





 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR SITE PIPING MATERIAL TRACEABILITY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-008	Rev. No. 0	Page 1 of 13

JOB CONSTRUCTION SPECIFICATION FOR SITE PIPING MATERIAL TRACEABILITY

			 Written By T Balasurugan 2019.12.02 17:41:31 +05'30'	 Signed By <small>Digitally signed by mordchristopher.jesumarian</small> <small>DN: c=IN, o=TechnipFMC, ou=TechnipFMC, email=mordchristopher.jesumarian@technipfmc.com</small> 2019.12.03 15:07:37 +05'30'	 Approved By Atakpian L. 2019.12.03 15:40:10 +05'30'	 Authorized By Mordchristopher Jesumarian 2019.12.03 17:05:20 +05'30'
0	21.11.2019	ISSUED FOR IMPLEMENTATION	TB	PKP / LA	LA	JMC
REV.	DATE	STATUS	WRITTEN BY	CHECKED BY	APPROVED BY	AUTHOR. BY
DOCUMENT REVISIONS						

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1. GENERAL

1.1. Scope

This specification covers requirements for the Material Identification of all piping components must be applied from site receiving up to fabrication, erection and final test. by Contractor at site

Contractor to apply the standard traceability and the full traceability (as applicable) to any piping components of the piping class which the components are part of.

This specification establishes the actions to be taken to ensure material Traceability that is the identification of piping materials during any construction phase.

This specification defines:

- the various Traceability methods;
- Traceability instruction work;
- extent of each Traceability;
- roles and responsibilities of personnel involved in Traceability activity.

1.2. Fields of application

This specification must be applied at material receiving and storage in the site warehouse and during site/shop piping prefabrication and erection activity.

This specification is applied to:

- piping loose component;
- piping shop fabricated and field erected;
- piping wholly field fabricated and erected.

The following steps of piping traceability are included:

- receiving at site/shop;
- storage;
- registration;
- identification;
- marking;
- inspection;
- coordination of staff involved and certification request;
- certification records.

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1.3. Exclusions

- 1.3.1. Traceability, among NDE/Heat Treatment records, joints, Isometric drawings, and welders is excluded from this specification.

These activities shall be coordinated and recorded according to the following:

- Job Construction Specification for Welders Management 080557C-000-PP-821

- 1.3.2. No metallic piping components are excluded from this specification.

2. REFERENCE

2.1. Documents

The following documents are correlated with following documents:

- Piping Construction Quality Control Plans
- Specification for Site Coordination & Communication 080557C-000-PP-805
- Job Specification for Material Receiving, Inspection, Handling Storage & Preservation 080557C-000-PP-807
- Specification for Positive Material Identification 080557C-000-PP-804
- Specification for colour Coding of piping materials By Vendors 080557C-000-SP-1390-009

All other documents referenced in this specification shall be applicable.

3. DEFINITIONS

3.1. Traceability

Traceability means a correct identification of original materials and material composition during construction phases and in particular after installation, using “stamping, etching and stencilling” as methods of implementation.

TARGET: Measures intended to prevent the installation of incorrect materials during construction and piping assembling of plant.

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Traceability can be implemented using:

3.1.1. **Colour code: STANDARD TRACEABILITY**

Colour code, fixed by Engineering, is used only for an easy identification to permit a quick material handling/segregation and visual check/monitoring during construction phases.

3.1.2. **Identification code: STANDARD TRACEABILITY**

Identification code, fixed by Engineering, is used to establish a correspondence between each piping component and the ISO's bill of material.

This code permits a full material tracking during the all phases:

- Engineering: ISO's bill of material and take-off
- Procurement: material requisitioning/P.O.
- Shipping: Inspection, Shipping release notes and packing list,
- Construction:
 - Warehousing: receiving inspection, segregation and storage, software material management input data and delivery voucher to site.
 - Piping engineering: ISO's prefabrication analysis
 - Erection: piping component tracking versus ISO's drawing.

3.1.3. **Tracking code: (TOTAL) FULL TRACEABILITY**

Tracking code ensures the identification of installed material by means of the twofold correlation of the heat number and related Material Test Report (MTR) issued by the Manufacturer.

3.1.4. **PMI: POSITIVE MATERIAL IDENTIFICATION**

PMI ensures a correct installation of materials/weld deposit throughout chemical verification, at any construction phases, of distinctive (s) component (s) of requested alloy steel.

3.2. **Definition of the Party**

Wherever used in this procedure, the following words shall have the meaning as given hereunder

“OWNER or IOCL or CLIENT” shall mean INDIAN OIL CORPORATION LIMITED

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“CONSULTANT or PMC” shall mean TECHNIP INDIA LIMITED

“CONTRACTOR” shall mean the bidder selected by the OWNER for performing the scope of works specified in the Tender documents.

“AUTHORISED REPRESENTATIVE” shall mean OWNER’s/CONSULTANT’s representative authorized to act for and on behalf of OWNER/CONSULTANT, as the case may be

“VENDOR” shall mean any third party supplying any of the equipment/materials for setting up the Plant.

“PROJECT” shall mean Sulphur Recovery Unit and Additional Tanks Project, Paradip Refinery

“PLANT” shall mean the units and facilities comprised in the project, and if divided into different packages for the award of Contracts.

“UNIT” shall mean a particular process unit etc. which forms a distinct operating system and a part of the plant.

"WORKS" means and includes any and all works and services undertaken by the CONTRACTOR.

"MATERIALS" means equipment, materials, chemicals, spare parts, tools etc. to be provided by the CONTRACTOR in accordance with the CONTRACT, which are for incorporation into the Temporary or Permanent Works.

“SUB-CONTRACTOR” shall mean Sub-Contractor engaged by CONTRACTOR

4. KICK OFF MEETING

CONTRACTOR QC Manager and CONSULTANT QC Manager/Personnel shall define and agree working details/instructions to implement this Traceability procedure during a dedicate Kick Off Meeting, before starting of shop/field activities.

5. STANDARD TRACEABILITY (Colour and identification code)

5.1. Fields of application

Standard Traceability is applied to all piping components.

Standard Traceability is applied/checked during:

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- warehousing
- piping prefabrication;
- piping erection.

The colour coding established for the identification of piping components is mentioned below :

5.2. Colour Coding

The colour code shall be used for material identification. Color coding is intended to supplement standard marking required by ASME, MSS, ASTM, API or other codes and/or specifications. The colour code shall be marked at **Manufacture shop itself**. The main purpose of color coding is to simplify identification of piping elements during storage and after the pipe has been cut for fabrication or returned to stock.

All pieces shall be marked with a stripe of water-proof paint / ink in accordance with the colour code specification. The painted stripe shall be executed as per the relevant detailed supply specification for each piping component category.

Surfaces to be color coded shall be clean, dry and free from oil, grease, rust, scale and other foreign matter. The surface preparation shall be according to manufacturer's paint. Colour coding paint shall not be applied to any machined surface, including welded surfaces, weld bevels, etc., nor on any surface intended for welding.

The paint or ink used for austenitic stainless steel or nickel alloy steel shall not contain any chlorides, nor shall it contain zinc, lead, halogens or other harmful metal or metal salts that may cause a corrosive attack.

One or more stripes of water-proof paint, shall be provided according to the Specification Specification for Color Coding of Piping **Materials 080557C-000-SP-1390-009**

5.3. Identification

Correct identification of material/spool shall be implemented by color coding and/or tagging such as clarified in this table:

IDENTIFICATION TABLE - 5.3.1.

Description	Identification			
	Color code	Tagging codes		
		Identification code ⁽⁵⁾	Material ⁽⁶⁾ Specification	Spool numbering ⁽⁷⁾
Material typology ⁽¹⁾		x	x	
Material dimensions ⁽²⁾		x		

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Description	Identification			
	Color code	Tagging codes		
		Identification code ⁽⁵⁾	Material ⁽⁶⁾ Specification	Spool numbering ⁽⁷⁾
Material grade/std ⁽³⁾	x	x	x	
Material supply status ⁽⁴⁾	x	x	x	
Fabricated spool				x

Notes:

- 1) Pipe, elbow,
- 2) Diameter/thickness
- 3) API 5L Gr B, A53 Gr B,
- 4) Seamless, welded, normalized,
- 5) As defined in Contractor Software
- 6) As defined by applicable ASTM, API, etc.
- 7) As agreed by CONTRACTOR & CONSULTANT.

5.3.1. Warehouse Reception

- Prior to accepting the material, the warehouseman shall check the type and quantity of materials against the packing list and the purchase order.
- Warehouseman shall restore identification colour coding or tagging at site when this is not properly applied or damaged during shipping.

Note: The identification code is usually marked by Manufacture (Contractor has to provide this color code requirement to the Vendor during ordering) .

The warehouseman is responsible for marking the identification code during material acceptance before delivering the same to the piping fabrication

- Materials which cannot be identified shall be stored in a separate “QUARANTINE AREA” and shall be properly identified by the sign “HOLD”.
- Quarantined material may not be utilized as plant erecting material.

5.3.2. Marking

When the warehouse staff or CONTRACTOR'S personnel should restore or apply the identification on piping components, the following methods shall be used:

- “Low stress” punch.
- Paint markers, with insoluble water ink that will not attack or harmfully affect the material at ambient or elevated temperature. Ink shall be free from halogen (bromine, chlorine, fluorine, iodine), lead, sulphur, zinc, cadmium, mercury or other harmful compounds.

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- Punched metal sheet labels fastened with an adequate wire on piping.
- Note:** This method is advisable only for temporary use or for special materials

Marks shall be applied in the following locations:

- pipe: 75mm from one end of the outer surface
- welds: adjacent to the welder's identification marker on the weld.
- fittings, forging, or casting: adjacent to the Manufacturer's marking.

5.3.3. Preservation

Color and identification codes shall be maintained on loose materials and or spools during all fabrication/erection activities, including shot-blasting and priming.

Fabrication activities requiring preservation of identification are:

- cutting
- furnace Post Weld Heat Treatment (PWHT)
- shot blasting and priming

Raw Loose components to be primed

Straight pipes and piping components, with the bevelled ends, shot blasted and primed before fabrication/erection should have their ends, 50 mm at least, protected by tape to avoid any contamination during welding.

CONTRACTOR first of all shall provide to keep full identifications as follow:

- transcribing with paint marker (see point 5.3.2) into the inner part of piping the identification code, and applying a short line with color code (when possible);
- punching the identification code (see point 5.3.2) and applying a short line with color code directly onto the end of piping component and protecting it with adhesive tape;
- using metal labels fastened to the piping part;
- using metal labels tack welded to the piping part. This operation must be authorized by SITE MANAGEMENT.

After primer application CONTRACTOR will restore the identification code and color code.

Prefabricated Spools to be primed

The CONTRACTOR, in charge of piping prefabrication, will take care to keep the identification of spools during the various fabrication phases, as follows:

- Before cutting the pipe (or elbow), the CONTRACTOR will identify each loose part by marking the identification code as per point 5.3.2;

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- After welding each pre-fabricated spool will be identified by the isometric number and a sequential number. The identification will be applied, when possible, with adequate marker and circled, to be more clear, with the same marker;
- The identification of spools to be shot blasted and primed shall be transferred by marking on one end of the spool according to point 5.3.2 and protected by tape. After spool priming primary identification will be restored;
- Other methods may be submitted by CONTRACTOR to CONSULTANT/OWNER for approval;
- Moreover the CONTRACTOR shall protect the bevels with appropriate masking tape before applying the primer.

6. **FULL TRACEABILITY (As applicable)** (Tracking code)

6.1. **Scope**

The scope of Full Traceability is to identify installed material by means of the twofold correlation of the Heat Number and related Material Test Report (MTR) issued by the manufacturer

Full Traceability is performed in addition to standard Traceability and does not replace PMI

6.2. **Fields of Application**

In order to avoid possible mistakes of appraisal and/or interpretation the Full Traceability will be applied to all piping lines with a diameter $\geq 2''$.

The piping lines with a diameter $\leq 1\frac{1}{2}''$ shall be traced by the standard method.

Full Traceability is not applied to the following accessory components: bolting, gaskets, temporary strainers, etc.

These components shall be traced by the standard method.

6.3. **File Number**

6.3.1. **File Number Scope**

The File Number scope is to quickly find in the material certificate archives the Material Test Reports of each material Heat Number relevant to piping materials utilized in the Plant.

6.3.2. **File Number Assignment**

The warehouse team shall assign to each Material Test Report a File Number that univocally identifies the component with Heat Number, Material Test Report, material

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description/dimension, Identification Code and not mandatory but preferable if also MR/PO/Packing List number and supplier name will be mentioned.

The warehouse team will fill the above information in the suggested Form QC22 and will write on the Material Test Report (MTR) the assigned File Number (FN).

Note: If same MTR makes reference to different materials (description or dimensions) different FN for the same certificate shall be assigned for each different material.

As many copies of the MTR should be provided and positioned into the binder, according to FN sequence, as different FN arising for each MTR.

The File Number is a 4-digit number XXYY, in which:

XX = the number of the binder containing the MTR.

YY = the MTR position inside the binder.

6.4. Warehouse Reception

In addition to checking the type and quantity of materials against the packing list and purchase order and prior to accepting the material, the warehouse team shall immediately verify that the MTR matches the Heat Number marked on the pieces.

Materials which cannot be identified by its Heat Number and/or MTR shall be stored in a separate "QUARENTINE AREA" and shall be properly identified and segregated with "HOLD" tag.

Such material shall not be utilized as Plant erecting material.

6.4.1 Marking

Accepted materials shall be stored in warehouse areas only after the warehouse team has checked the Heat Number marking on each loose component.

6.5. Material Delivery

The material as per point 6.4.1 can be delivered to the Site for fabrications.

6.6. Heat Number Preservation

Full Traceability shall be maintained throughout all work phases. Suitable measures shall be taken for the purpose.

The following activities make to lose the Traceability:

- cutting;

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- heat treatment;
- shot-blasting and painting.

Before cutting, the Heat Number - which makes the material traceable - shall be indicated on the portion where it is lacking. Scrap shall be kept separate and traceable by transcribing or punching the Heat Number on them.

Prior to local heat treatment, the Heat Number shall be repeated on an area away from the heat.

Before shot-blasting and priming pipes or loose material, the Heat Number can be preserved through the technique reported in point 5.3.3

Before shot-blasting and priming complete spools, or before heat treatment in furnace, the Heat Number shall be transferred on the (attached) Form W10 produced for each isometric.

6.7. Heat Number Transfer on Site

Prior to the pressure test of any test circuit, the Heat Number marked on loose components, erected directly on site, shall be transferred on Form W10 produced for each isometric.

Any modification to the isometric sketch after pressure test shall be performed using traceable material.

The W10 Form shall also be revised.

6.8. Conversion of Heat Number to File Number on W10 Form

As specified in point 6.6. & 6.7. the Heat Number is recorded in W10 Form therefore by QC22 Form , which include both information Heat Number and relevant File Number, is possible the conversion from Heat Number to File Number on W10 Form.

