supplier are complete in accordance with the Vendor Data Requirements of Purchase Requisition.

Signature	:	Signature	: .....
Date	:	Date	: .....
Name	:	Name	: .....
Designation	:	Designation	: .....
Department	:	Department	: .....

Supplier/Contractor

EIL/TPIA

अनुमोदित/APPROVED
हस्ताक्षर/Sign: .....
नाम/Name: M.P. JAIN
दिनांक/Date: 12-3-2015

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अग्निरोधक नियंत्रण स्टेशनों के लिए निरीक्षण एवं परीक्षण योजना

INSPECTION AND TEST PLAN FOR FLAMEPROOF CONTROL STATIONS

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2.	21.11.2013	Revised and Reissued	MJ	RS	SCG	SC
2	29.06.2012	Revised and Reissued	AB	HVJ	AKC	DM
1	28.09.2007	Revised and Re-issued	AKG	PPM	MVKK	VC
0	30.04.2002	Issued for implementation	RG	AKC	AKB	GRR

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Abbreviations

AS	:	Alloy Steel	MPT/MT	:	Magnetic Particle Testing
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MRT	:	Mechanical Run Test
BIS	:	Bureau of Indian Standard	MTC	:	Material Test Certificate
CCE or CCOE	:	Chief Controller of Explosives	MOC	:	Material of Construction
CEIL	:	Certification Engineers International Limited	NPSH	:	Net Positive Suction Head
CIMFR	:	Central Institute of Mining & Fuel Research	NDT	:	Non Destructive Testing
CE	:	Carbon Equivalent	NEMA	:	National Electrical Manufacturers Association
DFT	:	Dry Film Thickness	PO	:	Purchase Order
DT	:	Destructive Testing	PESO	:	Petroleum Explosive Safety Organization
DPT	:	Dye Penetrate Testing	PQR	:	Procedure Qualification Record
ERTL	:	Electronics Regional Test Laboratory	PR	:	Purchase Requisition
FCRI	:	Fluid Control Research Institute	PMI	:	Positive Material Identification
FM	:	Factory Mutual	PVC	:	Poly Vinyl Chloride
FLP	:	Flame Proof	QC	:	Quality Control
HT	:	Heat Treatment	RT	:	Radiography Testing
HIC	:	Hydrogen Induced Cracking	TC	:	Test Certificate
ITP	:	Inspection and Test Plan	TPI or TPIA	:	Third Party Inspection Agency
IP	:	Ingress Protection	UT	:	Ultrasonic Testing
IC	:	Inspection Certification	UL	:	Under writer Laboratories
IGC	:	Inter Granular Corrosion	VDR	:	Vendor Data Requirement
IEC	:	International Electro technical Commission	WPS	:	Welding Procedure Specification
JEC	:	Japanese Electro technical Committee	WPQ	:	Welders Performance Qualification
			XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

Convenor : Mr. S.C. Gupta

Members:

Mr. R.K. Singh	Mr. Rajeev Kumar	Mr. Himangshu Pal
Mr.Neeraj Mathur	Mr. T Kamalakannan	Mr. Deepak Gupta (Project)
Mr. Mayank Jain		

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1.0 SCOPE

This Inspection and Test Plan covers the minimum testing requirements of Flameproof Control Stations.

2.0 REFERENCE DOCUMENTS

PO/PR/ Standards referred there in/Job specifications/Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	**Procedures**	--	--	--	--	--	--
2.0	**Material Inspection**						
2.1	Incoming material like castings, glass, meters, Fasteners etc	Visual, Dimensional, Operational checks, Review of Manufacturer's Certificates etc. as applicable	100%	TC's/ Inspection & Test records / Lab Test Records	H	H	R
3.0	**In process Inspection**						
3.1	Flameproof enclosure without components	Routine Pressure test	100% by Supplier	Supplier's Test Records	-	H	R

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.0	**Final Inspection**						
4.1	Flameproof Control Station (Acceptance tests)	• Visual/Dimensional/BOM Checks • Plan Gap/Path/Clearances • Electrical/Functional Checks • High voltage test • IR test before and after High voltage	100% by Supplier 10% by EIL/TPIA	Test Records / Inspection Witness Record	-	H	H
4.2	Submission of Certificates & Documents	• Certificate of Statutory testing agency for suitability of area classification • Certificate of Statutory approval authority like CCoE/ PESO as applicable. • Valid BIS License as applicable • Degree of protection certificate as applicable	Samples	Certificates from test agencies	-	H	R
5.0	**Painting**						
5.1	Painting and Packing	• Visual • Suitable protection to prevent entry of foreign material. • Proper packing to prevent any damage during transportation and storage.	100%	Packing list / Supplier's Records	-	H	-
6.0	**Documentation and IC**						

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
6.1	Documentation and IC	• Review of Internal Test Reports & MTC • IC Issuance	100%	Supplier's Test Records / Inspection Certificate	-	H	H

Legends: H- Hold (Do not proceed without approval), Random 10% , R-Review, RW-Random witness, W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

1. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
2. Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents

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एम वी स्विचबोर्डो
के लिए
निरीक्षण एवं परीक्षण योजना

INSPECTION AND TEST PLAN
FOR
M.V.SWITCHBOARDS

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
3	21.11.13	Revised and Reissued	MJ	RS	SCG	SC
2	15.07.11	Revised and Reissued	GS	SA	AKC	DM
1	28.09.07	Revised and Reissued	AKG	PPM	MVKK	VC
0	30.04.02	Issued for implementation	RG	AKC	AKB	GRR

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Abbreviations

CCE or CCOE	:	Chief Controller of Explosives	MPT	:	Magnetic Particle Testing
CEIL	:	Certification Engineers International Limited	MRT	:	Mechanical Run Test
CIMFR	:	Central Institute of Mining & Fuel Research	NPSH	:	Net Positive Suction Head
DFT	:	Dry Film Thickness	NDT	:	Non Destructive Testing
DT	:	Destructive Testing	PO	:	Purchase Order
ERTL	:	Electronics Regional Test Laboratory	PESO	:	Petroleum Explosive Safety Organization
FCRI	:	Fluid Control Research Institute	PQR	:	Procedure Qualification Record
FR	:	Fire Retardant	PR	:	Purchase Requisition
FAT	:	Factory Acceptance Test	PMI	:	Positive Material Identification
HMI	:	Human Machine Interface	RT	:	Radiography Testing
HT	:	Heat Treatment	TC	:	Test Certificate
HIC	:	Hydrogen Induced Cracking	TPI or TPIA	:	Third Party Inspection Agency
ITP	:	Inspection and Test Plan	VDR	:	Vendor Data Requirements
IP	:	Ingress Protection	WPS	:	Welding Procedure Specification
IC	:	Inspection Certificate	WPQ	:	Welders Performance Qualification
LPT	:	Liquid Penetrate Testing			

Inspection Standards Committee

Convenor : Mr. S.C. Gupta

Members:

Mr. R.K. Singh	Mr. Rajeev Kumar	Mr. Himangshu Pal
Mr.Neeraj Mathur	Mr. T Kamalakannan	Mr. Deepak Gupta (Project)
Mr. Mayank Jain		

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1.0 SCOPE

This Inspection and Test Plan covers the minimum testing requirements of fixed / draw out type MV Switchboards.

2.0 REFERENCE DOCUMENTS

PO/PR/ Standards referred there in/ Job specifications /Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	**Procedures**	--	--	--	--	--	--
2.0	**Material Inspection**						
2.1	Incoming Material like Insulators, Bus Bars, Fabricated items, Bus bar sleeves and supports, Instrument Transformers, Relays, Indicating Instruments, Switches, Breakers, Contactors etc.	Visual, Dimensional, operational checks, Manufacturer's test certificates etc. as applicable	100%	Material Test Certificates / Test Records	H	H	R

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
3.0	**Inprocess Inspection**						
3.1	Wiring checks	Size, termination, ferruling, continuity	100%	Test Records	--	H	R
4.0	**Final Inspection**						
4.1	Switchgear Assembly	• Visual check including layout, Tag plates. Paint shade, Bus marking and sleeving, joint shrouding, Identification and location of components etc. • Dimension check including operational height, Bus size, Clearances, Creepage distances, paint thickness, gland size etc. • Verification of Bus bar support arrangement with respect to type tested panel drawings, provision for external cable termination and Bus Duct flange Dimensions (if applicable). • Bill of material / Make of Components check. • Interchangeability of identical modules / feeders (if applicable).*	100%	Supplier's Test Records / Inspection Witness Record	-	H	H

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
	Switchgear Assembly (contd.)	• Operation check for control and auxiliary equipment circuits and auxiliary contacts. • Manual and electrical operation check of Breakers, Relays etc. under normal and worst voltage conditions.* • Operation checks for all control functions and interlocks as per schematic diagrams in Test and service position including mechanical interlock as applicable. • Relay operation check through primary/secondary injection.* • Communication check between relays and Data concentrator / HMI (if applicable).* • HMI operation and functional checks as per separate agreed ITP/FAT(if applicable). • Insulation resistance of main, auxiliary and control circuits before and after High Voltage tests.	100%	Test Records / Inspection Witness Record	-	H	H

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		• Power Frequency voltage withstand test on main, auxiliary and control circuits.					
4.2	Switchgear Assembly	TYPE TESTS: • Short Circuit making and breaking tests. • Short time current withstand test. • Temperature Rise test. • Degree of protection for panels.	Sample Basis	Test Agency Reports	-	R/H**	R/W**
5.0	**Painting**						
5.1	Painting and Packing	• Visual • Suitable protection to prevent entry of foreign material. • Proper packing to prevent any damage during transportation and storage.	100%	Packing list / Supplier's Records	-	H	-
6.0	**Documentation and IC**						
6.1	Documentation and IC	• Review of Internal Test Reports • Certification from supplier for Complete relay parameterization of numeral relays at works • IC issuance	100%	Supplier's Test Records / Inspection Certificate	-	H	H

* Quantum of check is 100% by Supplier & random basis by EIL/TPIA

* * Witness if called for in job specifications. In such cases specified Type test will be considered as part of Acceptance Tests.