Remarks:

- The filled W10 Forms and relevant isometrics with welded identified joints, utilized as welding/materials map, will allow the Full Traceability of welding NDE/Materials for installed piping lines.
- W10 Form will be prepared by electronic sheet; it will be possible to split W10 Form in two sections: W10/1 for NDE Traceability and W10/2 for Material Traceability.

In this case CONTRACTOR shall propose new Forms for CONSULTANT examination and approval.

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7. POSITIVE MATERIAL IDENTIFICATION (PMI)

7.1. Scope

PMI checks a correct installation of materials/weld deposit throughout chemical verification of distinctive component(s).

PMI is not a substitute for Material Test Reports, nor vice versa.

PMI does not replace “Standard Traceability” or “Full Traceability”.

7.2. Report

At the end of each inspection, a report shall be issued, signed by the attending inspectors on attached Form QC 21.

Reports Traceability and filing shall be assured according to the following:

- Welding/piping: PMI inspection report (QC21) of welds and base metal shall be recorded on Form W10 (NDE/PWHT/HT/PMI and material traceability summary) and filed for progressive number;
- Instrument: PMI inspection report of instrument shall be filed separately from piping and welding reports;
- Filler metal: PMI inspection report of filler metal shall be filed for progressive number together with welding reports;
- Others: PMI inspection report shall be filed for progressive number together with Piping reports.

8. ATTACHMENTS

ATT. 1 – QCF QC22 – FILE NUMBER RECORD

ATT. 2 – QCF W10 – NDE / PWHT / HT / PMI AND MATERIAL TRACEABILITY SUMMARY

ATT. 3 – QCF QC21 – PMI REPORT



COMPANY:

QC 22

SH. ____ OF ____

QC 22 N° _____

[illegible]**TECHNIP INDIA LIMITED**

					PROJECT:														
					COMPANY:														
QUALITY CONTROL FORM W 10					PROJ. No.:			QCF REV. 0			SH. ____ OF ____								
NDE / PWHT / HT / PMI AND MATERIAL TRACEABILITY SUMMARY					CONTRACTOR:					W 10 N° (SEE ISO N°)									
ISO N° _____		SH. ____ OF ____		NDE (Ref to W 09) _____		HEAT TREAT. REQUIR.		Y <input type="checkbox"/>		N <input type="checkbox"/>									
PIPING CLASS _____				MATERIAL _____		PMI		Y <input type="checkbox"/>		N <input type="checkbox"/>									
LEGEND RTR = RADIOG. REPORT N° PTR = PT REPORT N° UTR = UT REPORT N° MTR = MT REPORT N° REP = REPAIR REPORT N°																			
<div style="display: flex; justify-content: space-between;"> <div> (1) B = BUTTWELD; S = SOCKET WELD; EW = EXTERNAL WELD (2) P = PREBRICATION; E = ERECTION (3) A = ACCEPTED; R = TO BE REPAIRED; C = TO BE CUT; CM = CUT TO MODIFY </div> </div>																			
JOINTS			BASE MATERIAL TRACEABILITY				PMI	WELDER IDENTIF.	WPS N°	CONTROL AND EVALUATION CERTIFICATION									
N°	Type (1)	P/E (2)	HEAT NUMBER	MANUFACTURER	IDENT CODE	SHORT DESCR.	REPORT N°			VISUAL (3)	RADIOGRAPHIC / ULTRASONIC TEST			PT / MT			PMI	PWHT	HT
1																			
2																			
3																			
4																			
5																			
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10																			
11																			
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14																			

INSPECTORS		CONTRACTOR		PMC		OWNER			
PHASE		PREFA.	ERECT.	PREFA.	ERECT.	PREFA.	ERECT.	PREFA.	ERECT.
NAME									
SIGNATURE									
DATE									

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COMPANY:





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CONTRACTOR:

REMARKS:

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SPECIFICATION FOR PICKLING AND PASSIVATION OF STAINLESS STEEL SURFACES

			 Written By T Balaraman 2019.11.27 11:12:36 +05'30'	 Checked By Muthuvanan Ganesan 2019.11.28 10:02:51 +05'30'	 Approved By Akshay L. 2019.12.02 10:06:19 +05'30'	 Authorized By M. S. Chatterjee 2019.12.02 10:31:22 +05'30'
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1. INTRODUCTION:

INDIAN OIL CORPORATION LIMITED (IOCL) has awarded Fax of Acceptance (FOA) dated 29th August 2019 to M/s. Technip India Limited (TPIL) for Consultancy services (PMC/EPCM services) for overall project management, FEED Review / FEED, Detailed Engineering, Procurement & expediting services, Tendering & award, Construction Management & Supervision, Assistance in start-up, Commissioning & performance test runs for installation of a Standby SRU of 525 TPD capacity and execution of Additional tanks for Paradip Refinery, Odisha, India.

2. DEFINITIONS:

2.1 Wherever used in this procedure, the following words shall have the meaning as given hereunder

“**OWNER** or **IOC** or **IOCL** or **Client**” shall mean INDIAN OIL CORPORATION LIMITED

“**CONSULTANT** or **PMC**” shall mean TECHNIP INDIA LIMITED.

“**CONTRACTOR**” shall mean the bidder selected by the OWNER for performing the scope of works specified in the bid documents.

“**AUTHORISED REPRESENTATIVE**” shall mean OWNER's/PMC's representative authorized to act for and on behalf of OWNER/PMC, as the case may be.

“**VENDOR/SUPPLIER**” shall mean any third party selected by either the OWNER or CONTRACTOR for supplying any of the equipment/materials for the Unit specified in the bid documents.



“**SUBVENDOR/SUBSUPPLIER**” shall mean any party on whom Vendor/Supplier suborders materials and items and whose role is defined in Quality Control Plans.

“**PROJECT**” shall mean Sulphur Recovery Unit and Additional Tanks Project, Paradip Refinery

“**UNIT**” shall mean the totality of the units and facilities comprised in the Scope of work, which forms a distinct operating system.

2.2 ABBREVIATIONS

- a. ITP: Inspection and Test Plan
- b. QA/QC: Quality Assurance / Quality Control

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- c. FQCP: Fabrication Quality Control Plan
- d. TPIA: Third Party Inspection Agency

2.3 **REFERENCE STANDARD**

ASTM A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

3 **PURPOSE:**

This document describes the Inspection Methodology to be used for inspection of equipment and materials to be supplied for the project to comply with the specifications and Quality Standards laid down in the Tender / Contract. This document details the Inspection Methodology to be adopted for ensuring the quality of the equipment and materials being supplied and defining the roles of various agencies involved and the quality system to be adhered to.

4 **SCOPE:**

Scope of this specification is to give main instructions for pickling and passivation of 300 and 400 series stainless steel surfaces. The specific equipment/piping surfaces and weld joints to be cleaned shall be given in other technical documents.

Head shell forming for vessels shall be guided by a proper procedure, to be submitted by Vendor / Fabricator for Contractor review. The procedure shall indicate how to avoid iron contamination during various stages of fabrication of Vessel.

The Vendor shall deliver a proper procedure for cleaning, pickling and passivation for approval. The procedure shall contain a detailed description of product used, temperatures, duration, safety requirements, etc.



WARNING:

**The test solution and contaminated water can be dangerous to personnel health.
The national regulations concerning dispose industrial dangerous refuse must be respected**

5. **INITIAL SURFACES CONDITION**

All surfaces shall be free from dust, dirt, weld slag etc.

For this purpose, only nylon brushes and stainless tools have to be used. After cleaning, the surfaces shall be washed with clean water.

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6 **OPERATING PRECAUTION**

Adequate precautions relevant to handling of the test solution shall be adopted.

Great care shall be taken in handling hydrofluoric acid, although the actual pickling solutions or pastes are relatively mild. It is essential that the manufacturer's instructions be followed implicitly as burns due to contact with acid may be apparent only after several hours.

Proper personnel protection including face shields, rubber gloves and rubber protective clothing must be provided.

Adequate ventilation and strict personnel access controls must be maintained in areas where such chemicals are being used.

7 **PICKLING**



7.1 All surfaces must be degreased before acid pickling.

Typical cleaning agents which may be used are organic solvents or paint remover (the same solvent approved for cleaning before liquid penetrant examination).

Wash surface with water to remove any residual organic solvent.

7.2 The composition of pickling/passivation solution shall be as per recommendation of ASTM A380

- PICKLE/PASSIVATION PASTES OR JELLS: These are typically proprietary mixture from a supplier and are material specific for the purpose of oxidation removal and shall contain no halogens. Thus, specific pastes should be selected for different materials and the specific manufactures directions followed. Pickling and passivation using pastes or Jells shall only be carried out on the outside of equipment, pipelines, pipes etc. Any residuals of such pastes shall be removed after cleaning by washing with copious quantities of fresh water

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- 7.3 The temperature during the pickling action shall be within 15°C to 30°C, or as per the Manufacturer's recommendation.

Typically, the lower the cleaning temperature the greater shall be the concentration of pickling agent.

- 7.4 The contact time necessary to obtain the desired surface is solution and temperature dependent, but typically between 5 to 30 minutes: Manufacturer's recommendations should be followed. To prevent over pickling, a previous test shall be made to establish the correct procedures for the specific application.

8 **RINSING**

On pickling completion, all the surfaces must be brushed with hot water. The "pH value" of final rinsing water shall be between 6 and 8 (max. Chloride level 50 ppm); manufacturer's recommendation can be followed if necessary.

Note: To minimize staining, surface must not be permitted to dry between successive steps of the pickling and rinsing procedure.

9 **DRYING**

After rinsing, all surfaces shall be dried in open air or with blower and by means of cleaned and dried clothes.





10 **EXAMINATIONS**

Complete area shall be inspected for any visible contamination using proper illumination. All the surface shall be shiny and free of scales. Weld Joint locations shall be free of oxides and any discoloration

"Spot-Testing" for iron contamination shall be performed when there are doubts on cleanliness, using a documented Feroxyl Test as per ASTM A380. Areas to be tested shall be determined by the Engineer-in charge/Appointed Inspector. Successful completion of testing shall also be approved by the Engineer-in charge/Appointed Inspector.

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STANDARD SPECIFICATION FOR POSITIVE MATERIAL IDENTIFICATION AT CONSTRUCTION SITES

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0	16.10.2019	ISSUED FOR INFORMATION	NVK	PKP	LA	JMC
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1 SCOPE

- 1.1 This specification applies to metallic alloy materials as well as carbon steel materials as defined in this document used in piping, heater coils, storage tanks, vessels etc. at construction sites. Positive Material Identification (PMI) is to be carried out on Owner supplied material as well on materials purchased by the contractor after installation (before testing). PMI may be carried out at the ware house also for identification /segregation of materials as per instruction of Engineer in Charge

Any deviation from this specification must be approved by Owner/ PMC in the prescribed format.

2 DEFINITIONS

For this specification, the following definitions are applicable:

“OWNER or IOC or IOCL or Client” shall mean INDIAN OIL CORPORATION LIMITED

“CONSULTANT or PMC” shall mean TECHNIP INDIA LIMITED.

“CONTRACTOR” shall mean the bidder selected by the OWNER for performing the scope of works specified in the bid documents.

“AUTHORISED REPRESENTATIVE” shall mean OWNER's/CONSULTANT's representative authorized to act for and on behalf of OWNER/CONSULTANT, as the case may be

“VENDOR” shall mean any third party selected by either the OWNER or CONTRACTOR for supplying any of the equipment/materials for the Unit specified in the bid documents.

“PROJECT” shall mean Sulphur Recovery Unit and Additional Tanks Project, Paradip Refinery

“UNIT” shall mean the totality of the units and facilities comprised in the Scope of work, which forms a distinct operating system.

“TPIA” shall mean Third Party Inspection Agency

Abbreviations:

API : American Petroleum Institute

ASM : American Society for Metals

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ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing and Materials
ITP	:	Inspection Test Plan
PMI	:	Positive Material Identification
RTJ	:	Ring Type Joint
TPI / TPIA	:	Third Party Inspection /Third Party Inspection Agency Carbon Steel
CS	:	Carbon Steel
AS	:	Alloy Steel
SS	:	Stainless Steel

2.1 Positive Material Identification (PMI)

The term Positive Material Identification (PMI) refers primarily for determination/ verification of alloy type or its composition using portable or mobile spectrometer/ alloy analyzer. For the purpose of this specification, some carbon steel materials as defined in clause no 3.1.9 in this document are also included for PMI checking to avoid mix up with Alloy steel during installation.

Chemical spot checking, resistivity testing, eddy current testing, electromagnetic alloy sorting, thermoelectric testing shall not be considered as PMI for this specification.

3 SPECIFIC APPLICABILITY

3.1 The following items (AS/SS from clause 3.1.1 up to 3.1.10 and CS at clause 3.1.11) require PMI unless specifically exempted through a Concession/ Deviation permit by OWNER/CONSULTANT

3.1.1 All pressure containing piping components including, thermowells instrument manifolds, RTJ gaskets, Spiral Wound gaskets other than carbon steel, fasteners etc. All valves installed on line.

3.1.2 Tubular products used in the fabrication of heaters.

3.1.3 Pressure - containing instrument housings (e.g. gauge glass housings, orifice meter tubes).

3.1.4 Internal metallic linings/cladding, and weld overlay, done at site, used for protection against corrosive environments.

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3.1.5 Tubing

3.1.6 Stud, bolts & nuts and anchors used to hold refractory materials.

3.1.7 Plates

3.1.8 All pressure containing welds.

3.1.9 Pipe supports (welded/ bolted) such as pads, saddles, dummy pipes etc.

3.1.10 Any other components or materials specifically designated for PMI on the purchase order/ contract.

3.1.11 a) Pressure containing CS piping components of rating 900# and above

b) Pressure containing CS steel piping items under Hydrogen service.

c) Pressure Containing CS Piping where substitution of hardenable alloy materials in carbon steel piping systems may result to failure and loss of containment in process services like wet hydrogen sulfide (H₂S), hydrofluoric acid (HF), sulfuric acid (H₂SO₄) services etc.

3.2 Exclusions

The following items are exempted unless specifically designated for PMI in the purchase order/contract:

3.2.1 Internal instrument parts.

3.2.2 Internal machinery parts.

3.2.3 Internal non-pressure - containing baffles, trays, tray clips, supports, pall-rings, support rings, etc.

3.2.4 Electrical components.

3.2.5 Internal valve components.

3.2.6 Compression-type ferrules and fittings for use with 3/4 inch (19mm) outside diameter and smaller tubing.

3.2.7 All carbon steel piping components (including carbon steel pipe supports) other than those

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specified at 3. 1.11

3.2.8 All carbon steel Studs/ bolts/ nuts.

3.2.9 Carbon Steel Plates.

4 REFERENCES

American Society of Mechanical Engineers (ASME) BPV Code Section-II Part A, B and C.

ASME B 31 .3

American Society for Testing and Materials (ASTM): As applicable

Material Verification Program for New and Existing Alloy Piping Systems: API RP 578 Any other material specification referenced by the Purchase Order/Contract.

Any other applicable BIS / ISO /EN / BS material Standard /Specification.