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Legends: H- Hold (Do not proceed without approval), Random -10%, R-Review, RW-Random witness, W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

1. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
2. Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents

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बैटरी चार्जर
के लिए
निरीक्षण व परीक्षण योजना

INSPECTION AND TEST PLAN
FOR
BATTERY CHARGERS

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
3	21.11.13	Revised and Reissued	MJ	RS	SCG	SC
2	29.06.12	Revised and Reissued	RKP	RJD	AKC	DM
1	28.09.07	Revised and Re-issued	AKG	PPM	MVKK	VC
0	30.04.02	Issued for implementation	RG	AKC	AKB	GRR

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Abbreviations

AS	:	Alloy Steel	MPT/MT	:	Magnetic Particle Testing
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MRT	:	Mechanical Run Test
BIS	:	Bureau of Indian Standard	MTC	:	Material Test Certificate
CCE or CCOE	:	Chief Controller of Explosives	MOC	:	Material of Construction
CEIL	:	Certification Engineers International Limited	NPSH	:	Net Positive Suction Head
CIMFR	:	Central Institute of Mining & Fuel Research	NDT	:	Non Destructive Testing
CE	:	Carbon Equivalent	NEMA	:	National Electrical Manufacturers Association
DFT	:	Dry Film Thickness	PO	:	Purchase Order
DT	:	Destructive Testing	PESO	:	Petroleum Explosive Safety Organization
DPT	:	Dye Penetrate Testing	PQR	:	Procedure Qualification Record
ERTL	:	Electronics Regional Test Laboratory	PR	:	Purchase Requisition
FCRI	:	Fluid Control Research Institute	PMI	:	Positive Material Identification
FM	:	Factory Mutual	PVC	:	Poly Vinyl Chloride
FLP	:	Flame Proof	QC	:	Quality Control
HT	:	Heat Treatment	RT	:	Radiography Testing
HIC	:	Hydrogen Induced Cracking	TC	:	Test Certificate
ITP	:	Inspection and Test Plan	TPI or TPIA	:	Third Party Inspection Agency
IP	:	Ingress Protection	UT	:	Ultrasonic Testing
IC	:	Inspection Certification	UL	:	Under writer Laboratories
IGC	:	Inter Granular Corrosion	VDR	:	Vendor Data Requirement
IEC	:	International Electro technical Commission	WPS	:	Welding Procedure Specification
JEC	:	Japanese Electro technical Committee	WPQ	:	Welders Performance Qualification
LPT	:	Liquid Penetrate Testing	XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

Convenor : Mr. S.C. Gupta

Members:

Mr. R.K. Singh	Mr. Rajeev Kumar	Mr. Himangshu Pal
Mr.Neeraj Mathur	Mr. T Kamalakannan	Mr. Deepak Gupta (Project)
Mr. Mayank Jain		

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1.0 SCOPE

This Inspection and Test Plan covers the minimum testing requirements of Battery Chargers (DC System consisting of Battery Charger, Cell Booster, DCDB and Battery).

2.0 REFERENCE DOCUMENTS

PO/PR/ Standards referred there in/Job specifications/Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	**Procedures**	--	--	--	--	--	--
2.0	**Material Inspection**						
2.1	Incoming Material like Fabricated items, Electronic components, PCBs, Relays, Indicating Instruments, Power Supply Unit, IGBT/SCRs, etc.	Visual, Dimensional, operational checks, etc. as applicable	100%	TC's/ Inspection & Test records / Lab Test Records	H	H	R
3.0	**In process Inspection**						
3.1	PCBs & Electronic components, Sub-assemblies	Burn-in Test for 96 hours at 50deg C	100%	Supplier's Test Records	H	H	R

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.0	**Final Inspection**						
4.1	Battery Charger Assembly (Acceptance Tests)	• Visual check including layout, Tag plates, Paint shade, Bus marking, Identification and location of components, etc. • Check calibration status of all testing equipment. • Dimension check including operational height, Bus size, Clearances, paint thickness, etc. • Bill of material/ Make of Components. • Full Load test for 16 hours with minimum 8hrs for each Charger*. Temperature rise for critical components would be recorded during this test. • Charger testing at constant output voltage in float and boost charge mode, including measurement of AC phase voltage, frequency, current, power, DC output voltage, current and output voltage ripple at nominal AC input voltage at zero, 50% and 100% of rated output current. Measurement shall be repeated at 100% full load current at 90% and 110% of nominal AC supply • Charger testing under constant output current limiting condition in float and boost mode, including measurement of DC	100% by Supplier and on Random Basis by EIL/TPIA	Test Records / Inspection Witness Record	-	H	H

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
	Battery Charger Assembly (Acceptance Tests Contd.)	output voltage and current with DC output voltage varying between zero and set value corresponding to constant voltage operation. • Proper functioning of all measuring instruments, alarms, indications, protection and controls as per requirement. • Parallel operation of both chargers including load sharing and automatic isolation of faulty charger. • Charger Efficiency and Voltage regulation test. • Harmonic Measurement. • Dynamic Response test for step load as per PR/spec. • Audible noise test. • Insulation resistance before and after HV test for power, control and auxiliary circuits. • High voltage withstand test for power, control and main circuits. • Check for protection against reverse battery connection.	100% BY Supplier and on Random Basis by EIL/TPIA	Test Records / Inspection Witness Record	-	H	H
4.2	D.C Distribution Board	Visual, Dimensions, Feeder Tag plates, Functional checks, IR and HV test.	100% by Supplier and on Random Basis ny EIL/TPIA	Supplier's Test Records / Inspection Witness Record	-	H	H

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.3	Cell Booster	• Visual and Functional checks • Full load capability test at 90% , 100% and 110% of nominal AC supply • IR and HV test	100% by Supplier and on Random Basis ny EIL/TPIA	Supplier's Test Records / Inspection Witness Record	-	H	H
4.4	Battery	All test as per respective ITP, as a minimum	Sample	Supplier Test Record	-	H	H
4.5	Submission of Certificates/ Documents	• Type test report on radio frequency interference voltages on RFI filter.	100%	Supplier's Test Records/ Statutory Body Certificates	-	H	R
5.0	**Painting**						
5.1	Painting and Packing	• Visual • Suitable protection to prevent entry of foreign material. • Proper packing to prevent any damage during transportation and storage.	100%	Packing list / Supplier's Records	-	H	-
6.0	**Documentation and IC**						
6.1	Documentation and IC	• Review of Internal Test Reports • IC issuance.	100%	Supplier's Test Records / Inspection Certificate	-	H	H

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* Tests shall be conducted on one charger of each rating (In case of dual Chargers, both chargers will be put on load separately)

Legends: H- Hold (Do not proceed without approval), Random 10% , R-Review, RW-Random witness, W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

1. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
2. Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents

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एम.वी. वैरीएबल फ्रीक्वेन्सी ड्राईव सिस्टम के लिए निरीक्षण एवं परीक्षण योजना

INSPECTION AND TEST PLAN FOR MV VARIABLE FREQUENCY DRIVE SYSTEM

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	30.01.14	Revised and Re-issued	MJ	RS	SCG	SC
1	29.06.12	Revised and Re-issued	AB	HVJ	AKC	DM
0	08.12.2008	Issued for implementation	RB	SKD	SKP	VC

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Abbreviations

AS	:	Alloy Steel	MPT/MT	:	Magnetic Particle Testing
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MRT	:	Mechanical Run Test
BIS	:	Bureau of Indian Standards	MTC	:	Material Test Certificate
CCE or CCOE	:	Chief Controller of Explosives	MOC	:	Material of Construction
CEIL	:	Certification Engineers International Limited	NPSH	:	Net Positive Suction Head
CIMFR	:	Central Institute of Mining & Fuel Research	NDT	:	Non Destructive Testing
CE	:	Carbon Equivalent	NEMA	:	National Electrical Manufacturers Association
DFT	:	Dry Film Thickness	PO	:	Purchase Order
DT	:	Destructive Testing	PESO	:	Petroleum Explosive Safety Organization
DPT	:	Dye Penetrate Testing	PQR	:	Procedure Qualification Record
ERTL	:	Electronics Regional Test Laboratory	PR	:	Purchase Requisition
FCRI	:	Fluid Control Research Institute	PMI	:	Positive Material Identification
FM	:	Factory Mutual	PVC	:	Poly Vinyl Chloride
FLP	:	Flame Proof	QC	:	Quality Control
HIC	:	Hydrogen Induced Cracking	RT	:	Radiography Testing
ITP	:	Inspection and Test Plan	TC	:	Test Certificate
IP	:	Ingress Protection	TPI or TPIA	:	Third Party Inspection Agency
IC	:	Inspection Certification	UT	:	Ultrasonic Testing
IGC	:	Inter Granular Corrosion	UL	:	Under writer Laboratories
IEC	:	International Electro technical Commission	VDR	:	Vendor Data Requirement
JEC	:	Japanese Electro technical Committee	WPS	:	Welding Procedure Specification
LPT	:	Liquid Penetrate Testing	WPQ	:	Welders Performance Qualification
			XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

Convenor : Mr. S C Gupta

Members:

Mr. R.K. Singh
Mr.Neeraj Mathur
Mr. Mayank Jain
Mr. Rajeev Kumar
Mr. T Kamalakannan
Mr. Himangshu Pal
Mr. Deepak Gupta (Project)

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1.0 SCOPE

This Inspection and Test Plan covers the minimum testing & inspection requirements of MV Variable Frequency Drive System(VFD).

2.0 REFERENCE DOCUMENTS

PO/PR & Standards referred there in /Job specifications / Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	**Procedures**	--	--	--	--	--	--
2.0	**Material Inspection**						
2.1	Incoming Material like fabricated panels, IGBT/SCRs, relays, Meters, CT/PT, transducers, transformer unit, rectifier unit, filter etc.	Material Identification Operational checks.	100%	Material Test Certificates / Test records	H	H	-
3.0	**In process Inspection**						

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
3.1	VFD Assembly	Visual ,Dimensional, Bill of material	100%	Test Records	-	H	-
4.0	**Final Inspection**						
4.1	VFD (Acceptance Tests)**	• Visual • Dimensional • Bill of Material check Simulation check of control signals • Check of Speed/rpm at different frequency at various mode as applicable • Memory function check of fault diagnostics • Insulation Test • Light Load and Functional test • Load characteristics • Load duty test • Check Auxiliary Devices • Check the properties of the control equipment • Check the Protective Devices • Check control and functional requirements • High voltage test • Leakage and pressure test for cooling system where provided • Automatic restart/re-acceleration • Noise Level Measurement	100% By Supplier and on Random Basis by TPIA/EIL	Inspection test records	-	H	H

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.2	VFD (Type Tests)	• Load current versus speed at different frequency at constant torque/ Voltage/Power Mode as applicable. • Efficiency • Temperature rise • Voltage division • Line side current distortion content • Power factor • Dynamic performance test • Current limit and current loop test • Speed loop test capability to ride through voltage dips upto 20% • Noise Level Measurement • Capability to restart the system and resynchronize converter onto running motor after a voltage interruption. • Harmonic measurement at output of VFD for Voltage and Current **Integral Test is to be carried out along with job motor, as per PR/ EIL Standard Specification.**	One sample from each type/rating	Inspection test records	-	H	H

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.3	Submission of certificates /documents	• Degree of protection certificate as per latest IS/IEC. • Type test certificates from recognized independent test house such as ERTL, CIMFR,BASEEFA,FM/UL, PTB, ATEX etc for rated current test, power loss determination, temperature rise, EM Immunity and EM Emission	Sample/Proto type	Statutory Approval Certificates / Type Test Certificates	-	H	R
5.0	**Painting**						
5.1	Painting of VFD Panels	Pre treatment, primer and final paint, shade, thickness	100%	Test records	-	H	R
6.0	**Documentation and IC**						
6.1	Documentation and IC	• Review of Internal Test Reports and MTCs. • IC issuance	100%	Supplier's Test Records / Inspection Certificate (IC)	-	H	H
6.2	Final Document submission	Compilation of Inspection reports ,drawings, etc as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

** All the load tests/ Functional Checks are to be carried out either with the job motor or with Shop Motor

Legends: H- Hold (Do not proceed without approval, R-Review, RW-Random witness (As specified or 10 % - Samples must include min 1 No of each type), W- Witness (Give due notice, work may proceed after scheduled date).

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NOTES :-

1. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
2. Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents

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स्टेशनरी निकल केडमियम बैटरी के लिए निरीक्षण एवं परीक्षण योजना

INSPECTION AND TEST PLAN FOR STATIONARY NICKEL-CADMIUM BATTERY

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2.	21.11.13	Revised and Reissued	MJ	RS	SCG	SC
1	29.06.12	Revised and Re-issued	AB	HVJ	AKC	DM
0	01.12.08	Issued for implementation	SA	SKD	SKP	VC

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Abbreviations

AS	:	Alloy Steel
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres
BIS	:	Bureau of Indian Standards
CCE or CCOE	:	Chief Controller of Explosives
CEIL	:	Certification Engineers International Limited
CIMFR	:	Central Institute of Mining & Fuel Research
CE	:	Carbon Equivalent
DFT	:	Dry Film Thickness
DT	:	Destructive Testing
DPT	:	Dye Penetrate Testing
ERTL	:	Electronics Regional Test Laboratory
FCRI	:	Fluid Control Research Institute
FM	:	Factory Mutual
FLP	:	Flame Proof
HIC	:	Hydrogen Induced Cracking
ITP	:	Inspection and Test Plan
IP	:	Ingress Protection
IC	:	Inspection Certification
IGC	:	Inter Granular Corrosion
IEC	:	International Electro technical Commission
JEC	:	Japanese Electro technical Committee
LPT	:	Liquid Penetrate Testing
MPT/MT	:	Magnetic Particle Testing
MRT	:	Mechanical Run Test
MTC	:	Material Test Certificate
MOC	:	Material of Construction
NPSH	:	Net Positive Suction Head
NDT	:	Non Destructive Testing
NEMA	:	National Electrical Manufacturers Association
PO	:	Purchase Order
PESO	:	Petroleum Explosive Safety Organization
PQR	:	Procedure Qualification Record
PR	:	Purchase Requisition
PMI	:	Positive Material Identification
PVC	:	Poly Vinyl Chloride
QC	:	Quality Control
RT	:	Radiography Testing
TC	:	Test Certificate
TPI or TPIA	:	Third Party Inspection Agency
UT	:	Ultrasonic Testing
UL	:	Under writer Laboratories
VDR	:	Vendor Data Requirement
WPS	:	Welding Procedure Specification
WPQ	:	Welders Performance Qualification
XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

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Members:

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Mr.Neeraj Mathur
Mr. Mayank Jain
Mr. Rajeev Kumar
Mr. T Kamalakannan
Mr. Himangshu Pal
Mr. Deepak Gupta (Project)

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1.0 SCOPE

This Inspection and Test Plan covers the minimum testing & inspection requirements of Stationary Nickel Cadmium Battery.

2.0 REFERENCE DOCUMENTS

PO/PR & Standards referred there in /Job specifications / Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	**Procedures**	--	--	--	--	--	--
2.0	**Material Inspection**						
2.1	Incoming Material like Flame arrester, Electrodes used, Electrolyte , containers, Insulators, Battery stand and other accessories	Physical and Dimensional checks(as applicable), Mechanical properties, Chemical properties of the electrolyte and containers	100%	Sub-Supplier's TC / Supplier Test Records/ Third party lab	H	H	-

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
3.0	**Inprocess Inspection**						
3.1	Battery assembly	Visual, Dimensions, Bill of Material	100%	Supplier's Test Records	-	H	R
4.0	**Final Inspection**						
4.1	Battery(Acceptance Tests)	• Visual • Polarity and absence of short circuit • Dimension, mass and layout check. • Test For Ah capacity • Test For voltage during discharge. • Internal resistance test • Dimension, Paint Shade and Paint Thickness of Battery Stands	100%	Inspection test records	-	H	R
4.2	Battery Stand	• Dimension, Paint Shade/thickness	100%	Inspection test records	-	H	R
4.3	Battery (Type Tests)	• Air Pressure Test • Test for charge retention/ loss of capacity. • Ampere hour and Watt-hour efficiency test.	One Sample/ Rating	Type Test Report	-	H	R
5.0	**Painting and Packing**						
5.1	Painting and Packing	• Visual, Packing list. • Proper packing to avoid any damage during transportation.	100%	Supplier's records	-	H	-
6.0	**Documentation and IC**						
6.1	Documentation and IC	• Review of Internal Test Reports.	100%	Supplier's Test	-	H	H

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		• IC issuance		Records / Inspection Certificate (IC)			
6.2	Final Document submission	Compilation of Inspection reports ,drawings, etc as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

Legends: H- Hold (Do not proceed without approval, R-Review, RW-Random witness (As specified or 10 % - Samples must include min 1 No of each type), W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

1. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
2. Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents

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ऊर्जा दक्ष मध्यम वोल्टेज मोटरों के लिए निरीक्षण व परीक्षण योजना

INSPECTION AND TEST PLAN FOR ENERGY EFFICIENT MEDIUM VOLTAGE MOTORS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
0	12 11 2018	ISSUED FOR IMPLEMENTATION	MM	RS	RKS	RKT

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Abbreviations

BIS	:	Bureau of Indian Standard
CIMFR	:	Central Institute of Mining & Fuel Research
EIL	:	Engineers India Limited
FM	:	Factory Mutual
FLP	:	Flame Proof
ITP	:	Inspection and Test Plan
IP	:	Ingress Protection
IC	:	Inspection Certification
IEC	:	International Electro technical Commission
JEC	:	Japanese Electro technical Committee
MTC	:	Material Test Certificate
NEMA	:	National Electrical Manufacturers Association
PO	:	Purchase Order
PESO	:	Petroleum Explosive Safety Organization
PR	:	Purchase Requisition
QC	:	Quality Control
TC	:	Test Certificate
TPI or TPIA	:	Third Party Inspection Agency
VDR	:	Vendor Data Requirement
VFD	:	Variable Frequency Drive

Inspection Standards Committee

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Members: Mr. Rajeev Kumar
Mr. Neeraj Mathur
Mr. Himangshu Pal
Mr. R Muthuramalingam
Mr. T Kamalakannan
Mr. Mahendra Mittal
Mr. Deepak Gupta (Projects)

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1.0 SCOPE

This Inspection and Test Plan covers the minimum testing & inspection requirements of three phase medium voltage energy efficient squirrel cage induction motors.