5 GENERAL REQUIREMENTS

- 5.1** The test methods outlined in this specification are intended to identify the nominal composition of alloy/ Stainless steel materials. These test methods are not intended to establish the conformance of a material to a particular specification.
- 5.2** PMI shall not be considered as a substitute for required mill test reports listing chemical composition. In addition, mill test reports shall not be considered as confirming alloy/ composition verification.
- 5.3** The PMI activity shall be included in the overall quality plan and Inspection & Test Plan for fabrication/ erection. The contractor shall submit to OWNER/CONSULTANT, a procedure for PMI to comply with the requirements of this specification. Approval of PMI procedure shall be obtained from OWNER/CONSULTANT prior to commencement of fabrication/ erection as the case may be.
- 5.4** Contractor shall engage reputed TPIA specified in the contract to witness inspection at site and accordingly submit ITP for review of owner/ PMC. In case list of approved TPIA is not available in contract, prior approval shall be taken before engagement of TPIA.
- 5.5** A copy of PMI records duly verified by TPIA shall be submitted to Owner/PMC .

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5.6 After installation, but prior to hydrostatic testing/painting/insulation, the contractor shall examine all components requiring PMI for proper compliance to this specification. A record of this final check duly endorsed by TPIA, as specified below, shall be submitted to OWNER/CONSULTANT and made part of the permanent inspection records.

5.7 Owner Supplied Material If any

Records signed by contractor and duly verified by TPIA (engaged by contractor)/ and reviewed by OWNER/CONSULTANT shall be generated as part of the receiving inspection at warehouse.

5.8 Contractor Supplied Material

Records signed by contractor and certified by an approved TPIA and reviewed by OWNER/CONSULTANT.

5.9 After acceptance, all components shall be marked with a suitable and readily visible paint mark. These markings are in addition to markings/color coding required by other codes/specifications/Technical Notes.

5.10 Controls shall be established to keep the non-conforming items identified till proper resolution of non-conformity.

5.11 OWNER/CONSULTANT shall have the right to witness the performance of any PMI test.

6 EXTENT OF PMI

6.1 PMI shall be done on each component (100 percent PMI inspection) including welds (Except carbon steel Piping welds), unless specifically exempted by OWNER/CONSULTANT.

6.2 PMI shall be done on pipe supports (welded/ bolted) such as pads, saddles, dummy pipes etc. (100 percent PMI inspection) in all piping systems of alloy material.

6.3 PMI shall be done on all bolts and nuts (100 percent PMI inspection) of flange joints in all piping systems of alloy material.

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7 PMI OF PIPING AND HEATER COIL COMPONENTS

PMI testing (irrespective of PMI done at earlier stages) shall be carried out when piping loops/ heater coils have been cleared for hydrostatic testing by OWNER/CONSULTANT. Hydrostatic Testing shall be carried out only when non- conforming components have been replaced with conforming components and subsequent Non- Destructive Testing, Post Weld Heat-Treatment, Hardness checking and re- verification by PMI etc., as required by specifications have been completed. PMI records shall form a part of piping /heater inspection records. Contractor shall demonstrate to PMC that each & every component of the piping system and heater coils has been subjected to PMI by providing line wise records of PMI duly endorsed by TPIA.

8 TESTING METHODOLOGY

- 8.1 The method used for PMI examination shall provide a quantitative determination of the alloying elements like chromium, nickel, molybdenum or vanadium in alloy steel items for the characteristic elements specified in clause 9.0
- 8.2 Instruments or methods used for PMI examination shall be able to provide quantitative, recordable, elemental composition results for positive identification of elements.
- 8.3 The acceptable instruments for alloy analyzer shall be either "portable X-ray Fluorescence" or optical Emission type each capable of verifying the percentage of elements within specified range. The instruments must have the printout facility and sensitivity to detect the elements in the specified range.
- 8.4 Chemical spot testing, magnets, alloy sorters and other methods using eddy current or triboelectric testing methods are not acceptable for PMI examination.
- 8.5 All PMI instruments shall have been serviced within a 6 month period of the time of use to verify the suitability of batteries, sources, etc, and the date of the last service shall be stated on the PMI report form.
- 8.6 The surfaces to be examined shall be prepared and cleaned by suitable means before PMI so that surface be free from grease, oil, paint or oxides. Testing shall be done after proper surface cleaning and other requirements as outlined by the manufacturer of the portable alloy analyzer. Modification, if any, of these procedures must be approved by OWNER/CONSULTANT.
- 8.7 Ring type joint gaskets shall be inspected by using portable X-ray fluorescence instrument.

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9 CHARACTERISTIC ELEMENTS

ALLOY	Cr	Ni	Mo	Cb	Ti	Cu	Al	C	Co	W	Fe
1¼ Cr - ½ Mo	x		x								
2¼ Cr -1 Mo	x		x								
5 Cr - ½ Mo	x		x								
9 Cr - 1 Mo	x		x								
304	x	x									
304L	x	x						x*			
304H	x	x						x*			
310	x	x									
316	x	x	x								
316L	x	x	x					x*			
317	x	x	x								
317L	x	x	x					x*			
321	x	x			x			x*			
321H	x	x			x			x*			
347	x	x		x				x*			
347 H	x	x		x							
405	x				x		x				
410	x				x						
410S	x				x			x*			
430	x				x						
Alloy 20	x	x	x	x		x					
Hast C-276	x	x	x							x	
Alloy 600	x	x									
Alloy 601	x	x					x				
Alloy 625	x	x	x	x							
Alloy 800/800H	x	x				x		x*			
Alloy 825	x	x	x		x						
Monel 400		x				x					
9 Ni/3.5 Ni		x									
70/30 CuNi		x				x					
90/10 CuNi		x				x					
Duplex Stainless steel	x	x	x								

*Testing of C is only required when in the Plant exists the same type of material but with L/H carbon content

- 9.1** Carbon Steel materials under clause no 3.1.11 shall be checked to confirm that no mix up has taken place with alloy steel Components.
- 9.2** Characteristic elements for materials not listed above shall be proposed by the Contractor for approval of the OWNER/CONSULTANT

10 CALIBRATION

- 10.1** Instruments used for PMI shall have the sensitivity to detect the alloying elements in the specified

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ranges. Instruments or methods used for examination shall be of the type that will provide quantitative, recordable, elemental composition results for positive identification of the alloy elements present.

- 10.2** Each alloy analyzer shall be calibrated using known alloy standards for intended materials to be checked by PMI. A calibration certification from the Manufacturer or his authorized agency shall be submitted to OWNER/CONSULTANT for records.
- 10.3** PMC/ Owner shall review the procedure and qualification and witness sample alloy/ carbon steel materials verification tests to confirm that the procedures, equipment and personnel are capable of providing consistent and accurate results. Certified samples, with full traceability, of a known alloy materials/ carbon steel materials shall be available for use as a random spot checking on instrument calibration.

11 SITE VERIFICATION OF ANALYZER

Verification using Standard samples supplied by institutes such as ASM (American Society of Metals) for the intended materials type and grade shall be performed each day before using the analyzer. Such verification shall be done again if PMI test is to be performed on different grade or type of material.

12 PERSONNEL QUALIFICATION

The persons performing the PMI test should be knowledgeable about properties of material, all aspects of operation of PMI equipment including the method of testing. Qualification/ experience documents of the person performing the PMI test including his training and experience shall be submitted to OWNER/CONSULTANT for review and approval.

13 ACCEPTANCE CRITERIA

13.1 Base Metal

PMI test results showing presence of characteristic elements up to 8% less than the minimum specified value in the material specification and up to 8% more than the maximum specified value in the material specification shall be acceptable.

13.2 Deposited Weld Metal

For deposited weld metal between base metals of the same specification using matching consumables, the recorded presence of characteristic elements up to 12% less than the minimum

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specified value in the welding consumables specification and up to 12% more than the maximum specified value in the welding consumable specification shall be acceptable.

14 REJECTION CRITERIA

- 14.1** If the PMI test results fall outside the acceptable range as given in 13.0 above, the contractor shall obtain a quantitative check analysis performed by a laboratory acceptable to OWNER/CONSULTANT for a complete chemical analysis. Results of this analysis shall be submitted to OWNER/CONSULTANT, with contractor's recommendation, for final decision.

Decision of OWNER/CONSULTANT shall be final in this regard.

If any material component or weld is found unacceptable, all other represented materials (e.g. in case of fasteners, supports) or welds shall be considered suspect. In such cases, the contractor has the following options:

- 14.2.1** Scrapping all those represented materials or components and replacing with new components or welds.
- 14.2.2** Performing 100% examination of the remainder of the represented materials/ components and replacing each item that fails the PMI check.
- 14.2.3** If the performance of any verification activity is unacceptable to OWNER/CONSULTANT or if any material has been incorrectly identified, continuation of all further tests shall be subject to approval of OWNER/CONSULTANT until the problem is corrected.

15 DOCUMENTATION

- 15.1** PMI report duly verified by PMI agency and Inspection Representative of LSTK Contractor.
- 15.2** PMI report as per format no QC-21 (Attached)
- 15.3** Basis and action for resolving and documenting PMI non-conformances.
- 15.4** Contractor shall demonstrate to OWNER/CONSULTANT that all components requiring PMI have been subjected to PMI testing and accepted.

		PROJECT:												
		COMPANY:												
QUALITY CONTROL FORM QC 21		PROJ. No.:	SH. 1 OF__											
POSITIVE MATERIAL IDENTIFICATION REPORT		CONTRACTOR:												
PMI CARRIED OUT: SHOP FIELD BEFORE INSTALLATION AFTER INSTALLATION														
EQUIPMENT: ITEM DESCRIPTION														
PIPING COMPONENT: SUPPLIER:														
MR/PO: REV:														
LINE/DRAWING Nr: PIPING SUPPORT:														
FILLER METAL: Ø AWS:														
ALLOY ELEMENTS TO BE CHECKED:														
{ PMI EQUIPMENT: ANALYTICAL LABORATORY METHODS:														
CALIBRATION:	YES	<input type="checkbox"/>	NO <input type="checkbox"/>											
SAMPLING:	10%	<input type="checkbox"/>	100% <input type="checkbox"/> % <input type="checkbox"/>											
ITEM TO BE TESTED	IDENT CODE	ALLOY ELEMENTS												DATE & INITIALS
		Cr	Ni	Mo	Cb/Nb	Ti	V	Cu	Al	C	Co	W	FE	
TEST RESULT:		ACCEPTABLE <input type="checkbox"/>		REMARKS:										
		NOT ACCEPTABLE <input type="checkbox"/>												
INSPECTORS		CONTRACTOR		TECHNIP		OWNER								
NAME														
SIGNATURE														
DATE														



COMPANY:

QC 21

SH. 2 OF

CONTRACTOR:

[illegible]

TEST RESULT: ACCEPTABLE ☐

NOT ACCEPTABLE ☐

REMARKS:

INSPECTORS	CONTRACTOR	TECHNIP	OWNER	
NAME				
SIGNATURE				
DATE				

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WELDING & NDE SPECIFICATION FOR FABRICATION OF PIPING

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3	10.03.2020	ISSUED FOR IMPLEMENTATION	TB	GM	GM	JMC
2	04.12.2019	ISSUED FOR IMPLEMENTATION	TB	GM	LA	JMC
1	8.11.2019	ISSUED FOR IMPLEMENTATION	NVK	PKP	LA	JMC
0	16-10-2019	ISSUED FOR INFORMATION	NVK	PKP	LA	JMC

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1. GENERAL

This specification shall be followed for the fabrication of all types to welded joints of piping system within the battery limits of the plant.

The welded pipe joints shall include the following:

- All pipe joints, longitudinal butt welds, circumferential butt welds and socket welds.
- Attachments of forgings, flanges and other supports to pipes.
- Welded manifold headers and other sub-assemblies.
- Welded branch connections with or without reinforcing pads.
- Joints in welded/fabricated piping components.
- The attachments of smaller connections for vents, drain drips and other instrument tapings.

Any approval granted by the Engineer-in-Charge or Owner /PMC's inspector, shall not relieve the CONTRACTOR / VENDOR of his responsibilities and guarantee.

This specification shall not be applicable for welding of pipelines for transportation of liquid petroleum, gas and other similar products in on shore and off shore.

2. ABBREVIATIONS & DEFINITIONS:

“OWNER or IOCL” shall mean INDIAN OIL CORPORATION LIMITED

“CONSULTANT or PMC” shall mean TECHNIP INDIA LIMITED

“CONTRACTOR” shall mean the bidder selected by the OWNER for performing the scope of works specified in the tender documents.

“AUTHORISED REPRESENTATIVE” shall mean OWNER's/ CONSULTANT's representative authorized to act for and on behalf of OWNER/ CONSULTANT, as the case may be

“VENDOR” shall mean any third party supplying any of the equipment/materials for setting up the Plant.

“PROJECT” shall mean Sulphur Recovery Unit and Additional tanks Project, Paradip Refinery

“PLANT” shall mean the units and facilities comprised in the project, and if divided into different packages for the award of Contracts.

“UNIT” shall mean a particular process unit etc. which forms a distinct operating system and a part of the plant.

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“Sub- Contractor” shall mean Sub-Contractor engaged by Contractor

3. APPLICABLE CODES & STANDARDS

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 following accepted standards and procedures unless otherwise specified in the Welding Specification Chart and the Technical Notes attached thereof. In the case of conflicting requirements, the requirements mentioned in Welding Specification Chart/Technical Notes shall be applicable.

- a. ASME Code for Pressure Piping ASME B31.3
- b. ASME Code for Power Piping- ASME B31.1
- c. ASME Boiler & Pressure Vessel Code, Sec II Part C, Materials specifications: Welding Rods, Electrodes and Filler metals.
- d. ASME Boiler & Pressure Vessel Code, Section V, Non-destructive examination
- e. ASME Boiler & Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels.
- f. ASME Boiler & Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
- g. The Indian Boiler Regulations I.B.R.
- h. API 582 - Welding Guidelines for the Chemical, Oil and Gas Industries
- i. ASNT- SNT-TC-1A- Recommended Practice for Nondestructive Testing
- j. ASTM A833- Indentation Hardness of Metallic Materials by Comparison Hardness Testers
- k. ASTM E110- Standard Test Method for Indentation Hardness of Metallic Materials by Portable Hardness Testers.
- l. ASTM E140- Standard Hardness Conversion Tables for Metals
- m. NACE MR0103 - Petroleum, petrochemical and natural gas industries -- Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments
- n. NACE SP0472 - Methods and Controls to Prevent In-Service Environmental Cracking of Carbon Steel Weldments in Corrosive Petroleum Refining Environments.

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o. AWS A4.2 - Standard Procedures for Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic and Duplex Ferritic-Austenitic Stainless Steel Weld Metal

p. Licensers specifications.

In the event of any differences due to the additional requirements mentioned in this specification, over and above those obligatory as per codes, this specification shall be binding.