2.0 REFERENCE DOCUMENTS

PO/PR & Standards referred therein /Job specifications / Approved documents/ Relevant IEC/IS.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	**Procedures**	--	--	--	--	--	--
2.0	**Material Inspection**						
2.1	Raw Material: Body (casting or fabrication), Rotor Shaft, Core Laminations, Copper, Insulation Material, Bearings, Cable Boxes, Cable Glands, etc.	Chemical, Physical Properties, Finish as per Relevant Standard	100%	Material Test Certificates / Test records	H	H	-

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
3.0	**In-process Inspection**						
3.1	Motor Assembly	Vacuum Impregnation and Bracing of Winding, Core Assembly, Rotor Bars and End Rings Assembly, Rotor Balancing, Terminal Box Mounting and Clearances in between, Bearing Setting, etc. as per Supplier's Internal Standards	100%	Test Records	-	H	R
4.0	**Final Inspection**						
4.1	Motor (Routine Tests)	• Visual Check (Nameplate, Terminal Box Location, Terminal Type, Clearances, Size, Entries, Space Adequacy & Gland Size, Direction of Rotation etc.) • Dimensions Check (Including Shaft Height etc., Foundation Hole Dia and Distance, Shaft Dia.) • Cable Glands, Cable Lugs Size and No. of Entries in Terminal Box • Winding Resistance • No Load Test and Measurement of Voltage, Speed, Current, Power Input • Reduced Voltage Starting and Running • Insulation Resistance before & after High Voltage Test • High Voltage (Per Phase) • Vibration at No Load • Noise Level	100%	Inspection test records	-	H	See Note 4 & 5

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.2	Motor (Type Tests)	• Full Load Test and Measurement of Voltage, Current, Power, Slip, Power Factor, Bearing Noise. • Efficiency and Pf at 100%, 75% and 50% Load • Temp Rise Test • Momentary Overload Test • Vibration • Over Speed • Measurement of Starting Torque, Starting Current, Full Load Torque, Pull Out Torque by JEC/IEC (By Logarithmic Proportion Current Method II	One sample from each type/rating	Inspection test records	-	H	See Note 4 & 5
5.0	**Painting**						
5.1	Painting and Packing	• Visual • Suitable protection to prevent entry of foreign material. • Proper packing with suitable plugs to prevent Ingress of Moisture and any damage during Transportation and Storage.	100%	Packing list / Supplier's Records	-	H	-
6.0	**Documentation and IC**						
6.1	Documentation and IC	• Review of Internal Test Reports • Test Certificate from Recognized Testing Laboratory for Area Classification. • BIS Certificate for FLP Motors and Accessories as applicable.	100%	Supplier's Test Records / Certificates from statutory bodies /	-	H	H

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		• PESO approved Certificates for Motors and Accessories as applicable. • Degree of Protection of Terminal Box and Body • IC Issuance		Inspection Certificate (IC)			
6.2	Final Document submission	Compilation of Inspection Reports, Drawings, etc. as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

Legends: H- Hold (Do not proceed without approval, R-Review, RW-Random witness (As specified or 10 % - Samples must include min 1 No of each type), W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

1. For VFD application motors, separate FAT procedure to be submitted for EIL/ TPIA approval.
2. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable.
3. Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred therein/ Job specifications /Approved documents.
4. Motors up to 55 KW would be accepted based on Manufacturer's test certificates. Higher rating will have witness by TPIA appointed by Main Supplier.
5. Motors ordered with integration test (VFD fed motors) requirement as per PR shall be witnessed by EIL/ TPIA and main supplier for integration test (irrespective of rating) at motor manufacturer's works.

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INSTRUMENT CONNECTION ON VESSEL, STANDPIPES AND TANKS

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	27.01.15	REVISED AND REISSUED	MN	RKG	RG	SC
3	11.02.13	REVISED AND REISSUED	MN	RG	RP/JMS	DM
2	13.04.07	REVISED AND REISSUED	MN	TGM	HCJ	VC
1	25.09.98	REVISED AND REISSUED	MN	RK	BRS	AS

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SR. NO	TYPE OF INSTRUMENTS	UNCLADDED EQUIPMENTS		CLADDED EQUIPMENTS		INSTRUMENT CONNECTION
		EQUIPMENT/STANDPIPE CONNECTION	FIRST BLOCK VALVE	EQUIPMENT/STANDPIPE CONNECTION	FIRST BLOCK VALVE	
1.	EXTERNAL DISPLACER LEVEL INSTRUMENT ON EQUIPMENT	2" FLGD.	2" FLGD.	3" FLGD.	3" FLGD.	2" FLGD.
2.	EXTERNAL DISPLACER LEVEL INSTRUMENT ON STANDPIPE	2" FLGD.	2" FLGD.	2" FLGD.	2" FLGD.	2" FLGD.
3.	EXTERNAL GUIDED WAVE LEVEL INSTRUMENT ON EQUIPMENT	2" FLGD.	2" FLGD.	3" FLGD.	3" FLGD.	2" FLGD.
4.	EXTERNAL GUIDED WAVE LEVEL INSTRUMENT ON STANDPIPE	2" FLGD.	2" FLGD.	2" FLGD.	2" FLGD.	2" FLGD.
5.	EXTERNAL MAGNETIC LEVEL INSTRUMENT/ GAUGE ON EQUIPMENT	2" FLGD.	2" FLGD.	3" FLGD.	3" FLGD.	2" FLGD.
6.	EXTERNAL MAGNETIC LEVEL INSTRUMENT/ GAUGE ON STANDPIPE	2" FLGD.	2" FLGD.	2" FLGD.	2" FLGD.	2" FLGD.
7.	EXTERNAL BALL FLOAT LEVEL INSTRUMENT ON VESSEL	2" FLGD.	2" FLGD.	3" FLGD.	3" FLGD.	1" SW
8.	EXTERNAL BALL FLOAT LEVEL INSTRUMENT ON STANDPIPE	1" SW/BW #	1" SW/BW #	1" SW/BW #	1" SW/BW #	1" SW
9.	INTERNAL DISPLACER / FLOAT LEVEL INSTRUMENTS	4" FLGD	-	4" FLGD	-	4" FLGD.
10.	INTERNAL GUIDED WAVE LEVEL INSTRUMENT ON EQUIPMENT	4" FLGD.	-	4" FLGD.	-	4" FLGD.
11.	MAGNETIC LEVEL INSTRUMENT/ GAUGE (INTERNAL - TOP MOUNTED)	4" FLGD.	-	4" FLGD.	-	4" FLGD.
12.	LEVEL GAUGE ON VESSEL	2" FLGD.	2" FLGD.	3" FLGD.	3" FLGD.	¾" SCRD.
13.	LEVEL GAUGE ON STANDPIPE	¾" SW/BW #	¾" SW/BW #	¾" SW/BW #	¾" SW/BW #	¾" SCRD.
14.	SPECIAL LEVEL INSTRUMENT ON EQUIPMENT (CAPACITANCE PROBE/ULTRASONIC PROBE/R.F.PROBE)	2" FLGD.	-	3" FLGD.	-	2" FLGD.
15.	D.P. INSTRUMENT/ GAUGES ON VESSEL	2 " FLGD.	2 " BW/FLGD #	3" FLGD.	3" FLGD.	½ " SCRD.
16.	D.P. INSTRUMENT/ GAUGES ON STANDPIPE	¾" SW/BW #	¾" SW/BW #	¾" SW/BW #	¾" SW/BW #	½ " SCRD.
17.	DIAPHRAGM SEAL D.P. INSTRUMENT/ GAUGES ON VESSEL	3" FLGD.	3" FLGD.	3" FLGD.	3" FLGD.	3" FLGD.
18.	EXTENDED DIAPHRAGM SEAL D.P. INSTR/ GAUGE ON VESSEL	4" FLGD. (NOTE-1)	-	4" FLGD. (NOTE-1)	-	4" FLGD.

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SR. NO	TYPE OF INSTRUMENTS	UNCLADDED EQUIPMENTS		CLADDED EQUIPMENTS		INSTRUMENT CONNECTION
		EQUIPMENT/STANDPIPE CONNECTION	FIRST BLOCK VALVE	EQUIPMENT/STANDPIPE CONNECTION	FIRST BLOCK VALVE	
19.	DIP TUBE LEVEL INSTRUMENT	6 " FLGD.	½ " SW (BY INST)	6" FLGD.	½ " SW (BY INST)	½ " SCRD
20.	TANK LEVEL INSTRUMENT (MECHANICAL)	1½ " FLGD	1½ " FLGD (BY INST)	-	-	½ " SCRD
21.	TANK LEVEL INSTRUMENT (SERVO) ON ATMOSPHERIC TANKS	6" FLGD.	-	-	-	6" FLGD
22	TANK LEVEL INSTRUMENT (SERVO) FOR PRESSURISED EQUIPMENT	6" FLGD.	6" FLGD. (BY INST)	6" FLGD.	6" FLGD. (BY INST)	6" FLGD
23.	TANK LEVEL INSTRUMENT (RADAR) ON ATMOSPHERIC TANK (CLEAN SERVICE)	8" FLGD.	-	-	-	8" FLGD.
24.	TANK LEVEL INSTRUMENT (RADAR) ON ATMOSPHERIC TANK (VISCOUS SERVICE)	24" FLGD.	-	-	-	24" FLGD.
25.	TANK LEVEL INSTRUMENT (RADAR) FOR PRESSURISED EQUIPMENTS	8" FLGD.	-	8" FLGD.	-	8" FLGD.
26.	TANK LEVEL INSTRUMENT – CAPACITANCE / ULTRASONIC/ RF TYPE ON ATMOSPHERIC TANKS/PRESSURISED EQUIPMENTS	2" FLGD.	-	3" FLGD.	-	2" FLGD.
27.	TANK LEVEL INSTRUMENT – TUNING FORK	3" FLGD.	-	-	-	3" FLGD.
28.	PRESSURE INSTRUMENT/ GAUGE ON VESSEL	2 " FLGD	2 " BW/ FLGD #	3" FLGD.	3" BW/FLGD. #	½ " SCRD
29.	PRESSURE INSTRUMENT/ GAUGE ON STANDPIPE	¾" SW/BW #	¾" SW/BW #	¾" SW/BW #	¾" SW/BW #	½ " SCRD
30.	CHEMICAL SEAL PRESSURE INSTRUMENT/ GAUGE ON VESSEL	2 " FLGD	2 " FLGD	3" FLGD.	3" FLGD.	½ " SCRD
31.	DIAPHRAGM SEAL PRESSURE INSTRUMENT /GAUGE ON VESSEL	2 " FLGD	2 " FLGD	3" FLGD.	3" FLGD.	2" FLGD.
32.	THERMOWELL ON EQUIPMENT	2 " FLGD	-	3" FLGD.	-	2 " FLGD/ 3" FLGD
33.	MULTI-POINT TEMPERATURE ELEMENTS FOR TANKS	3"FLGD.	-	3" FLGD.	-	3" FLGD
34.	STANDPIPE (RATING UP TO 600#)	2"FLGD.	-	3" FLGD.	-	-
35.	STANDPIPE (RATING > 600#)	3"FLGD.	-	3" FLGD.	-	-

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NOTES: 1 O.D OF EXTENDED DIAPHRAGM OF INSTRUMENT SHALL BE SELECTED TO SUIT NOZZLE I.D OF EQUIPMENT.