4. ORDER OF PRECEDENCE

4.1 In case of conflict between documents, the following order of precedence shall govern:

- Mandatory local regulations and requirements
- Licensor's specifications
- Purchase order, Scope of work and material requisitions, Data sheets
- Project specifications
- Applicable codes and standards

4.2 All exceptions/conflicts to the specifications and purchase specifications, codes, forms and drawings shall be brought to the attention of PMC/Owner in writing and shall requires prior approval before any action is taken by the CONTRACTOR / VENDOR, until a written resolution is issued, most stringent requirements shall apply

5. WELDING PROCEDURE SPECIFICATION (WPS) and PROCEDURE QUALIFICATION RECORD (PQR)

5.1 Welding Procedure Specifications (WPS) and their Procedure Qualification Records (PQR) shall conform to the requirements of ASME Section IX, Licensers requirements and to the requirements of this specification.

5.2 Each WPS shall be identified by a unique number and shall make reference to the applicable piping classes.

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5.3 WPS forms provided by CONTRACTOR / VENDOR shall have complete welding data defines in ASME IX forms QW- 482, and following information are included:

- a. Welding process or processes when more than one is used in making a complete joint.
- b. Parent metal specification and thickness.
- c. Whether shop or field welding.
- d. Joint preparation (sketch).
- e. Cleaning, degreasing, etc.
- f. Welding position (including direction for vertical position).
- g. Brand name, AWS classification and size (diameter) of welding consumables.
- h. Pre-heating and inter pass temperature, including method and control.
- i. Travel speed (automatic welding).
- j. Approximate number and arrangement of runs and weld dimensions (sketch).
- k. Welding sequence.
- l. Back gouging if applicable
- m. Gases, /Shielding/backing to include composition and flow rate.
- n. P.W.H.T. requirements including the detailed cycle of heat treatment, heating rate cooling rate, holding time and temperature.
- o. When welding quenched and tempered steels, steel requiring impact testing, or alloy steels requiring ferrite control, the heat input in conjunction with the maximum inter pass temperatures shall be restricted to the maximum values shown in the supporting PQR. Heat input values shall be specified on WPS and recorded on PQR.
- p. Heat input in Joules / cm =
$$\frac{\text{Amperage} \times \text{Voltage} \times 60}{\text{Travel speed in cm/min}}$$

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5.4 Special requirement for CS with PWHT

Welding Procedure Specification WPS for CS material with PWHT shall include PWHT regardless of construction code requirement. PWHT temperature shall not be less than 620°C (1150°F) and minimum 10 °C preheat temperature should be used for all welding & requires a hardness survey on preproduction welded coupons to be conducted. Test indentations should be taken on the weld deposit, Heat Affected Zone (HAZ) and base metal, in the cap and root of the weld. Welding Procedure Qualification Record (PQR) shall be documented with hardness survey.

Hardness should be limited to the following after PWHT:

- Base metal: 237HBW (22HRC)
- Weld deposit: 200HBW
- Heat Affected Zone: 200 HBW

5.5 Ferrite

When required in paragraph 7.10 of this specification, ferrite content shall be checked and determined by chemical analysis making reference to WRC (Welding Research Council) diagram or by measurement with calibrated magnetic instruments as per AWS A 4.2 or ISO 8249.

6. BASE METAL

In general, use of carbon steel, alloy steel and stainless steel is envisaged. The details of the material specifications are given in the Welding Specification Chart.

The CONTRACTOR / VENDOR shall provide the manufacturer's test certificates for every heat of the materials supplied by him.

7. WELDING CONSUMABLES

7.1 The CONTRACTOR / VENDOR shall provide, at his own expense, all the welding consumables necessary for the execution of the job such as electrodes, filler wires, argon etc. and these should bear the approval of the Engineer-in-Charge.

7.2 The welding electrodes and filler wires supplied by the CONTRACTOR/ VENDOR shall conform to the class specified in the Welding Specification Chart & as per licensors requirement. The materials shall be of the make approved by the Engineer-in-Charge. It

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shall record the minimum test results required for classification of welding consumable as per ASME Section II-part C.

- 7.3 **CONTRACTOR / VENDOR shall submit the list of welding consumable manufacturers for PMC/Client approval. Only PMC/Client approved welding consumable manufacturers shall be used during the entire course of Site construction activities.**
- 7.4 **The CONTRACTOR / VENDOR shall submit batch test certificates, from the electrode manufacturers, giving details of physical and chemical tests carried out by them, for each batch of electrodes to be used.**
- 7.5 All electrodes shall be purchased in sealed containers and stored properly to prevent deterioration. The electrodes removed from the containers shall be kept in baking ovens at temperatures recommended by the electrode manufacturer. "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.
- 7.6 In order to have the control over welding consumables, CONTRACTOR / VENDOR shall have proper system for issue and return of unused electrodes, batch test certificates for the welding consumable, baking time and temperature control, control of relative humidity, avoid mix-up through the use of proper documentation. CONTRACTOR / VENDOR shall ensure that drying oven and portable oven are in working condition and the meters/gauges used are in properly calibrated condition.
- 7.7 **All low hydrogen type of electrodes and others, shall be baked as per manufacturers recommendation and stored in holding ovens at temperature recommended by the manufacturer.**
- 7.8 The electrodes, filler wires and flux used shall be free from rust, oil, grease, earth and other foreign matter which affect the quality of welding.
- 7.9 Tungsten electrodes used shall conform to ASME Sec.II C SFA 5.12 specification. **Thoriated Tungsten electrodes shall not be permitted due to possible radiation hazard. Instead, ceriated Tungsten Electrodes (EWCe-2 or equivalent) shall be used for GTA Welding.**
- 7.10 **Electrodes and/or filler metals shall be selected such as:**
- Strength of deposited weld metal is at least equal to the specified minimum mechanical properties of the materials being welded.

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- Chemical composition of the principal elements in deposited weld metal shall match as closely as possible to the nominal composition of the base metal.
- However, this shall not preclude the use of welding materials containing alloying elements of different types or in different amounts than those in the base materials provided there is no evidence that such elements are not harmful or are beneficial from standpoint of achieving desirable weld metal properties, such as adequate tensile strength after post weld heat treatment or adequate impact toughness at low temperatures.
- For weld procedures requiring impact testing, the brand name of welding consumables (electrodes, rods, wire, flux cored, flux) shall be the same as used in the welding procedure qualification test.
- Carbon and low alloy steel electrodes/bare wire that have a non-specific chemistry as indicated by a "G" classification suffix (i.e. EXXXX-G, ERXXX-G, EG, or EXXXTX-G) shall not be assumed acceptable and shall require CONTRACTOR approval. Any authorization shall imply welding procedure qualifications batch wise.
- Contractor has to select the welding electrode Vendors as per "List of approved Welding electrodes for IOCL Refineries" - Attached as Annexure-A

Carbon / Low alloy /Ferritic steels

When using the shielded metal arc welding and process, only **low hydrogen** electrodes shall be used for all pressure retaining welds or attachments to pressure boundaries

Chemistry restriction as per Table 2 of NACE SP0472 & Licenser requirements shall be applied for NACE services.

Austenitic Stainless Steel

Filler metals shall be selected to produce weld deposits that fall within the ferrite number (FN) range of 4 to 8 as determined by the WRC (Welding Research Council) diagram which is included in AWS A-5.4.

When using 300 "H Grade" materials, high carbon electrodes /wires with 0.040 to 0.08% Carbon shall be used.

Type 321 stainless steel shall be joined with Type 347 weld consumables.

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Austenitic/Ferritic Stainless Steel (DUPLEX)

Filler metal shall be selected to produce weld deposits that fall within the ferrite range of 30 to 65. Welding Procedure Qualification shall include Ferrite measurements as defined in paragraph 5.5

7.11 Consumable Storage

Welding consumables shall be stored with care, under dry conditions in their original unopened packing. After opening shipping containers of electrodes, fluxes and other welding materials, storage and handling shall be as specified in the Manufacturer's recommendations and ASME Section II, Part C.

No electrodes, filler wires or fluxes that are damaged, damp, greasy or oxidized may be used.

CONTRACTOR / VENDOR facilities shall include a temperature and humidity controlled welding consumable and flux store, including holding and drying ovens.

Low hydrogen electrodes and fluxes shall be dried at 250°C/300 °C for two hours prior to use, unless otherwise recommended by the electrodes manufacturer. Welding electrodes shall then be stored in ovens at a minimum temperature of 120 °C.

When issued for production they shall be placed in heated quivers capable of maintaining a minimum temperature of 70 °C.

Above drying conditions do not apply to electrodes supplied in vacuum conditioning boxes.

Carbon steel and 0.3-0.5% Mo low hydrogen electrodes shall be used within 8 hours when stored in quivers. Low hydrogen Cr-Mo steel electrodes shall be used within four hours when stored in quivers. Electrodes stored in quivers, but not used within the specified time, shall be restored in ovens. No electrodes shall be left lying about the site or in the shop. Electrodes so left shall be scrapped.

Submerged arc flux shall be clearly identified in moisture-proof containers and shall be stored in a dry location at a temperature above 20°C. Submerged arc, gas metal arc and flux-cored wire shall be clearly identified and shall be stored in a dry location at a temperature above 20°C. The identification shall state manufacturer, grade and batch number. Unidentifiable wire shall not be used.

Submerged arc, gas metal arc and flux-cored arc consumables shall be withdrawn from storage only when required for immediate use. Unused consumables shall be returned to storage on completion of the welding operation. Batch numbers shall be recorded on

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issue

Submerged arc flux may be recycled but shall be free from fused flux, mill scale, dirt or other foreign matter. Before reuse, the flux shall be rebaked in accordance with the manufacturer's instructions.

All electrodes which have been in direct contact with water shall be definitely rejected.

CONTRACTOR / VENDOR shall submit his procedure for the storage and handling of electrodes, filler metals and fluxes to Owner /PMC for review prior to the start of fabrication. The procedure shall include moisture, cleanliness and identification controls.

8. SHIELDING & PURGING GAS

Argon gas used in GTA welding for shielding purposes shall be 99.995% pure. The purity of the gas shall be certified by the manufacturer. The rate of flow for shielding purposes shall be established through procedure qualification tests.

Argon gas with a purity level of 99.995% shall be used for purging.

When GTAW process alone or a combination of GTAW and SMAW processes is recommended for the production of a particular joint, the purging shall be maintained during the root pass and for the first filling pass (SMAW) to minimize oxidation on the inner side of the pipe, unless otherwise specified in Welding Specification Chart.

Initial purging shall be maintained for sufficient period of time so that at least 4-5 times the volume between the dams is displaced, in order to completely remove the entrapped air. In no case should the initial purging period be less than 10 minutes. High gas pressure should be avoided.

After initial purging, the flow of the backing gas should be reduced to a point where only a slight positive pressure prevails. For systems, which have a small volume (up to 1/2 cubic foot) to be purged, a gas flow rate of 6-CFH may adequate. Systems of larger volume may require higher flow rates and these should be established during procedure qualification tests.

Gas backing (purging) is not required for socket type of welded joints.

Dams, used for conserving inert gas during purging, shall be removed after completion of the welding, and shall be accounted for. Wherever, removal of dams is not possible after welding, use of water-soluble dams should be made.

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9. EQUIPMENTS & ACCESSORIES

The CONTRACTOR / VENDOR shall arrange sufficient number of welding & cutting equipment, and accessories of sufficient capacities so as to meet the target /schedule.

All the equipment for performing the heat treatment, including transformers, thermocouples, pyro-meters, automatic temperature recorders (with suitable calibration arrangement etc.) shall be provided by the CONTRACTOR / VENDOR at his own expenses.

CONTRACTOR / VENDOR shall make necessary arrangements at his own expense, for providing the radiographic equipment, radiographic films, processing equipment all other darkroom facilities, pit room and all the equipment/materials required for carrying out the dye-penetrant /magnetic particle test/ultrasonic testing for satisfactory and timely completion of the job.

Redoing of any work, necessitated by faulty equipment or operation used by the CONTRACTOR / VENDOR, will be done at his own expense.

10. WELDING PROCESS

10.1 General

Welding of various materials under this specification shall be carried out using one or more of the following processes with the approval of the Engineer-in-Charge.

- Shielded Metal Arc Welding Process (SMAW).
- Gas Tungsten Arc Welding Process (GTAW)

In addition to SMAW >AW welding of various materials under this specification may be carried out using one or more of the following process with approval of Engineering -in-charge.

- Gas Metal Arc Welding (GMAW)
- Flux Cored Arc Welding (FCAW)
- Submerged Arc Welding (SAW)

The welding processes to be employed are given in the Welding Specification Chart. Any deviation desired by the CONTRACTOR / VENDOR shall be obtained through the express consent of the Engineer-in-Charge.

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Automatic and semi-automatic welding processes shall be employed only with the express approval of the Engineer-in-Charge. The welding procedure adopted and consumables used shall be specifically approved.

The welding processes could be employed for a particular joint only after duly qualifying the welding procedure to be adopted and obtaining the approval of Engineer-in-Charge.

10.2 Requirement for specific welding process

10.2.1 Flux Cored Arc Welding (FCAW)

Application of FCAW process on piping retaining pressure welds shall not be assumed acceptable by the CONTRACTOR / VENDOR during bid preparation and would require Owner /PMC prior approval.

Flux cored welding shall not be used for wet H₂S services

Flux cored arc welding shall not be used if MDMT is lower than -29°C

Flux Cored Arc Welding (FCAW) may be used for piping prefabrication of carbon steel of rating up to 600Lbs provided that following conditions are fulfilled:

- CONTRACTOR / VENDOR can provide evidence of successful previous experience (minimum 5 years) with this process.
- The flux-cored arc welding process is combined with an external shielding gas.
- FCAW shall be used in the globular/spray transfer modes only.
- T-2 & T-5 type wires shall not be used for vertical-up welding.
- Consumable manufacturer and trade name shall be considered essential variables.
- Welding is carried at prefabrication using automatic /semi-automatic machine equipment.

Flux cored arc welding procedures shall be requalified whenever a change is made in filler metal from one manufacturer to another or to a different brand or type from the same manufacturer.

10.2.2 Submerged Arc Welding Process (SAW)

Solid wires for automatic-welding processes shall contain the principal elements required for the deposited weld metal.

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Both fused and bonded fluxes are acceptable. Only neutral fluxes shall be used

Fluxes that the flux Manufacturer recommends for single pass welds shall not be used for multiple pass welds. Active fluxes are not permitted as defined by ASME section II, Part C SFA 5.17 or 5.23.

The brand name and grade of flux and wire used for production of submerged arc welds shall be the same as used in the relevant procedure qualification test.

Welding procedures for submerged arc welding shall be requalified whenever the welding flux or wire is changed from one manufacturer to another or from one grade to another grade from the same manufacturer. Equivalence under ASME section II, Part C shall not be considered adequate for substitution without requalification.

Both fused and bonded fluxes are acceptable. Only neutral fluxes shall be used

10.2.3 Tungsten Arc Welding (GTAW)

Single sided groove welds in P-No.3 and greater materials shall have the root pass made with the GTAW process.

GTAW process shall be used to deposit the root pass in butt welds of NPS 2 and smaller, and for root pass of socket welds NPS 1 and smaller.

The use of consumable inserts shall be subject to Owner /PMC prior approval.

Backing gas purging procedure shall be submitted to Owner/PMC for approval

CONTRACTOR / VENDOR shall submit to the acceptance of Owner/PMC a "Purging procedure" detailing the method of back purging, and associated inspection procedure to be implemented during piping pre-fabrication and field welding including final closing welds and local repairs.

Argon backing gas is required for Base Material P-No.4 and greater.

The use of nitrogen as backing gas for stainless steels shall not allowed.

10.2.4 Shielded Metal Arc Welding (SMAW)

When using low hydrogen electrodes, only uphill progression shall be allowed.

10.2.5 Gas Metal Arc Welding (GMAW)

The use of GMAW shall not be allowed on ferrous piping retaining pressure even on root pass.

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GMAW procedures utilizing the “short circuiting” metal transfer mode shall be limited to groove, fillet, and structural welds in materials 3/8 inch (10mm) maximum thickness. GMAW in the short-circuiting transfer mode may be used for tack welds, temporary attachments or other applications where the weld metal is completely removed. GMAW process shall not be used for socket welds.

11. EDGE PREPARATION

11.1 General

Weld joint preparation details shall be in accordance with ASME B 31.3 Figures 328.4.2 to 4.4 and Figures 328.5 or ASME B 31.1 as applicable.

The edges to be welded shall be prepared to meet the joint design requirements by any of the following methods recommended:

Carbon Steel

Gas cutting, machining or grinding methods shall be used. After gas cutting, oxides shall be removed by chipping or grinding.

Low Alloy Steels (containing up to 5% Chromium):

Gas cutting, machining or grinding methods shall be used. After gas cutting, machining or grinding shall be carried out on the cut surface.

High alloy steel (> 5% Chromium) and stainless steels, nickel alloys:

Plasma cutting, machining or grinding methods shall be used. After plasma cutting, cut surfaces shall be machined or ground smooth.

Permanent backing rings and consumable inserts shall not be used unless specifically approved by Owner/PMC

Branch connection joints shall be prepared so as to permit full penetration welds of a quality comparable to the circumferential welds in the same piping system. When making the opening on the run by plasma arc-cut, care shall be taken for the internal cleanliness of run pipe. For stainless steel piping, internal protection shall be required during plasma-arc cutting of branch opening from arc spatter, slags, etc.

Grinding discs containing sulphur (iron sulphate) or other harmful components shall not be used on stainless steels, 9% nickel steel or non-ferrous materials.

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11.2 Cleaning

The ends to be welded shall be properly cleaned to remove paint, oil, grease, rust, oxides, sand, earth and other foreign matter. The ends shall be completely dry before the welding commences.

On completion of each run, craters, welding irregularities, slag etc., shall be removed by grinding and chiseling. Wire brushes used for cleaning stainless steel joints shall have stainless steel wires and the grinding wheels used for grinding stainless steel shall be of a suitable type. Separate grinding wheels and wire brushes should be used for carbon steels and stainless steels.

12 ALIGNMENT & 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.

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13. WEATHER CONDITIONS

The parts being welded and the welding personnel should be adequately protected from rain and strong winds. In the absence of such a protection no welding shall be carried out.

During field welding using GTAW process, particular care shall be exercised to prevent any air current affecting the welding process.

14. WELDING TECHNIQUE

14.1 Root Pass

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 S WG) but in any case, not greater than 3.25 mm (10 S WG).

Upward technique shall be adopted for welding pipe held fixed with its axis horizontal.

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.

Any deviation desired from the recommended welding technique and electrodes indicated in the welding specification chart should be adopted only after obtaining express approval of the Engineer-in-Charge.

Welding shall be uninterrupted.

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.

Peening shall not be used.

A gap of 1.5mm shall be maintained on socket weld.

No welding shall be carried out when the parts to be welded are wet.

Where possible, butt welds may be made from both sides, in accordance with approved welding procedures. In that case, the back side of the root pass shall be ground or gouged to sound metal before welding on that side.

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Welding shall not be stopped before the second pass is completed, and until the thickness of the weld is at least equal to one third of the pipe wall thickness & follow the Clause 330.2.2 of ASME B31.3 & 131.6 of ASME B31.1 in case of Welding interruption.

14.2 Joint Completion

Joint shall be completed using the class of electrodes, recommended in the Welding Specification Chart. Size of the electrode shall not exceed 4 mm in diameter for stainless steels and alloy steels used for low temperature applications.

Two weld beads shall not be started at the same point in different layers.

Butt joints shall be completed with a cover layer that would affect good fusion at the joint edges and a gradual notch free surface.

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.

Rust preventive/protective painting shall be done after the weld joint has been approved.

14.3 Dissimilar Welds

Where welds are to be produced between carbon steels and alloy steels, preheat and post weld heat treatment requirements shall be those specified for corresponding alloy steels and filler wire/electrodes shall correspond to ER 70 S-G or AWS E-7016/7018 type. For welds between two dissimilar Cr-Mo low alloy steels, preheat and post weld heat treatments shall be those specified for higher alloy steel and electrodes used shall correspond to those specified for steel of lower alloy content. For carbon steel or alloy steel to stainless welds, use of filler wire/electrodes E/ER-309/E-310/ENiCrFe-3/ENiCrMo-3 shall be made. The welding procedure, electrodes/filler wires to be used shall be approved by the Engineer-in-Charge.

Dissimilar metal welding shall be avoided in wet sour service

15 HEAT TREATMENT

15.1 Preheating

Preheating temperature shall be in accordance with the applicable requirements or recommendations of section 330 of ASME B31.3 and licensors documents.

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No welding shall be performed without preheating the joint to 10°C (50°F) when the ambient temperature is below 10 degree.

Preheating requirements for the various materials shall be as per the Welding Specification Chart attached.

Preheating shall be performed using resistance or induction heating methods. Preheating by gas burners, utilizing oxy-acetylene or oxy-propane gas mixtures, with neutral flame may also be carried when permitted by the Engineer-in-Charge.

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.

Preheating temperature shall be maintained over the whole length of the joint during welding. Temperature recorders shall be provided by the CONTRACTOR / VENDOR to record the temperature.

Minimum and Maximum interpass temperature limits shall be in accordance with the approved WPS.

15.2 Post Heating

In case of alloy steel materials such as Cr-Mo steels, if the post weld heat treatment is not performed immediately after welding, the weld joint and adjacent portion of pipe, at least 50 mm on either side of weld, shall be uniformly heated to 300°C. This temperature shall be maintained for half an hour minimum, and then wrapped with mineral wool before allowing it to cool to room temperature. If the Post Heating temperature specified in the Welding Specification Charts exceeds 300°C, the same shall be followed. Similarly, if the welding specification chart specifies post-heat time, the same shall be applicable. Post weld heat treatment as specified in the Welding Specification Chart shall be carried out later on.

15.3 Post Weld Heat Treatment (PWHT)

PWHT shall be in accordance with the requirements of ASME B 31.3 or ASME B 31.1 as applicable & as per licensor requirement and Welding Specification Chart. During PWHT, the metal temperature shall be maintained within the specified temperature ranges and for the minimum holding times specified.

Post weld heat treatment, wherever required for joints between pipes, pipes and fittings, pipe body and supports shall be carried out as per the welding specification chart, applicable codes standards and the instructions of the Engineer-in-Charge. In this regard procedure qualification to be done before carrying out PWHT in production welds

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The CONTRACTOR / VENDOR shall submit for the approval of the Engineer-in-Charge, well before carrying out actual heat treatment, 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.

Post weld heat treatment shall be done in a furnace or by using an electric resistance or induction-heating equipment, as decided by the Engineer-in-Charge.

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 attained is at least that specified in the relevant applicable standards/codes. Control of temperature shall be done using microprocessor/computer controlled system. The desired time-temperature cycle shall be entered into the microprocessor/computer.

Throughout the cycle of heat treatment, the portion outside the heated 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 should not be allowed to exceed 50% of the peak temperature.

The temperature attained by the portion under heat treatment shall be recorded by means of thermocouple pyrometers. Adequate number of thermocouples should be attached to the pipe directly at equally spaced location along the periphery of the pipe joint. The minimum number of thermocouples attached per joint shall be 1 up to 2" dia., 2 up to 10" dia. and 3 for 20" dia, 4 for pipe diameter above 20 and above. However, the Engineer-in-Charge can increase the required number of thermocouples to be attached if found necessary.

Automatic temperature recorders, which have been suitably calibrated, shall be employed for measuring & recording temperature. Both, the actual time-temperature graph and the designed time temperature graph shall be available on every chart. The time-temp graph shall be submitted to Engineer-in-Charge immediately on completion of Stress Relieving Cycle

The calibration record of each recorder should be submitted to the Engineer-in-Charge prior to starting the heat treatment operations and his approval should be obtained.

Manufacturer's test certificate shall be submitted for the thermocouples materials and record shall be maintained by the CONTRACTOR / VENDOR.

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Immediately on completion of the Heat Treatment, the Post Weld Heat Treatment charts/records along with the hardness test results on the weld points, wherever required as per the Welding Specification Chart, shall be submitted to Engineer-in- Charge for his approval.

Each weld joint shall bear a unique identification number, which shall be maintained in the piping sketch to be prepared by the CONTRACTOR / VENDOR. The weld joint identification number should appear on the corresponding post weld heat treatment charts. The chart containing the identification numbers and piping sketch shall be submitted to the Engineer-in-Charge in suitable folders.

16. CLEANING OF THE WELD JOINT

All weld joints shall be free from adherent weld spatters slag, sward, dirt or foreign matter. This can be achieved by brushing. For stainless steels, brushes with only stainless steel bristles shall be used.

17. INSPECTION AND TESTING

17.1 General

The Owner /PMC's inspector shall have free access to all concerned areas, where the actual work is being performed. The CONTRACTOR / VENDOR shall also accord the Owner /PMC's Inspector all means and facilities necessary to carry out inspection.

The Owner /PMC is entitled to depute his own inspector to the shop or field where prefabrication and erection of pipe lines is in progress for (but not limited to) the following objectives:

- To check the conformance to relevant standards and suitability of various welding equipment and the welding performance.
- To witness the welding procedure qualification.
- To witness the welder performance qualification.
- To check whether shop/field welding being executed is in conformity with the relevant specifications and codes of practice followed in piping construction.

CONTRACTOR / VENDOR shall intimate sufficiently in advance the commencement of qualification tests, welding works and acceptance tests, to enable the Owner /PMC's inspector to be present to supervise them, as decided by the Engineer-In-Charge.

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17.2 Welding Procedure Qualification

Welding procedure qualification shall be carried out in accordance with the applicable requirements of ASME Sec. IX latest edition and/or other applicable codes and the job requirements. The CONTRACTOR / VENDOR shall submit the welding procedure specification in format as per Exhibit-C (attached) immediately after the receipt of the order. Owner /PMC's inspector will review, check and approve the welding procedure submitted and shall release the procedure for qualification tests. The procedure qualification test shall be carried out by the CONTRACTOR / VENDOR at his own expense. A complete set of test results in the format as per Exhibit-D attached) shall be submitted to the Owner /PMC's inspector for his approval immediately after completing the procedure qualification test and at least 2 weeks before the commencement of actual work. Standard test as specified in the code shall be carried out in all cases. In addition to these tests, other tests like macro/micro examination, hardness tests, dye penetrant examination, charpy V- notch, Corrosion tests, impact tests, Ferrite test etc. shall be carried out on specimens depending upon the type of base material, operating conditions and requirements laid down in the detailed drawings and specifications. It shall be the responsibility of the CONTRACTOR / VENDOR to carry out all the tests required to the satisfaction of the Owner /PMC's inspector. Welding procedures shall be qualified in accordance with the requirements of ASME IX. In addition, the PQR's shall include Brinell testing and ferrite measurements as follows:

17.3 Brinell hardness tests

PQR shall always include hardness testing in case of Ferritic and Duplex materials.

In Wet H₂S service also Austenitic materials shall have hardness testing.

One test per PQR/material/range of qualification is required.

All welding procedure qualification subject to Post Weld Heat treatment shall be as well hardness tested by Brinell method after P.W.H.T.

Unless otherwise specified in Welding Specification Chart & licenser specification the maximum hardness shall not exceed:

- 200 HB for P-No.1 material
- 225 HB for P-No.3 and 4 materials
- 241 HB for P-No.5 material

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17.4 Welder's Qualification

Welders shall be qualified in accordance with the ASME Section-IX or other applicable codes. The Owner /PMCs inspector reserves the right to witness the test and certify/approve the qualification of each welder separately. Only those welders who have been approved by the Owner /PMC's Inspector shall be employed for welding. CONTRACTOR / VENDOR shall submit the welder qualification test reports in the format as per Exhibit-E (attached) and obtain express approval before commencement of work. It shall be the responsibility of CONTRACTOR / VENDOR to carry out qualification tests of welders. For welding of the steam piping, falling under the purview of Indian Boiler Regulations, only those welders with IBR Certification, qualified by Boiler Inspectorate, and acceptable to the local Boiler Inspector authority shall be employed.

The welders shall always have in their possession, an identification card containing information contained in Exhibit-G and shall produce it on demand by the Engineer-In-Charge or his representative. It shall be the responsibility of the CONTRACTOR / VENDOR to issue the identify cards after it has been duly certified by the, Owner /PMC's Inspector.

No welder shall be permitted to work without the possession of the identify card.

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 / VENDOR

In addition to ASME qualification, CONTRACTOR / VENDOR shall submit the training and examination program of qualification of all welders and foremen assigned in the welding and repairs of piping Carbon/stainless steel material.

All Welders and welding operators shall be qualified at Site.

All field welders and welding operators shall be requalified on site before beginning the works.

Qualification certificate records shall be submitted to the review of the Owner /PMC Inspector

17.5 Welder Performance Registration.

In order to control and maintain the validation of performance qualification, a welder performance register shall be kept up to date by the CONTRACTOR / VENDOR

This register should at least contain the following data:

- Welder's name and stamp.

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- Data of weld inspection and inspection results.
- Materials (base and consumable).
- Configuration data (diameter, wall thickness, etc.).
- Reference to WPS used.
- Position of welding.
- Purging records including repairs.

18. NON-DESTRUCTIVE EXAMINATION

The extent of NDE shall be as per attached **Table -01**

Where the extent indicated is 10%, this is defined as 100% examination of 1 in 10 of those welds indicated. The welds to be examined shall cover each pipe size and each welder.

18.1 Visual Examination

Visual Examination of all welds shall be carried out 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 of welds, shrinkage cracks, inadequate penetration, unrepaired burn-through, under cuts, dimensions of the weld, surface porosity and other surface defects. Undercutting adjacent to the completed weld shall not exceed the limits specified in the applicable standard/code.

Visual examination procedures shall be in accordance with ASME Section V, Article 9. Visual examinations shall be performed on accessible surfaces of all completed welds.

The evaluation of indications and the acceptance criteria for visual inspection shall be in accordance with ASME B31.3, Table 341.3.2 or ASME B 31.1 as applicable.