2 ALL FLANGES/SW RATING SHALL BE AS PER PIPING SPECIFICATION UNLESS PROJECT SPECIFICATION REQUIRES MIN. 300#.

3 IN CASE OF DIRECT MOUNTED FLANGED INSTRUMENTS AND WHERE FLANGED TYPE FIRST ISOLATION VALVE ARE PROVIDED, BOLTING AND GASKETS SHALL BE IN PIPING SCOPE.

4 INSTALLATION OF STLL WELL OF TANK LEVEL INSTRUMENTS (SERVO, MECHANICAL AND MULTIPOINT TEMPERATURE ELEMENT) ON TANKS ARE IN TANK VENDOR SCOPE.

5 FOR ANY OTHER INSTRUMENTS NOT REFERED ABOVE THE CONNECTION DETAILS SHALL BE AS PER PROJECT REQUIREMENT.

AS PER PIPING SPECIFICATION/PROJECT PHILOSOPHY

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INSTRUMENT CONNECTION ON PIPES

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	27.01.15	REVISED AND REISSUED	MN	RKG	RG	SC
3	11.02.13	REVISED AND REISSUED	MN	RG	RP/JMS	DM
2	13.04.07	REVISED AND REISSUED	MN	TGM	HCJ	VC
1	25.09.98	REVISED AND REISSUED	MN	RK	BRS	AS

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(A) BARE PIPES

S. NO	TYPE OF INSTRUMENTS		WHERE PIPING CLASS RECOMMENDS SCRD CONNECTION			WHERE PIPING CLASS RECOMMENDS SW/BW # CONNECTION			WHERE PIPING CLASS RECOMMENDS FLGD CONNECTION		
			PROCESS CONNECTION	FIRST BLOCK VALVE	INSTRUMENTS CONNECTION	PROCESS CONNECTION	FIRST BLOCK VALVE	INSTRUMENTS CONNECTION	PROCESS CONNECTION	FIRST BLOCK VALVE	INSTRUMENTS CONNECTION
1	FLOW METER ORIFICE	≤ 600#	½" SCRD*	½" SCRD*	½" SCRD	½" SCRD*	½" SW	½" SCRD	½" SCRD*	½" FLGD	½" SCRD
		> 600#	-	-	-	¾" SCRD**	¾" BW	½" SCRD	¾" SCRD**	¾" FLGD	½" SCRD
2	FLOWMETER VENTURI/NOZZLE	≤ 600#	½" FLGD	½" FLGD	½" SCRD	½" FLGD	½" FLGD	½" SCRD	½" FLGD	½" FLGD	½" SCRD
		> 600#	-	-	-	¾" FLGD	¾" FLGD	½" SCRD	¾" FLGD	¾" FLGD	½" SCRD
3	FLOW METER ORIFICE (DIAPH.SEAL)	≤ 600#	½" SCRD*	½" SCRD*	3"FLGD	½" SCRD*	½" SW	3" FLGD	½" SCRD*	½" FLGD	3"FLGD
		> 600#	-	-	-	¾" SCRD**	¾" BW	3" FLGD	¾" SCRD**	¾" FLGD	3"FLGD
4	FLOW METER VENTURI/NOZZLE (DIAPH.SEAL)	≤ 600#	½" FLGD	½" FLGD	3" FLGD	½" FLGD	½" FLGD	3" FLGD	½" FLGD	½" FLGD	3"FLGD
		> 600#	-	-	-	¾" FLGD	¾" FLGD	3" FLGD	¾" FLGD	¾" FLGD	3"FLGD
5	FLOW METER AVERAGING PITOT TUBE		3" FLGD	3" FLGD (BY INST)	3" FLGD+	3" FLGD	3" FLGD (BY INST)	3" FLGD	3" FLGD	3" FLGD (BY INST)	3" FLGD+
6	DIFFERENTIAL PRESSURE (DP) INSTRUMENTS <5>		¾" SCRD*	¾" SCRD*	½" SCRD.	¾" SW/BW#	¾" SW/BW#	½" SCRD	¾" FLGD	¾" FLGD	½" SCRD
7	DIAPHGRAM SEAL D.P. INSTRUMENTS <5>		3" FLGD.	3" FLGD.	3" FLGD.	3" FLGD.	3" FLGD.	3" FLGD	3" FLGD.	3" FLGD.	3" FLGD.
8	PRESSURE INSTRUMENTS <5>		¾" SCRD*	¾" SCRD*	½" SCRD.	¾" SW/BW#	¾" SW/BW#	½" SCRD	¾" FLGD	¾" FLGD	½" SCRD
9	DIAPH. (CHEMICAL) SEAL PRESSURE INSTRUMENT<5> (SCRD.)		¾" SCRD*	¾" SCRD*	½" SCRD.	¾" SW/BW#	¾" SW/BW#	½" SCRD	¾" FLGD	¾" FLGD	½" SCRD
10	DIAPHGRAM SEAL PRESSURE INSTRUMENTS (FLGD.)		1 ½" FLGD.	1 ½" FLGD.	1 ½" FLGD.	1 ½" FLGD.	1 ½" FLGD.	1 ½" FLGD.	1 ½" FLGD.	1 ½" FLGD.	1 ½" FLGD.
11	THERMOWELL	≤600#	1 ½" FLGD.	-	1 ½ " FLGD	1 ½" FLGD.	-	1 ½ " FLGD	1 ½" FLGD.	-	1 ½ " FLGD
		>600#	2" FLGD.	-	2" FLGD	2" FLGD.	-	2" FLGD	2" FLGD.	-	2" FLGD

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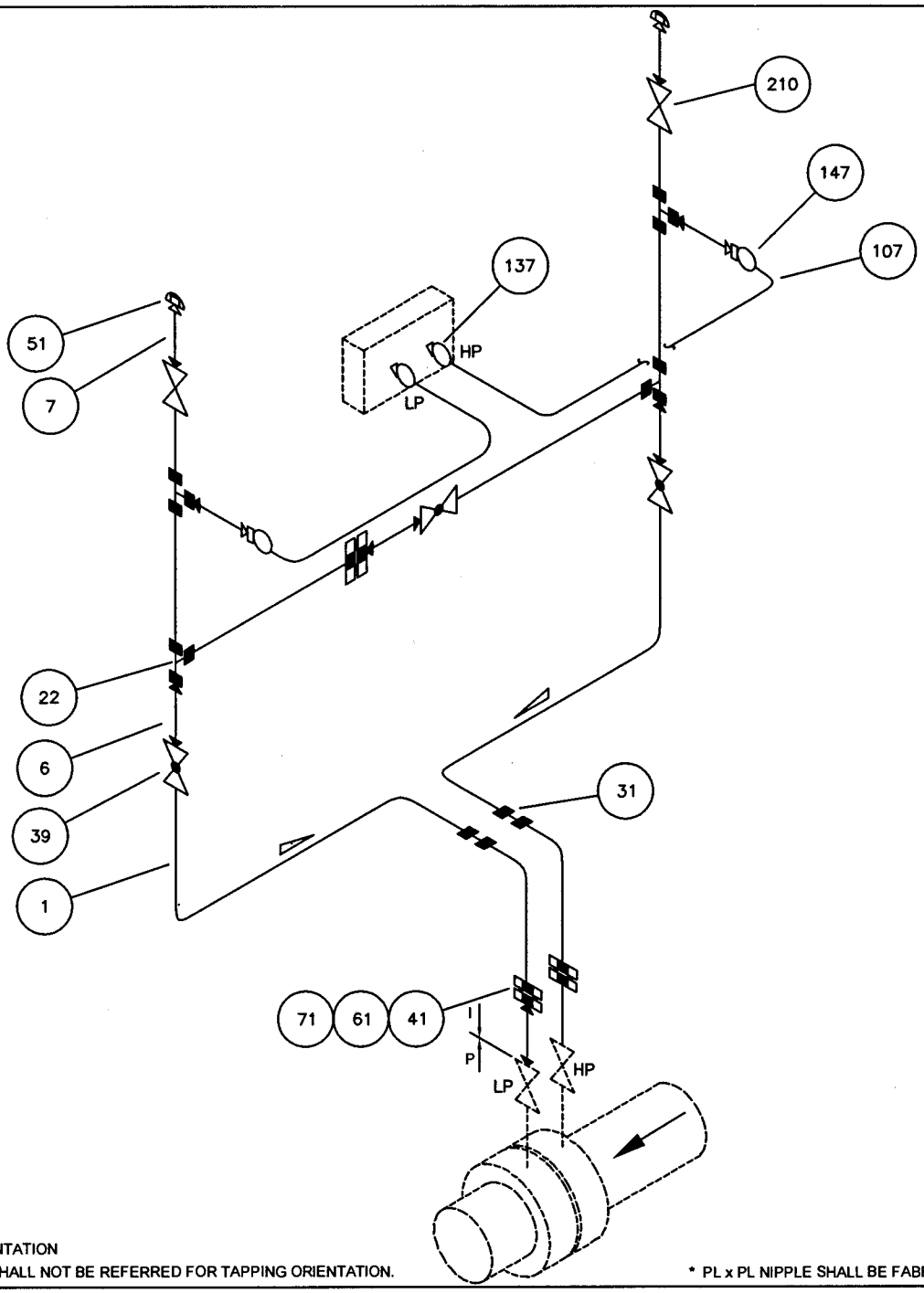
(B) CLADDED\CEMENTED\LINED PIPES