18.2 Radiographic Examination

CONTRACTOR / VENDOR shall appoint agency for carrying out the radiography works at site from the list of agencies enclosed in the bid document or separately supplied by Owner /PMC

Use of digital radiography requires prior approval of Engineer-in charge

The Radiographic Examination procedures to be adopted shall be submitted by the CONTRACTOR / VENDOR as per Exhibit-F and shall be got approved from the Owner /PMC's Inspector prior to employment. A person qualified to ASNT Level-II or ASNT Level-III in Radiographic testing shall prepare the procedure. The Radiography Procedure shall be established to demonstrate that the required sensitivity can be consistently achieved under the most unfavorable parameters (e.g. source to film distance, geometric

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un sharpness, thickness etc.). The radiographic technique and procedure adopted shall conform of the requirements mentioned in Article 2 as well as Article 22 of ASME Sec.V. The IQI sensitivity obtained shall be equal to or better than the requirements mentioned in Article 2 of ASME Sec.V. Source side penetrometer shall be used in establishing radiographic procedure/ technique. The acceptance criteria shall be as per the relevant codes of Fabrication and overriding requirements if mentioned elsewhere in the technical specifications of the contract. The CONTRACTOR / VENDOR shall be responsible for carrying out Radiography; rectification of defects and re-radiography of welds repaired/rectified at his cost.

Unless otherwise specified, the evaluation of indications and the acceptance criteria of radiographs shall be in accordance with ASME B31.3 Table 341.3.2 Normal and category M Fluid Service or ASME B 31.1 as applicable.

The extent of Radiography shall be as per specifications to be supplied to the CONTRACTOR / VENDOR. For welds between dissimilar materials, the extent of Radiographic Examination shall be the more stringent of the two recommended for the materials being welded. Wherever random Radiography is called for, in a particular piping class, the dissimilar materials weld joints shall essentially be included.

Type of Radiation source and film to be used shall be as per Exhibit-F for carrying out radiographic examination. However, if specifications (as given elsewhere in the contract) for some critical material require usage of X-Radiation, then Radiography shall be done using X-Rays only.

The CONTRACTOR / VENDOR shall fulfil all the statutory and Owner /PMC's safety requirements while handling X-ray and Gamma-ray equipment.

In case of random radiography, the joints for Radiography shall be selected by the Owner /PMC's Inspector and the Radiography shall be performed in his presence, if he instructs the CONTRACTOR / VENDOR to do so. The CONTRACTOR/ VENDOR shall furnish all the radiographs, to the Owner /PMC's Inspector immediately after processing along with evaluation by a person qualified to ASNT Level-II in Radiographic testing, in line with Article 2 of ASME Sec.V. The certificate of ASNT/ISNT Level II qualification of the NDE personnel shall be submitted to Owner /PMC's inspector for his approval prior to start of job.

The CONTRACTOR / VENDOR shall provide the Owner /PMC's Inspector, all the necessary facilities at site such as a dark room with controlled temperature, illuminator (viewer) suitable for varying densities, a duly calibrated electronic densitometer with batteries, magnifying glass, tracing papers, ruler, marking pencils etc. to enable him to review the radiographs.

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Where random radiography is specified, the first weld of each welder shall be completely radiographed. In the case of pipe of size 6" and below, the first two welds shall be completely radiographed.

For each weld performed by a welder found unacceptable, two additional checks shall be carried out on welds performed by the same welder. This operation is iterative and the of two additional welds for each weld deemed unsatisfactory shall be continued till such time that two consecutive welds of satisfactory quality are found for every defective weld.

The CONTRACTOR / VENDOR shall carry out these additional radiographic testing at his own expense. To avoid the possibility of too many defective welds by a single welder remaining undetected for a long period to time, the CONTRACTOR shall promptly arrange for Radiographic Examination so that there is no accumulation of defective joints.

All shop examination (Piping) up to and including 25mm total wall thickness shall use X-radiography. Gamma radiography may be used for thicknesses above 25mm. Gamma radiography could be used on thicknesses of 25mm and below when X-radiography is impractical i.e. construction sites. The gamma source shall be Iridium 192. In any event image sensitivity shall be 2% or better based on source side wire type Image Quality Indicators (IQI).

18.3 Check shots

Owner /PMC / Engineer- in- charge or his representative shall select 5% of the total joints radiographed on a day for check shots. CONTRACTOR / VENDOR shall carry out check shots as directed at his own cost.

Weld profiles of check shots shall be compared with weld profile observed in the earlier Radiographs. In the event of any one variation in the check shots and earlier Radiographs, CONTRACTOR / VENDOR shall re-shoot the entire lot of joints radiographed by particular Radiography agency on the particular date. All the re-shot films shall be compared with the originally submitted films.

18.4 Ultrasonic examination (UT)

Ultrasonic examination procedures shall be in accordance with the requirements and methods specified in ASME Section V, Article 5. The evaluation of indications and the acceptance criteria shall be in accordance with ASME B31.3 or B 31.1 as applicable.

For P-No.1 through P-No.5 material, piping of thickness 40 mm and above 100% ultrasonic examination shall be required on butt welds in addition to the specified radiography examination.

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Ultrasonic examination shall be only considered for the detection of “Planar Flaws”.

The UT procedure shall include the following information as minimum:

Scope; equipment; probe type and details; surface preparation, cleaning and couplant; technique sheet for each technique specified (number of techniques to be sufficient to cover all type of joints to be covered by the procedures scope); material; weld material (if different); sketch showing joint configuration, beam coverage; extent of scan; scanning pattern; material thickness and curvature; calibrations and frequency; means of setting and scanning, sensitivity levels and DAC curves; flaw location and size evaluation; acceptance criteria; reporting format; operator qualifications.

18.5 Liquid Penetrant and Magnetic Particle Examination

Whenever such tests are specified, the tests shall be carried out on joints chosen by the Owner /PMC's inspector, as per ASME Section V article 6 and 7 respectively. The tests are to be performed by a person possessing a valid ASNT/ISNT Level-II qualification in the method being used.

For austenitic stainless steels and other nonmagnetic materials, liquid (dye) penetrant test shall be carried out. For carrying out this test, the materials shall be brought within a temperature limit of 15° to 50°C.

Penetrant materials shall meet the requirements of ASME Section V, Article 6 for sulfur and halogen content regardless of the type of material to be examined.

Liquid penetrant examination of welds shall include a band of base metal at least 25 mm wide on each side of the weld.

The evaluation of indications and the acceptance criteria shall be in accordance with ASME VIII Div. 1 Appendix 8.

The PT procedure shall include the following information as minimum:

- Scope; surface preparation; cleaning and drying; temperature limitations; penetrant application method and time; removal of excess penetrant; drying; application of developer; development time; acceptance level; reporting format; operator qualification; stage performed.

CONTRACTOR / VENDOR shall submit the LPT / MPT procedure to Owner/PMC for review & approval.

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Magnetic particle examination procedures shall be in accordance with the requirements and methods specified in ASME Section V, Article 7.

Magnetic particle examination of welds shall include a band of base metal at least 25 mm wide on each side of the weld.

The evaluation of indications and the acceptance criteria shall be in accordance with ASME VIII Div: 1 Appendix 6.

The MT procedure shall include the following minimum information.

Scope; surface preparation; areas to be examined; stage(s) at which examined (i.e. after welding, after heat treatment, after hydrotest, etc.); magnetizing technique (e.g. AC Yoke); equipment used; magnetic ink trade name; frequency of calibration of equipment and test of bath strength; coverage and direction of magnetic field; measurement of field strength; application of examination media; acceptance level; reporting format; operator qualifications.

18.6 Hardness Test

Hardness requirements for welds shall be as per the Welding Specification Chart/Nondestructive Examination Specification attached elsewhere in the contract. Hardness testing shall be carried out by Vickers Hardness Tester during welding procedure qualification and shall be cross sectional. For production welds, hardness testing shall be carried out by portable digital hardness testers. Poldi hardness tester shall not be permitted. CONTRACTOR / VENDOR shall produce documentary evidence/calibration certificate to the Owner /PMC's Inspector and obtain approval of the hardness testing equipment.

18.7 Proof Tests

Hydrostatic and pneumatic tests shall be performed as per the requirements laid down by respective flushing and Testing specification/applicable codes to demonstrate the soundness of the welds. The tests shall be conducted after fulfilling the requirement of visual examinations radiography etc. and after the entire work has been certified by the Owner //PMC's inspector to be fit for being subjected to such tests.

19. REPAIRS OF WELDS

Defects ascertained, through the inspection methods, which are beyond acceptable limits shall be removed after the joint is completely radiographed by the process of chipping and grinding. The repaired welds shall be subjected, as a minimum requirement to the same testing and inspection requirements as the original weld.

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Unacceptable discontinuities shall be completely removed by chipping, gouging, grinding, or other methods (for the type of material being repaired) to clean, sound metal, and the excavated area shall be examined by MT or PT to assure complete removal of defects.

Repairs to correct weld defects shall be made using the same WPS used for the original weld or other previously authorized WPS

One repair attempts will be allowed on any one defective area. No further attempts to repair shall be carried out without the authorization of Owner /PMC

Weld repair procedures shall be submitted to Owner/PMC prior to piping repair. The procedure shall state, as a minimum, the following information:

- Means of excavating defect from weld.
- NDE method (when applicable) used to verify complete defect removal.
- WPS /PQR used to fill excavated area.
- NDE method used to verify repair weld is sound.
- Purging procedure when root pass is made by GTAW process

When the entire joint is judged unacceptable, the welding shall be completely cut and edges suitably prepared as per required alignment tolerances. The re-welded joint shall again be examined following standard practices.

- No repair shall be carried out without prior permission of the Owner /PMC's inspector.
- Repairs and/or work of defective welds shall be done in time to avoid difficulties in meeting the construction schedules.

20. **DOCUMENTS TO BE SUBMITTED BY CONTRACTOR / VENDOR (4 COPIES EACH)**

Batch Test Certificates, for the Electrodes used, obtained from the Electrode Manufacturers.

Proposed Heat Treatment Procedure as per Exhibit-B.

Heat Treatment Charts.

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Weld joint hardness test results.

Welding Procedure Specifications as per Exhibit-C immediately after receipt of the order.

Welding Procedure Qualification records as per Exhibit-D.

Welder Performance Qualification records as per Exhibit-E immediately after conducting Welder Qualification Tests.

Radiography Procedure as per Exhibit-F and other NDE procedures.

Radiographic test Report along with Radiographs and other NDE reports.

Piping Sketch (Isometric) giving all the details regarding the pipe specifications, welded joints, joints radiographed magnetic particle, tested, ultrasonic tested, penetrant tested, joints heat treated, WPS used, welder's identification number, etc.

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EXHIBIT – B

Sheet 1 of 1

STRESS RELIEF HEAT TREATMENT PROCEDURE SPECIFICATION

Contractor : _____

Name of the Heat treater : _____

Name of the Project : _____ Specification

Reference No. _____

1. General Details Other Details

Name of the
Equipment : _____

Type of Heating : Elec. Res./
Induction
(Tick mark applicable method)

Maximum Permissible Temp at
Uncovered Parent Metal _____

Width of heated band _____

Width of Insulation _____

Material : _____

No. of Thermo couples (dia wise)

Type of Thermo couples _____

3. Heat Treatment Cycle Details

Charging Temp °C _____

Rate of heating °C /Hr. _____

Soaking Temperature, °C _____

Soaking Time, Hrs. _____

Rate of Cooling °C /Hr. _____

Method of Cooling _____

4. Other details, if any _____

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FORMAT FOR WELDING PROCEDURE SPECIFICATION (WPS)

Company Name _____ By _____

Welding Procedure Specification No. _____ Date _____ Supporting PQR No. (S) _____

Revision No. _____ Date _____

Welding Process (es) _____ Type (s) _____
(Automatic, Manual, Machines or Semi Auto)

JOINTS

Joint Design _____

Backing (Yes) _____ (No) _____

Backing Material (Type) _____

Sketches Production Drawings. Weld Symbols Written

Description should show the general arrangement of the parts to be welded. Where applicable, the root spacing and the details of weld groove may be specified.

(At the option of the Manufacturer sketches may be attached to illustrate joint design weld layers and bead sequence e.g. for notch toughness procedures, for multiple process procedures, etc.)

BASE METALS

P.No. _____ Group No. _____ to P. No. _____ Group No. _____

OR

Specification type and grade _____

to Specification type and grade _____

OR

Chem. Analysis and Mech. Prop. _____

to Chem. Analysis and Mech. Prop. _____

Thickness Range :

Base Metal : Groove _____ Fillet _____

Deposited Weld Metal : Groove _____ Fillet _____

Pipe Dia Range : Groove : _____ Fillet _____

Other _____

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FILLER METALS

F.No. _____ Other _____
A.No. _____ Other _____
Spec. No. (SFA) _____
AWS No. (Class) _____
Size of filler metals _____
_____ (Electrodes, Cold Wire, Hot Wire etc.)
Electrode-Flux (Class) _____
Flux Trade Name _____
Consumable Inset _____
Each base metal/filler metal combination should be recorded individually.
WPS NO. _____ Rev. _____

POSITIONS: Position (s) of Groove _____ Welding Progression : UP ____ Down ____ Position (s) of Fillet _____	POSTWELDED HEAT TREATMENT Temperature Range _____ Time Range _____
PREHEAT Preheat Temp. Min. _____ Interpass Temp. Max. _____ Preheat Maintenance _____	GAS Shielding Gas (es) _____ Percent Composition (mixtures) _____ Flow Rate _____ Gas Backing _____ Trailing Shielding Gas Composition _____

ELECTRICAL CHARACTERISTICS

Current AC or DC _____ Polarity _____
Amps (Range) _____ Volts (Range) _____
(Amps and volts range should be recorded for each electrode size, position, and thickness, etc. This information may be listed in a tabular form similar to that shown below).
Tungsten Electrode Size and Type _____ (Pure Tungsten, 2% Ceriated, etc)
Mode of Metal Transfer for GMAW _____ (Spray arc, short circuiting arc, etc.)
Electrode Wire feed speed range _____

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery		
	CLIENT		INDIAN OIL CORPORATION LIMITED		
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EXHIBIT – C
SHEET 3 OF 3

TECHNIQUE

String or Weave Bead _____

Orifice or Gas Cup Size _____

Initial and Interpass Cleaning (Brushing, Grinding, etc.) _____

Method of Back Gouging _____

Oscillation _____

Contact Tube to Work Distance _____

Multiple or Single Pass (per side) _____

Multiple or Single Electrodes _____

Travel Speed (Range) _____

Peening _____

Other _____

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Others
		Class.	Dia.	Type Polarity	Amp. Range			
								e.g. Remarks, Comments, Hot wire Addition, Technique Torch Angle, etc.