S. NO	TYPE OF INSTRUMENTS		WHERE PIPING CLASS SPECIFIES CLADDED PIPES			WHERE PIPING CLASS SPECIFIES CEMENT LINED PIPES			WHERE PIPING CLASS SPECIFIES RUBBER/TEFLON LINED PIPES		
			PROCESS CONNECTION	FIRST BLOCK VALVE	INSTRUMENTS CONNECTION	PROCESS CONNECTION	FIRST BLOCK VALVE	INSTRUMENTS CONNECTION	PROCESS CONNECTION	FIRST BLOCK VALVE	INSTRUMENTS CONNECTION
1	FLOW METER ORIFICE	≤ 600#	½" SCRD*	½" SCRD*	½" SCRD	½" SCRD*	½" SW/BW	½" SCRD	1" FLGD	1" FLGD	½" SCRD
		> 600#	¾" SCRD**	¾" SW/BW	½" SCRD	-	-	-	-	-	-
2	FLOW METER ORIFICE (DIA-PHGRAMSEAL)	≤ 600#	½" SCRD*	½" SCRD*	3" FLGD	½" SCRD*	½" SW/BW	3" FLGD	1" FLGD	1" FLGD	3" FLGD
		> 600#	¾" SCRD**	¾" SCRD*	3" FLGD	-	-	-	-	-	-
3	FLOW METER ++ AVERAGING PITOT TUBE		3" FLGD	3" FLGD (BY INST)	3" FLGD+	3" FLGD	3" FLGD (BY INST)	3" FLGD+	3" FLGD	3" FLGD (BY INST)	3" FLGD+
4	DP INSTRUMENTS <5>		¾"SW/BW#	¾"SW/BW#	½" SCRD.	3" FLGD	¾" FLGD	½" SCRD	1½" FLGD	1 ½" FLGD	½" SCRD
5	DIAPHGRAM SEAL D.P. INSTRUMENTS <5>		3" FLGD.	3" FLGD.	3" FLGD	3" FLGD	3"FLGD	3" FLGD	3" FLGD.	3" FLGD.	3" FLGD.
6	PRESSURE INSTRUMENTS <5>		¾"SW/BW#	¾"SW/BW#	½" SCRD.	3" FLGD	¾"SW/BW	½" SCRD	1" FLGD	1" FLGD	½" SCRD
7	DIAPHGRAM (CHEMICAL) SEAL PRESSURE INSTRUMENTS (SCRD.) <5>		¾"SW/BW#	¾"SW/BW#	½" SCRD.	3" FLGD	1 ½" SW/BW	½" SCRD	1" FLGD	1" FLGD	½" SCRD
8	DIAPHGRAM SEAL PRESSURE INSTRUMENTS (FLGD) <5>		1 ½" FLGD.	1 ½" FLGD.	1 ½" FLGD.	3" FLGD	1 ½"FLGD	1 ½" FLGD	1 ½" FLGD	1 ½" FLGD	1 ½" FLGD
9	THERMOWELL		3" FLGD.	-	3 " FLGD	3" FLGD	-	3" FLGD	3" FLGD	-	3" FLGD

NOTES:
1. FOR ANY OTHER INSTRUMENTS NOT REFERRED ABOVE THE CONNECTION DETAILS SHALL BE AS PER INDIVIDUAL REQUIREMENT.
2. ALL FLANGES/SW RATING SHALL BE AS PER PIPING SPECIFICATION.
3. IN CASE OF DIRECT MOUNTED FLANGED INSTRUMENTS AND WHERE FLANGED FIRST ISOLATION VALVE ARE PROVIDED, BOLTING AND GASKETS SHALL BE IN PIPING SCOPE.
4. INSTALLATION OF ALL IN LINE INSTRUMENTS SHALL BE IN PIPING SCOPE.
5. PRESSURE INSTRUMENTS INCLUDE PRESSURE TRANSMITTERS AND PRESSURE GAUGES.

* SEAL WELDING REQUIRED.
\# AS PER PIPING SPECIFICATION.
** STRENGTH WELD
\+ CONNECTIONS FOR D.P. INSTRUMENT ½" SCRD
++ WELDOLET, FLANGE, BOTTOM SUPPORT SHALL BE SUPPLIED BY INSTRUMENT VENDOR. HOWEVER ERECTION BY MECHANICAL CONTRACTOR.

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P - BY PIPING
I - BY INSTRUMENTATION
THIS DRAWING SHALL NOT BE REFERRED FOR TAPPING ORIENTATION.

* PL x PL NIPPLE SHALL BE FABRICATED FROM PIPE

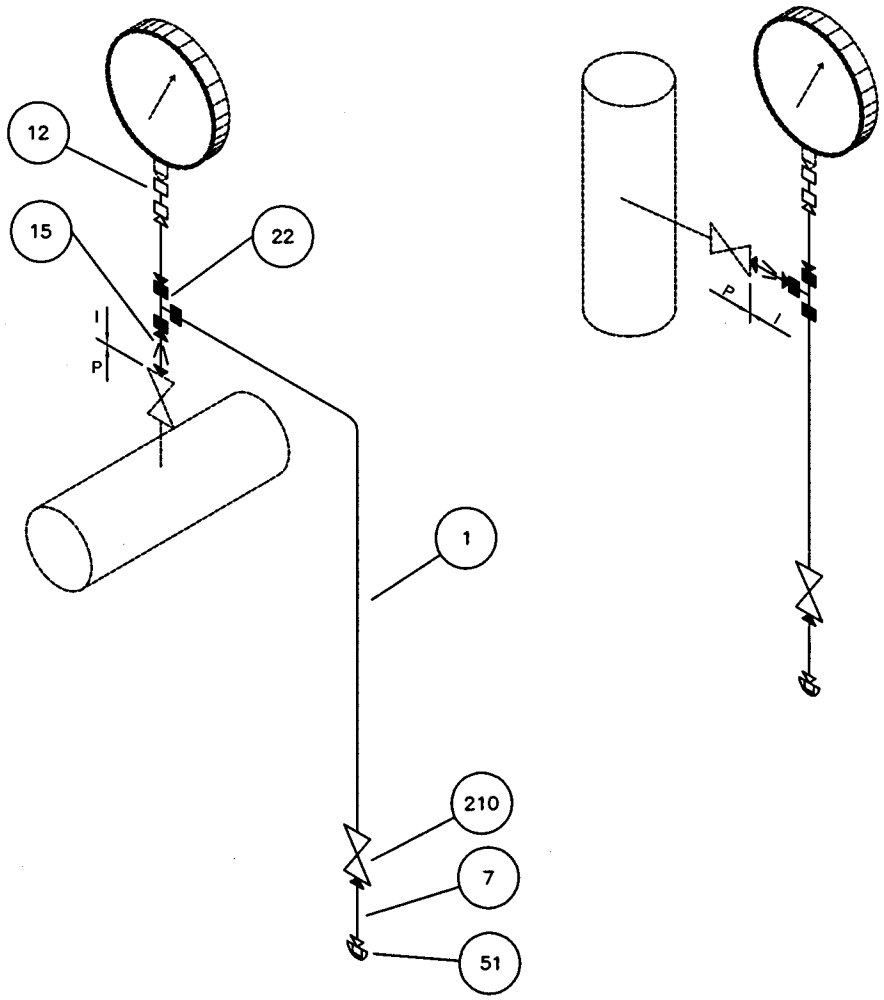
LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
1	PIPE	1/2"	PL	A/R	m	107	TUBE	1/2"	OD	A/R	m
6	NIPPLE *	1/2"	PL X PL	4	Nø	137	MALE CONNECTOR	1/2" X 1/2"	TH X OD	2	Nø
7	NIPPLE	1/2"	TH X PL	4	Nø	147	FEMALE CONNECTOR	1/2" X 1/2"	TH X OD	2	Nø
22	EQUAL TEE	1/2"	SW	4	Nø						
31	COUPLING	1/2"	SW	2	Nø						
39	GLOBE VALVE	1/2"	SW	3	Nø						
41	FLANGE	1/2"	SW	6	Nø						
51	CAP	1/2"	TH	2	Nø						
61	GASKET	FOR 1/2" FLG.		3	Nø						
71	STUDS & NUTS	FOR 1/2" FLG.		3	Set						
210	GATE VALVE	1/2"	SW	2	Nø						

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
5	26-08-16	Revised & Reissued	Manoj	MN/RKG	RG	RN
4	01-08-11	Revised & Reissued	Manoj	RG	RP/JMS	DM

Approved by

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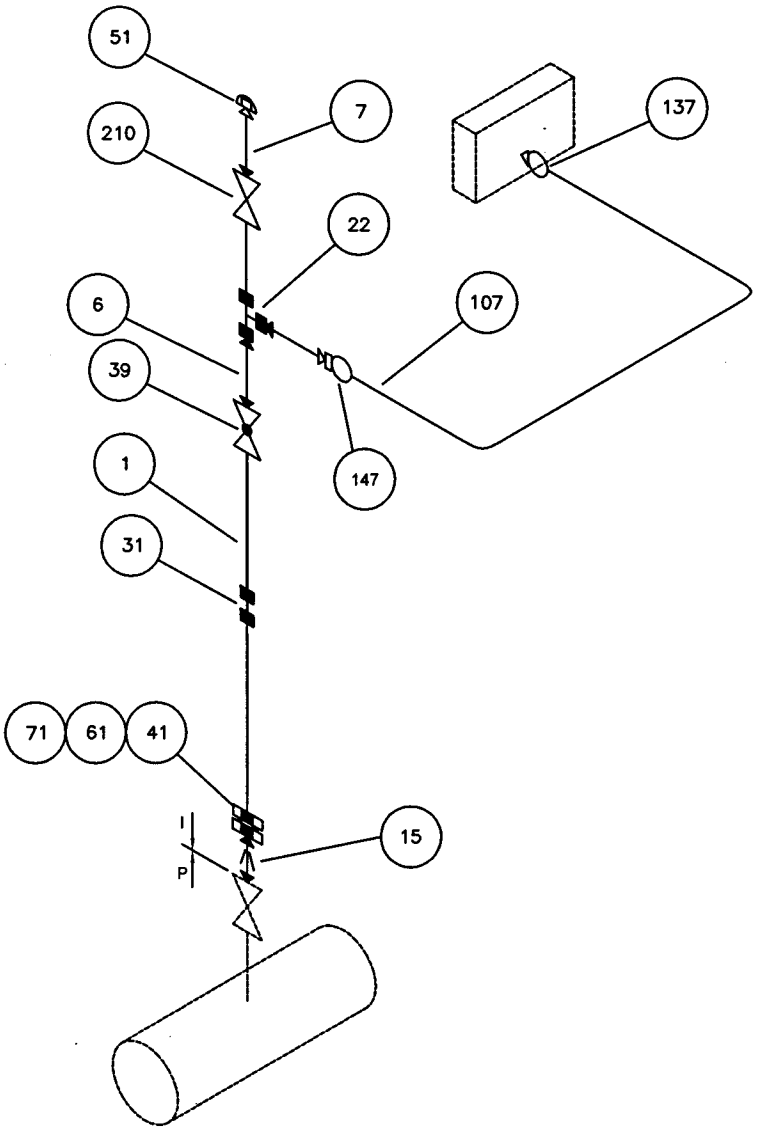
LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
1	PIPE	1/2"	PL	A/R	m						
7	NIPPLE	1/2"	TH X PL	2	Nø						
12	COUPLING	1/2"	TH	1	Nø						
15	SWAGE NIPPLE	3/4" X 1/2"	PL X PL	1	Nø						
22	EQUAL TEE	1/2"	SW	1	Nø						
51	CAP	1/2"	TH	1	Nø						
210	GATE VALVE	1/2"	SW	1	Nø						

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
5	26-08-16	Revised & Reissued	Manoj	MN/RKG	RG	RN
4	01-08-11	Revised & Reissued	Manoj	RG	RP/JMS	DM

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* PL x PL NIPPLE SHALL BE FABRICATED FROM PIPE

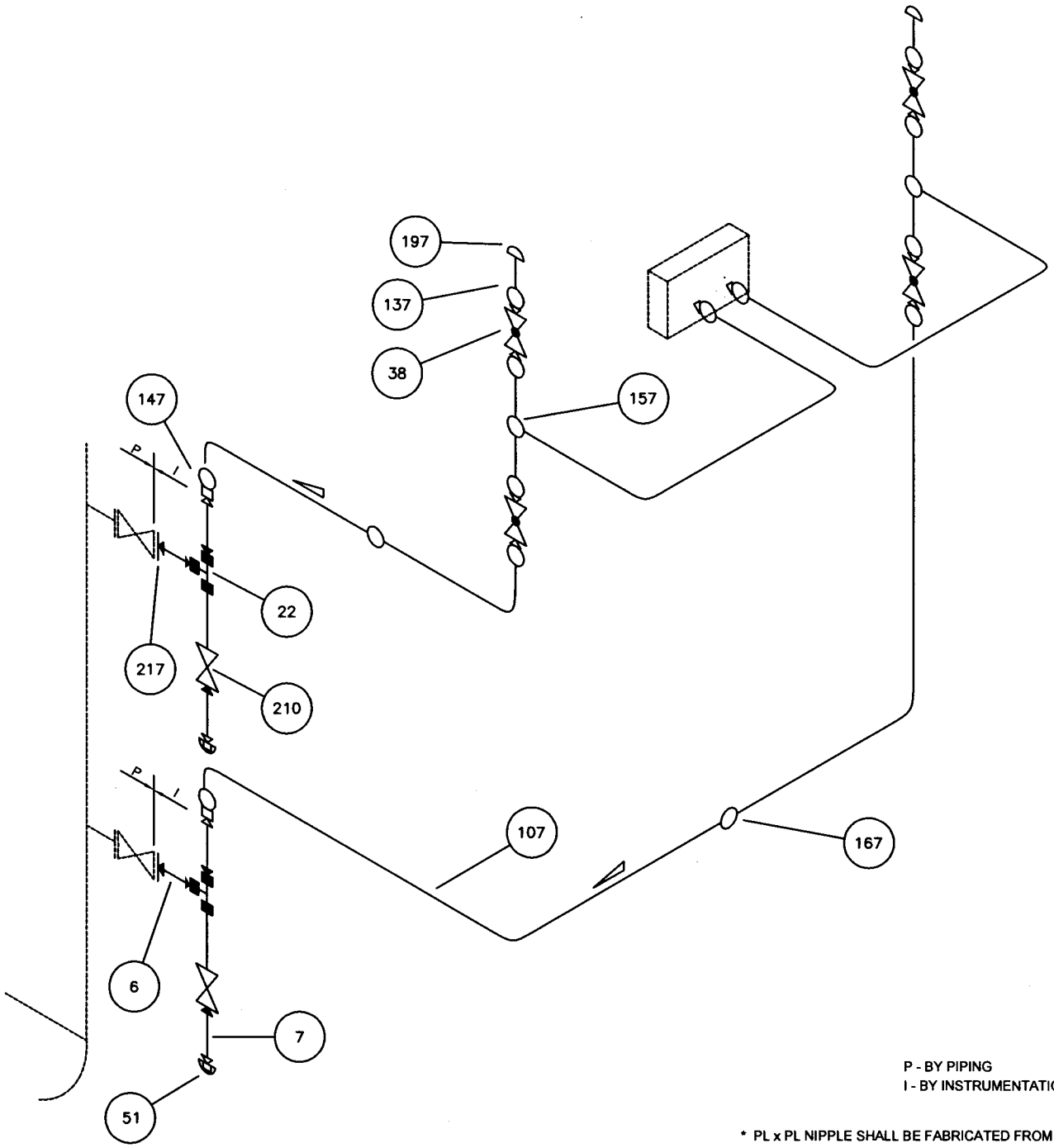
LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
1	PIPE	1/2"	PL	A/R	m	107	TUBE	1/2"	OD	A/R	m
6	NIPPLE *	1/2"	PL X PL	1	Nø	137	MALE CONNECTOR	1/2" X 1/2"	TH X OD	1	Nø
7	NIPPLE	1/2"	TH X PL	2	Nø	147	FEMALE CONNECTOR	1/2" X 1/2"	TH X OD	1	Nø
15	SWAGE NIPPLE	3/4" X 1/2"	PL X PL	1	Nø						
22	EQUAL TEE	1/2"	SW	1	Nø						
31	COUPLING	1/2"	SW	1	Nø						
39	GLOBE VALVE	1/2"	SW	1	Nø						
41	FLANGE	1/2"	SW	2	Nø						
51	CAP	1/2"	TH	1	Nø						
61	GASKET	FOR 1/2" FLG.		1	Nø						
71	STUDS & NUTS	FOR 1/2" FLG.		1	Set						
210	GATE VALVE	1/2"	SW	1	Nø						

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
5	26-08-16	Revised & Reissued	Manoj	MN/RKG	RG	RN
4	01-08-11	Revised & Reissued	Manoj	RG	RP/JMS	DM

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* PL x PL NIPPLE SHALL BE FABRICATED FROM PIPE