 	PROJECT Standby SRU & Additional Tanks IOCL Paradip Refinery			
	CLIENT INDIAN OIL CORPORATION LIMITED			
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EXHIBIT-D
SHEET 1 OF 2

FORMAT FOR PROCEDURE QUALIFICATION RECORD (PQR)

RECORD ACTUAL CONDITIONS USED TO WELD TEST COUPON

Company Name _____
 Procedure Qualification Record No. _____ Date _____
 WPS No. _____
 Welding Process (es) _____
 Types (Manual, Automatic, Semi-Auto) _____

JOINTS

Groove Design of Test Coupon

(For combination qualification the deposited weld metal thickness shall be recorded for each Filler metal or process weld)

BASE METALS Material Spec. _____ Type of Grade _____ P.No. _____ to P.No. _____ Thickness of Test Coupon _____ Diameter of Test Coupon _____ Other _____	POSTWELD HEAT TREATMENT Temperature _____ Time _____ Other _____
FILLER METALS Weld Metal Analysis A No. _____ Size of Filler Metal _____ Filler Metal E.No. _____ SFA Specification _____ AWS Classification _____ Other _____	GAS Type of Gas on Gases _____ Composition of Gas Mixture _____ Other _____
POSITION Position of Groove _____ Weld Progression (Uphill, Downhill) _____ Other _____	ELECTRICAL CHARACTERISTICS Current _____ Polarity _____ Amps. _____ Tungsten Electrode Size _____ Other _____
PREHEAT Preheat Temp. _____ Interpass Temp. _____	TECHNIQUE Travel Speed _____ String or Weave Bead _____ Oscillation _____ Multipass or Single Pass (per side) _____ Single or Multiple Electrodes _____ Other _____

 	PROJECT	Standby SRU & Additional Tanks IOCL Paradip Refinery		
	CLIENT	INDIAN OIL CORPORATION LIMITED		
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EXHIBIT-D
SHEET 2 OF 2

GUIDED BEND TESTS

Type of Figure No.	Result

TOUGHNESS TESTS

Specimen No.	Notch Location	Notch Type	Test Temp.	Impact Value	Lateral Exp.		Drop Weight	
					% Shear	Mils	Break	No Break

FILLET WELD TEST

Result - Satisfactory : Yes ____ No ____ Penetration into Parent Metal : Yes ____ No. ____

Marco - Results _____

OTHER TESTS

Type of Test _____

Deposit Analysis _____

Other _____

Welder's Name _____ Clock No. _____ Stamp No. _____

Test Conducted by _____ Laboratory Test No. _____

We certified that the statements in this record are correct and test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Date _____

Manufacturer _____

By _____

(Detail of record of tests are illustrative only and may be moulded to conform to the type and number of tests required by codes and specifications).

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
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EXHIBIT – E

SHEET 1 OF 2

**FORMAT FOR MANUFACTURER'S RECORD FOR WELDER OR WELDING OPERATOR
QUALIFICATION TESTS**

Welder Name _____ Check No. _____ Stamp. No. _____

Using WPS No. _____ Rev. _____

The above welder is qualified for the following ranges

<u>Variable</u>	<u>Record Actual Values Used in Qualification</u>	<u>Qualification Range</u>
Process	_____	_____
Process Type	_____	_____
Backing (metal, Weld metal, flux, etc)	_____	_____
Material Spec.	_____ to _____	_____ to _____
Thickness		
Groove	_____	_____
Filler	_____	_____
Diameter		
Groove	_____	_____
Filler	_____	_____
Filler Metal		
Spec. No.	_____	_____
Class	_____	_____
F. No.	_____	_____
Position	_____	_____
Weld Progression	_____	_____
Gas Type	_____	_____
Electrical Characteristics		
Current	_____	_____
Polarity	_____	_____

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
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EXHIBIT – E
SHEET 2 OF 2

Guided Bend Test Results

Type and Fig. No.	Result

Radiographic Test Results
For alternative qualification of groove welds by radiography

Radiographic Results _____

Fillet Weld Test Results

Fracture Test (Describe the location, nature and size of any crack or tearing of the specimen) _____

Length and Per Cent of Defects _____ inches _____ %

Macro Test - Fusion _____

Appearance - Fillet Size (ing) _____ x _____ Convexity or Concavity _____

Test Conducted by _____ Laboratory - Test No. _____

We certify that the statements in this record are correct and that the test welds were prepared.
Welded and tested in accordance with the requirements of Section IX of the ASME Code.

Date _____

Organization _____

By _____

(Details of record tests are illustrative only and may be modified to conformation to the type & number of tests required by the Code).

Note: Any essential variables in addition to those above shall be recorded.

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
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<u>EXHIBIT - F</u>	
RADIOGRAPHIC PROCEDURE QUALIFICATION RECORD FOR PIPE WELDING	
1.	Location
2.	Date of Testing
3.	Name of the Contractor/Agency
4.	Material: Carbon steel/Alloy Steel/Stainless Steel
4 A.	Technique: DWSI/SWSI/DWDI
5.	Diameter & Thickness:
6.	Type of Weld Joint:
7.	Radiation Source:
8.	Intensifying Screens/Lead Screens:
9.	Geometric Relationship:
10.	Limit of Film Coverage:
11.	Film Type and Make:
12.	Exposure Time:
13.	Processing:
14.	Density:
15.	Sensitivity:
16.*	Type of penetrameter: (Source side)
17.*	Type of penetrameter: (Film side)
Signature of Contractor/Agency with Seal	
Approval of EIL's Inspector	
* Ref. Para regarding recommended practice on placement of penetrameters Article 22, SE 142, ASME Sec. V.	
* For "Random Radiography" lines placement of penetrameters as per Article 2, ASME, Sec. V is permitted.	

 		PROJECT	Standby SRU & Additional Tanks IOCL Paradip Refinery		
		CLIENT	INDIAN OIL CORPORATION LIMITED		
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ANNEXURE – A

(List of Approved Welding Electrodes
for IOCL Refineries)



**INDIAN OIL CORPORATION LIMITED
REFINERY HEADQUARTERS
MAINTENANCE & INSPECTION DEPARTMENT**

REF: M&I/ IP/Welding/33

Updated in Dec'2017

Sub: List of Approved welding electrodes for IOCL Refineries

List of approved Welding electrodes for IOCL refineries is updated on the basis of previous recommendations & communications and is tabulated below for reference;

A. Approved Vendor List for Welding Electrodes for Refineries division before year 14.03.2008 (Ref No. M&I/IP/GC/121 dated 14.03.2008)

1. M/s. ADOR Welding Limited
2. M/s. ESSAB India Limited
3. M/s. D&H Secheron Electrodes Limited

B. Approved Welding Electrodes (Ref No: M&I/IP/GC/121 dated 14/03/2008)

1. M/s Honavar Electrodes Pvt. Ltd., Mumbai

Sl. No.	Brand Name	AWS Classification
1.	CELLUMATE	E 6010
2.	REGULAR – S	E 6013
3.	ULTIMATE – 18	E 7018
4.	ULTIMATE – 18 SPL	E 7018-1
5.	ULTIMATE – 18 A1	E 7018 – A1
6.	ULTIMATE – 18 NC	E 7018 (NACE)
7.	ULTIMATE – 18 (SPL) NC	E 7018 – 1 (NACE).
8.	ULTIMATE – 80 B2	E 8018 – B2
9.	ULTIMATE – 90 B3	E 9018 – B3
10.	CROMOMATE 5	E 8018 – B6
11.	CROMOMATE 9	E 8018 – B8
12.	SILVERSHINE - 308	E 308 – 16
13.	SILVERSHINE – 308L	E 308L – 16
14.	SILVERSHINE – 309	E 309 – 16
15.	SILVERSHINE – 309L	E 309L -016
16.	SILVERSHINE – 309 Mo	E 309Mo – 16
17.	SILVERSHINE – 316	E 316 – 16
18.	SILVERSHINE – 316 L	E 316L – 16
19.	SILVERSHINE – 347	E 347 - 16

2. M/s Mailam India Ltd., Pondicherry

Sl. No.	Brand Name	AWS Classification
1.	MAILARC-10	E 6010
2.	MAILARC-13R	E 6013
3.	MAILARC-18	E 7018
4.	MAILARC-18 PLUS	E 7018-1
5.	MAILARC-1CR	E 8018-B2
6.	MAILARC-2CR	E 9018-B3
7.	MAILARC-5CR	E 8018-B6
8.	MAILARC-9CR	E 8018-B8
9.	MAILEX-AL	E 308L-16
10.	MAILEX-AH	E 308H-16
11.	MAILEX-25/12L	E 309L-16
12.	MAILEX-MoL	E316L – 16
13.	MAILEX-ANb	E 347-16

3. M/s EWAC Alloys Ltd. (Associate Company of L&T), Mumbai

Sl. No.	Brand Name	AWS Classification
1.	XUPER FAB E308-16	E 308-16
2.	XUPER FAB E308L-16	E 308L-16
3.	XUPER FAB E309-16	E 309-16
4.	XUPER FAB E309L-16	E 309L-16
5.	XUPER FAB E309Mo-16	E 309Mo-16
6.	XUPER FAB E310-16	E 310-16
7.	XUPER FAB E316-16	E316-16
8.	XUPER FAB E316L-16	E316L-16
9.	XUPER FAB E347-16	E347-16
10.	XUPER 2220	ENiCu-7

4. M/s Fusion Engineering Products Ltd., Jamshedpur

Sl. No.	Brand Name	AWS Classification
1.	Electra-6	E-6013
2.	Electra-9	E-6013
3.	Basicote-6	E-7018

C. Approved Welding Electrodes (List dated 09/04/2010 and M&I/IP/GC-HQ/10 dtd. April 9, 2010)

1. M/s. ADOR Welding Limited

2. M/s. ESSAB India Limited

3. M/s. D&H Secheron Electrodes Limited

4. **M/s. D&H India, Indore** (M&I/IP/Vendor/Registration/WU-4/19 dtd. 10.04.2012)

Sl. No.	Brand Name	AWS Classification
1.	STANDARD	E 6013
2.	SUPER-LH	E 7018
3.	SUPER-LH (SPL)	E 7018-1
4.	SUPER-CR-1	E 8018-B2
5.	SUPER-CR-2	E 9018-B3
6.	CROMALLOY-A	E 308-16
7.	CROMALLOY-B	E 308L-16
8.	CROMALLOY-C	E 316-16
9.	CROMALLOY-2C	E 316-L
10.	CROMALLOY-309	E 309-16
11.	CROMALLOY-309L	E 309L-16
12.	CROMALLOY-A ST	E 347-16
13.	HAST-B	E NiCrFe3

5. **M/s. Honavar Electrodes Pvt. Ltd., Mumbai**

Sl. No.	Brand Name	AWS Classification
1.	CELLUMATE	E 6010
2.	REGULAR – S	E 6013
3.	ULTIMATE – 18	E 7018
4.	ULTIMATE – 18 SPL	E 7018-1
5.	ULTIMATE – 18 A1	E 7018 – A1
6.	ULTIMATE – 18 NC	E 7018 (NACE)
7.	ULTIMATE – 18 (SPL) NC	E 7018 – 1 (NACE).
8.	ULTIMATE – 80 B2	E 8018 – B2
9.	ULTIMATE – 90 B3	E 9018 – B3
10.	CROMOMATE 5	E 8018 – B6
11.	CROMOMATE 9	E 8018 – B8
12.	SILVERSHINE - 308	E 308 – 16
13.	SILVERSHINE – 308L	E 308L – 16
14.	SILVERSHINE – 309	E 309 – 16
15.	SILVERSHINE – 309L	E 309L -016
16.	SILVERSHINE – 309 Mo	E 309Mo – 16
17.	SILVERSHINE – 316	E 316 – 16
18.	SILVERSHINE – 316 L	E 316L – 16
19.	SILVERSHINE – 347	E 347 - 16
20.	Ultimate 80	E 8018G
21.	Ultimate 90	E 9018G
22.	Cromomate-91	E 9018-B9
23.	Cryomate-2NS	ENiCrFe-2
24.	Cryomate-3NS	ENiCrFe-3
25.	Cryomate-5	ENiCrMo-3
26.	DE-1650	ENiCu-7
27.	Silvershine-4462 (spl.)	E-2209-17

28.	Silvershine-4470	E-2594-16
29.	Silvershine-410B	E-410-15
30.	Silvershine-310	E-310-16
31.	Ultimate 70B2L	E-7018-B2L
32.	Ultimate 80B3L	E-8018-B3L
33.	Cromomate 5L	E-8018-B6L
34.	Silvershine 309MoL	E 309MoL

6. M/s Mailam India Ltd. Pondicherry

Sl. No.	Brand Name	AWS Classification
1.	MAILARC-10	E 6010
2.	MAILARC-13R	E 6013
3.	MAILARC-18	E 7018
4.	MAILARC-18 PLUS	E 7018-1
5.	MAILARC-1CR	E 8018-B2
6.	MAILARC-2CR	E 9018-B3
7.	MAILARC-5CR	E 8018-B6
8.	MAILARC-9CR	E 8018-B8
9.	MAILEX-AL	E 308L-16
10.	MAILEX-AH	E 308H-16
11.	MAILEX-25/12L	E 309L-16
12.	MAILEX-MoL	E316L – 16
13.	MAILEX-ANb	E 347-16
14.	MAILARC-18(MOD) NACE	E 7018 - NACE
15.	MAILARC-18 PLUS (MOD) NACE	E 7018-1 NACE
16.	MAILARC-Mo	E 7018 – A1
17.	MAILEX-25/12LMo	E 309LMo
18.	ME-40	ENiCrFe-3
19.	ME-42	ENiCu7
20.	ME-44	ENiCrMo3
21.	MAILEX-410	E 410-15
22.	MAILEX-430	E 430-15

7. M/s. EWAC Alloys Limited (Associate company of L&T), Mumbai

Sl. No.	Brand Name	AWS Classification
1.	XUPER FAB E308-16	E 308-16
2.	XUPER FAB E308L-16	E 308L-16
3.	XUPER FAB E309-16	E 309-16
4.	XUPER FAB E309L-16	E 309L-16
5.	XUPER FAB E309Mo-16	E 309Mo-16
6.	XUPER FAB E310-16	E 310-16
7.	XUPER FAB E316-16	E316-16
8.	XUPER FAB E316L-16	E316L-16
9.	XUPER FAB E347-16	E347-16
10.	XUPER 2220	ENiCu-7

8. M/s Fusion Engineering Products Ltd., Jamshedpur

Sl. No.	Brand Name	AWS Classification
1.	Electra-6	E-6013
2.	Electra-9	E-6013
3.	Basicote-6	E-7018

9. M/s GEE Limited, Thane, Mumbai

(M&I/IP/Vendor/Registration/WU-4/19 dated 24.02.2012)

Sl. No.	Brand Name	AWS Classification
1.	GRICON WHITE	E 6010
2.	GEECON PINK	E 6013
3.	GRICON GREEN	E 7018
4.	GRICON GREEN (SPL)	E 7018-1
5.	GRIDUCT 3	E 8018 B2
6.	GRIDUCT 4	E 9018 B3
7.	GRIDUCT B6	E 8018 - B6
8.	GRIDUCT B8	E 8018 - B8
9.	GRINOX 4	E 308-16
10.	GRINOX 4L	E 308L-16
11.	GRINOX 9	E 309-16
12.	GRINOX 9L	E 309L-16
13.	GRINOX 16	E 316-16
14.	GRINOX 16L	E 316L-16
15.	GRINOX 47	E 347-16
16.	GRINOX 347 H	E 347 H-16 (SP)
17.	GRINOX 2209	E 2209-16
18.	GEMET 821N	E NiCrFe3