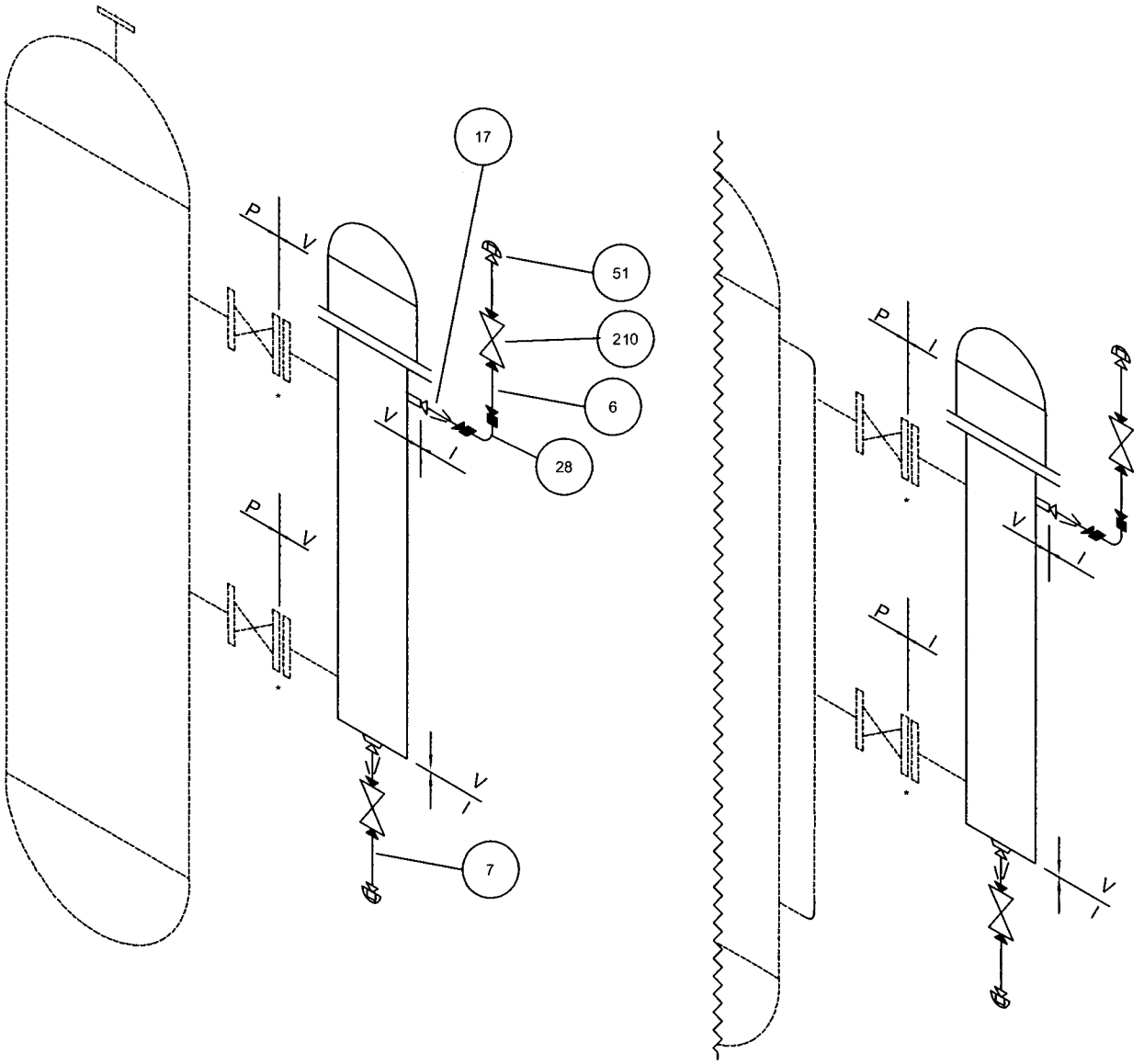
LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
6	NIPPLE *	1/2"	PL X PL	2	Nø	107	TUBE	1/2"	OD	A/R	m
7	NIPPLE	1/2"	TH X PL	4	Nø	137	MALE CONNECTOR	1/2" X 1/2"	TH X OD	10	Nø
22	EQUAL TEE	1/2"	SW	2	Nø	147	FEMALE CONNECTOR	1/2" X 1/2"	TH X OD	2	Nø
38	GLOBE VALVE	1/2"	TH	4	Nø	157	UNION TEE	1/2"	OD	2	Nø
51	CAP	1/2"	TH	2	Nø	167	TUBE UNION	1/2"	OD	2	Nø
210	GATE VALVE	1/2"	SW	2	Nø	197	TUBING CAP	1/2"	OD	2	Nø
217	FLANGE	2" X 1/2"	FL X SW (Red)	2	Nø						

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
6	24.10.16	Revised and Reissued	Manoj	MN	RG	RN
5	12-10-11	Revised and Reissued	Manoj	RG	RP/JMS	DM

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P - BY PIPING
I - BY INSTRUMENTATION
V - BY INST. VENDOR

* - STUD NUTS & GASKET BY PIPING

LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
6	NIPPLE	1/2"	PL X PL	1	No						
7	NIPPLE	1/2"	TH X PL	2	No						
17	SWAGE NIPPLE	3/4" X 1/2"	TH X PL	2	No						
28	ELBOW	1/2"	SW	1	No						
51	CAP	1/2"	SCRD	2	No						
210	GATE VALVE	1/2"	SW	2	No						

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
0	01-09-14	Issued As Standard	Manoj	RKG	RG	SC

Approved by

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पैकेज इकाइयों के लिए साइट निष्पादन गारंटी अपेक्षाएँ तैयार करने हेतु विक्रेता को अनुदेश

INSTRUCTIONS TO VENDOR FOR SITE PERFORMANCE GUARANTEE REQUIREMENTS FOR PACKAGE UNITS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	30.03.2019	Reaffirmed & Reissued	RRS	PPP	RP	RKT
1	30.05.2008	Revised & Reissued	SMA	PKR	AA	VC
0	10.11.2003	ISSUED AS STANDARD	PKR	PM	VC	SKG

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Abbreviations:

LSTK	:	Lumpsum Turnkey
PG	:	Performance Guarantee

General Engg. Standards Committee

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Mr RB Bhutda (EWS)
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1.0 INTRODUCTION

As a part of engineering services, EIL procures different types of Package Units for various Projects, for and on behalf of the Owner/Purchaser. The vendor is required to design, engineer, manufacture/ procure, inspect, test and supply to site, and also in many cases construct/erect, commission and Performance test the Package Units before handing over the same to Owner/Purchaser, based on Process and Technical requirements defined in the Inquiry/Order document.

2.0 PURPOSE

This document provides instructions to Vendor for Site Performance Guarantee (PG) Requirements for Package Units and shall form a part of the contract, wherever site performance guarantee test is specified in the Inquiry/Order document. The aim is to provide clarity to the Vendor as well as the Commissioning team on site performance guarantee parameters, their measurements during PG Test, and the acceptance of the Package Unit by the Owner/Purchaser after the successful PG Test.

3.0 SCOPE

The requirements of this standard are applicable for all Package Units including LSTK Bid Packages, which require Performance Guarantee Test, after installation and commissioning of the unit at site.

4.0 DEFINITIONS

4.1 "Vendor" means the person(s), company, organization from whom EIL procures products/services as a part of services rendered to the Owner/Purchaser. "Contractor", "Supplier" are considered synonymous to "Vendor".

4.2 "Owner" means the person(s), company, organization to whom EIL is rendering services for the Project.

4.3 "Purchaser" means the person(s), company, organization which awards order for the Package Unit on the Vendor.

5.0 PERFORMANCE GUARANTEE TESTING AT SITE

5.1 General

5.1.1 The overall performance testing of the completely assembled/erected Package unit as a whole shall be carried out at site to establish the performance guarantee parameters specified in Inquiry/Order document. In addition, certain critical equipment/sub-packages may also be performance tested at site if so specified in Inquiry/Order document. The duration of site performance guarantee run shall be as defined in the Inquiry/order document.

The measured parameters, where necessary, shall be adjusted to account for the variation in ambient/operating conditions actually prevailing at site during performance testing, before comparing it with the guaranteed value.

5.1.2 Performance test shall be carried out as per relevant Codes, Standards and Specifications. The Vendor shall submit the following during detail engineering and the same shall be subject to Owner/Purchaser's approval:

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- Detailed Test procedure including measurement tolerances, if applicable, calculations/ correction curves for changes in ambient/ operating conditions, and complete test layout, etc.

- Site Performance Guarantee Test Proforma completed in line with enclosed format 7-76-0103-F1.

- Vendor shall list out parameters to be measured and corresponding installed instrument type and tag no. to be used for measurements. Any instrument/measurement device, (required for testing) not installed at site, shall be arranged by vendor. Vendor shall furnish list of such instruments alongwith instrument details.

- Log sheets indicating all parameters that are to be recorded.

- Method of computation of test results including interpretation of test results.

5.2 Test Instruments

All necessary test instruments required for measuring the performance guarantee parameters shall be arranged by the vendor free of charge. These instruments shall be tested & calibrated from reputed test houses like National Physical Laboratories (NPL), Institute for Design of Electrical Measuring Instruments (IDEMI), Electronics Regional Test Laboratories (ERTL) or any other test house approved by the Owner. All test instruments shall have valid calibration reports. The Vendor shall furnish calibration certificates before putting them to use and also, wherever applicable, after completion of the PG test.

5.3 Performance Guarantee Parameters

Guarantee performance parameters shall be as defined in the Process/Mechanical data sheets, Specification, etc. included in the Inquiry/Order document.

5.4 Repair/Rectification/Modification

5.4.1 In case the unit fails to meet the guaranteed parameters, the Vendor shall carryout, necessary repair, rectification and modification within the time frame defined in the contract or as mutually agreed with the Owner/Purchaser, at his own risk and cost to establish the guaranteed parameters in the final performance test. All costs involved for above activities i.e. supply of manpower, materials, consumables and machines etc. shall be to Vendor's account.

5.4.2 Inspite of repair/rectification, incase the guaranteed performance parameters are not met, penalty/rejection as defined in the contract document for shortfall from guaranteed performance parameters shall be applied.

6.0 SITE PERFORMANCE GUARANTEE TEST PROFORMA

Typical Proforma shown in enclosed Format 7-76-0103-F1, shall be used for assessment of Performance guarantee parameters during site PG test.

7.0 ATTACHMENTS

Format No. 7-76-0103-F1	:	SITE PERFORMANCE GUARANTEE TEST PROFORMA.

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इंजीनियर्स इंडिया लिमिटेड (भारत सरकार का उपक्रम) ENGINEERS INDIA LIMITED (A Govt of India Undertaking)

DOCUMENT No.

SITE PERFORMANCE GUARANTEE TEST PROFORMA

Client : *
Project/Location : *
EIL Job No. : *
Package Unit/System: *
Order No. : *
Vendor : *

1. **PACKAGE OPERATING CONDITION (FOR GUARANTEE):**

Operating Parameter	Values as per Inquiry/Order	Value (Actual at site)
*	*	

2. **PERFORMANCE :**

SITE PERFORMANCE TEST PROCEDURE DOC. NO: *
TEST PERIOD:

Parameter (1) *	Measuring Unit (2) *	Guaranteed Value (3) *	Permissible Tolerance (4) *	Measured Value at site (5)	Value after correction for site conditions (6)	Deviation (6) w.r.t.- (3)	Remarks (Acceptable-Y/N) (7)
a)							
b)							
c)							
d)							
e)							

Vendor's Representative
Date

Owner's Commissioning Incharge
Date

Owner
Date

* TO BE FILLED-UP AND/OR DEVELOPED BY VENDOR & SUBMITTED ALONGWITH PERFORMANCE TEST PROCEDURE.

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3. OBSERVATIONS:

4. CONCLUSIONS :

Vendor's Representative	**Owner's Commissioning Incharge**	**Owner**
Date	Date	Date

Copy : Engineer-In-Charge.

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