10. M/s Modi Arc Electrode Co.

Sl. No.	Brand Name	AWS Classification
1.	STOVE 60 AP	E 6010
2.	SULTRA	E 6013
3.	MODI 7018	E 7018
4.	MODI 7018 SPL	E 7018-1
5.	MODI 7018-A1	E 7018-A1
6.	MODI 8018-B2	E 8018-B2
7.	MODI 9018-B3	E 9018-B3
8.	MODI 9018	E 9018-G
9.	SS 308	E 308-16
10.	SS 308L	E 308L-16
11.	SS 309	E 309-16
12.	SS 309L	E 309L-16
13.	SS 316	E 316-16
14.	SS 316L	E 316L-16
15.	SS 347	E-347-16

11. Royal Electrodes, Mumbai

Sl. No.	Brand Name	AWS Classification
1.	ROYAL 6010	E 6010
2.	ROYAL THERM	E 7018
3.	ROYAL-THERM SPL	E 7018-1

D. **Approved Welding Electrodes** (Ref. No. M&I/ IP/ VENDOR REGISTRATION/ WU-4/ 19 dated 04/05/2012)

1. M/s Modi Arc Electrode Co.

Sl. No.	Brand Name	AWS Classification
1.	Modi 7018 (NACE)	E 7018
2.	Modi 7018 SPL (NACE)	E 7018-1
3.	Modi 8018	E 8018G
4.	Modi 9015 B9	E 9015-B9
5.	Modi 309L Mo	E 309L Mo-16
6.	Modi 410-15	E 410-15
7.	Modi 430-15	E 430-15
8.	Modi Duex 1	E 2209-17
9.	Modi NICU	ENiCuB

2. M/s D&H India, Indore

Sl. No.	Brand Name	AWS Classification
1.	CELLO-10	E 6010
2.	CELLO-10MO	E 7010G
3.	SUPER MO	E 7018 A1
4.	SUPER SGS	E 7018 (NACE)
5.	SUPER SGS SPL	E 7018-1 (NACE)
6.	SUPER CR 5	E 8018 B6
7.	SUPER CR 9	E 8018 B8
8.	SUPER-LH Ni SPL	E 8018 G
9.	SUPER CR 9 MOD	E 9018 B9
10.	ULTRA-65	E 9018 G
11.	SV-CR-13	E 410-16
12.	ARMER 29L	E 2209-16

3. M/s GEE LIMITED

Sl. No.	Brand Name	AWS Classification
1.	GEMET 825 N	E NiCrMo3
2.	GEMET 811	ENiCu 7
3.	GRICON GREEN (SPECIAL) NC	E 7018 (NACE)
4.	GRICON GREEN NC	E 7018-1 (NACE)
5.	GRIDUCT-B2L	E 7018-B2L
6.	GRIDUCT-B3L	E 8018-B3L
7.	GRINOX 9Mo	E 309Mo-16

4. M/s Royal ARC Electrodes Limited



Sl. No.	Brand Name	AWS Classification
1.	ROYAL 7018B2	E 7018B2
2.	ROYAL THERM 2H SPL	E 7018 NACE
3.	ROYAL CHROM-1	E 8018 B2
4.	ROYAL CHROM-2	E 9018 B3
5.	ROYAL CHROM-5	E 8018 B6
6.	ROYAL CHROM-9	E 8018 B8
7.	ROYAL 1C	E 308L 16
8.	ROYAL 1AH	E 308H 16
9.	ROYAL 2C	E 316L 16
10.	ROYAL D2L	E 309L 16
11.	ROYAL 1B	E 347 16
12.	ROYAL CW	E 310 16
13.	ROYAL 2209	E 2209 16



E. M/s D&H India (Ref. No. PDRP/INSP/55 dated 27/01/2012)



Sl. No.	Brand Name	AWS Classification
1.	MIG ARC-WS-6	ER70S-6 (MIG)
2.	Super TIG-70S-2	ER 70S-2
3.	Super TIG-70S-2 (NACE)	ER 70S-2
4.	Super SGS(SPL)	E-7018-1
5.	Super SGS	E-7018



F. M/s Royal ARC Electrodes Limited (Ref. No. M&I/IP/Vendor/Registration /WU-4/19 dated 24/02/2012)



Sl. No.	Brand Name	AWS Classification
1.	Royal-S	E6013
2.	Royal-SS	E6013
3.	Royal-Bond	E6013
4.	Royal 6010	E6010
5.	Royal-Therm	E7018
6.	Royal-Therm SPL	E7018-1

<div><div></div><div></div></div>					TABLE-01 NDE CHART								Project N°		Unit	Doc. Type	Mat'l Code	Serial N°	Rev.
													080557C001		000	PP	814		3
Sl. No.	PIPING CLASS	LOCATION	RATING in #	BASIC MATERIAL (DESIGN CODE)	CORROSION ALLOWANCE (MM)	DESIGN CONDITIONS		DESCRIPTION	SPECIAL REQUIREMENT			OTHER REQUIREMENT	Visual in %	RT in %	DPT /MPT (Note-3)			Hardness Test	REMARKS
						P (Kg/Cm ² g)	T (Deg C)		NACE	HIC	PWHT (Note-4)				Socket welds	Branch Welds	External Attachment		
1	A12A	A/G	150	CARBON STEEL (ASME B31.3)	3.00	20.04 5.62	-29/38 427	NITROGEN OILY WATER SEWER PROCESS PLANT AIR LOW PRESSURE STEAM			B31.3 (Note-5)		100	10	10	10	10		Note-1
2	A15A	A/G	150	CARBON STEEL (ASME B31.3)	3.00	20.04 14.21	38 200	PROCESS PLANT AIR LOW PRESSURE STEAM			B31.3 (Note-5)	JACKETED	100	100% 10% (Note 6)	10	10	10		Note-1
3	A17A	U/G	150	CARBON STEEL (ASME B31.3)	6.00	ATM(1.03)	65	CONTAMINATED RAIN WATER SEWER OILY WATER SEWER VENT ATMOSPHERIC			B31.3 (Note-5)	3LPE COATED	100	10	10	10	10		Note-1
4	A1A	A/G	150	CARBON STEEL (ASME B31.3)	1.50	20.04 5.62	-29/38 427	LOW PRESSURE CONDENSATE NITROGEN OILY WATER SEWER PROCESS STORM SEWER SERVICE WATER			B31.3 (Note-5)		100	10	10	10	10		Note-1
5	A1K	A/G	150	SS 304L (ASME B31.3)	0.80	16.17 10.55	-29/38 260	VENT ATMOSPHERIC DEMINERALIZED WATER					100	10	10	10	10		Note-1
6	A21N	A/G	150	SS 316L (ASME B31.3)	1.50	16.17 7.71	-29/38 371	PROCESS					100	10	10	10	10		Note-1
7	A23A	A/G	150	CARBON STEEL (ASME B31.3)	1.50	10.5 10.5	-29/38 100	INSTRUMENT AIR PLANT AIR NITROGEN			B31.3 (Note-5)		100	10	10	10	10		Note-1

<div> </div>					TABLE-01 NDE CHART								Project N°		Unit	Doc. Type	Mat'l Code	Serial N°	Rev.
													080557C001		000	PP	814		3
Sl. No.	PIPING CLASS	LOCATION	RATING in #	BASIC MATERIAL (DESIGN CODE)	CORROSION ALLOWANCE (MM)	DESIGN CONDITIONS		DESCRIPTION	SPECIAL REQUIREMENT			OTHER REQUIREMENT	Visual in %	RT in %	DPT /MPT (Note-3)			Hardness Test	REMARKS
						P (Kg/Cm ² g)	T (Deg C)		NACE	HIC	PWHT (Note-4)				Socket welds	Branch Welds	External Attachment		
8	A28A	A/G	150	CARBON STEEL (ASME B31.3)	3.00	20.04 11.95	-29/38 260	NITROGEN PROCESS LOW PRESSURE STEAM	YES	YES	YES		100	100	100	100	100	Note-2	Note-9
9	A29A	A/G	150	CARBON STEEL (INTERNAL PHENOLIC BAKED EPOXY LINED) (ASME B31.3)	3.00	16 16	-29/38 65	COOLING WATER RETURN COOLING WATER SUPPLY FIRE WATER			B31.3 (Note-5)		100	10	10	10	10		Note-1
10	A2A	A/G	150	CARBON STEEL (ASME B31.1)	1.50	20.04 5.62	-29/38 427	BLOW DOWN LOW PRESSURE CONDENSATE HIGH PRESSURE STEAM LOW PRESSURE STEAM			B31.1 (Note-5)	IBR / FV	100	10	10	10	10		Note-1
11	A30A	U/G	150	CARBON STEEL (INTERNAL PHENOLIC BAKED EPOXY LINED & EXTERNAL 3LPE COATED) (ASME B31.3)	3.00	16 16	-29/38 65	COOLING WATER RETURN COOLING WATER SUPPLY FIRE WATER			B31.3 (Note-5)	3LPE COATED	100	10	10	10	10		Note-1
12	A31A	A/G	150	CARBON STEEL (ASME B31.1)	3.00	20.04 5.62 14.8/FV	-29/38 427 175	BLOW DOWN HIGH PRESSURE CONDENSATE LOW PRESSURE CONDENSATE NITROGEN OILY WATER SEWER HIGH PRESSURE STEAM LOW PRESSURE STEAM			B31.1 (Note-5)	IBR / FV	100	10	10	10	10		Note-1
13	A3A	A/G	150	CARBON STEEL (ASME B31.3)	3.00	20.04 5.62	-29/38 427	OILY WATER SEWER VENT ATMOSPHERIC COOLING WATER RETURN COOLING WATER SUPPLY SERVICE WATER			B31.3 (Note-5)		100	10	10	10	10		Note-1
14	A49A	A/G	150	CARBON STEEL (ASME B31.3)	6.00	20.04 5.62	-29/38 427	ACID GAS FLARE FUEL GAS OILY WATER SEWER PROCESS PROCESS WATER	YES	YES	YES		100	100	100	100	100	Note-2	Note-9

<div> </div>					<div>TABLE-01</div> <div>NDE CHART</div>								Project N°		Unit	Doc. Type	Mat'l Code	Serial N°	Rev.
													080557C001		000	PP	814		3
Sl. No.	PIPING CLASS	LOCATION	RATING in #	BASIC MATERIAL (DESIGN CODE)	CORROSION ALLOWANCE (MM)	DESIGN CONDITIONS		DESCRIPTION	SPECIAL REQUIREMENT			OTHER REQUIREMENT	Visual in %	RT in %	DPT /MPT (Note-3)			Hardness Test	REMARKS
						P (Kg/Cm ² g)	T (Deg C)		NACE	HIC	PWHT (Note-4)				Socket welds	Branch Welds	External Attachment		
15	A52A	A/G	150	CARBON STEEL (ASME B31.3)	3.00	20.04 18.01	-29/38 100	FUEL GAS			B31.3 (Note-5)		100	10	10	10	10		Note-1
16	A53G	A/G	150	CARBON STEEL (Galv.) (ASME B31.3)	1.50	16 16	0/38 65	INSTRUMENT AIR PLANT AIR DRINKING WATER FIRE WATER (AFTER DELUGE)			B31.3 (Note-5)		100	10	10	10	10		Note-1
17	A95A	A/G	150	CARBON STEEL (ASME B31.3)	6.00	20.04 5.62	-29/38 427	PROCESS			B31.3 (Note-5)		100	100	100	100	100		
18	A13A	A/G	150	CARBONSTEEL (ASME B31.3)	3.00	20.04 5.62	-29/38 427	HYDROCARBONS, SOUR WATER, SOUR GAS, SLOPS, ACID GAS FLARE,	YES		YES		100	100	100	100	100	Note-2	Note-1 & Note-10
19	A8A	A/G	150	CARBONSTEEL (ASME B31.3)	3.00	20.04 5.62	-29/38 427	AMINES AND NON NACE MILD SOUR			YES		100	100	100	100	100	Note-2	
20	B12A	A/G	300	CARBON STEEL (ASME B31.3)	3.00	52.03 28.83	-29 427	NITROGEN OILY WATER SEWER PROCESS			B31.3 (Note-5)		100	10	10	10	10		Note-1
21	B19A	A/G	300	CARBON STEEL (ASME B31.3)	1.50	52.03 28.83	-29 427	PROCESS			YES		100	100	100	100	100	Note-2	Note-9

<div> </div>					<div>TABLE-01</div> <div>NDE CHART</div>								Project N°		Unit	Doc. Type	Mat'l Code	Serial N°	Rev.
													080557C001		000	PP	814		3
Sl. No.	PIPING CLASS	LOCATION	RATING in #	BASIC MATERIAL (DESIGN CODE)	CORROSION ALLOWANCE (MM)	DESIGN CONDITIONS		DESCRIPTION	SPECIAL REQUIREMENT			OTHER REQUIREMENT	Visual in %	RT in %	DPT /MPT (Note-3)			Hardness Test	REMARKS
						P (Kg/Cm ² g)	T (Deg C)		NACE	HIC	PWHT (Note-4)				Socket welds	Branch Welds	External Attachment		
22	B1A	A/G	300	CARBON STEEL (ASME B31.3)	1.50	52.03 28.83	-29 427	PROCESS			B31.3 (Note-5)		100	10	10	10	10	Note-1	
23	B2A	A/G	300	CARBON STEEL	1.50	40 18 FV	150 350 305	MEDIUM PRESSURE STEAM, BLOW DOWN STEAM			B31.1 (Note-5)	IBR / FV	100	10	10	10	10		
24	B28A	A/G	300	CARBON STEEL (ASME B31.3)	3.00	52.03 28.83	0 427	PROCESS	YES	YES	YES		100	100	100	100	100	Note-2 Note-9	
25	B31A	A/G	300	CARBON STEEL (ASME B31.1)	3.00	40 18 FV	150 225 194	BOILER FEED WATER			B31.1 (Note-5)	IBR/FV	100	10	10	10	10	Note-1	
26	B49A	A/G	300	CARBON STEEL (ASME B31.3)	6.00	52.03 28.83	0 427	ACID GAS FLARE OILY WATER SEWER PROCESS WATER	YES	YES	YES		100	100	100	100	100	Note-2 Note-9	
27	D2A	A/G	600	CARBON STEEL (ASME B31.1)	1.50	79 46 FV	150 427 427	LOW PRESSURE CONDENSATE OILY WATER SEWER HIGH PRESSURE STEAM			B31.1 (Note-5)	IBR/FV	100	100	100	100	100		
28	D3A	A/G	600	CARBONSTEEL (ASME B31.3)	3.00	104.05 58/FV	-29/38 427	PROCESS VACUUM - NON SOUR			B31.3 (Note-5)		100	20	20	20	20	Note-1	

<div><div></div><div></div></div>					<div>TABLE-01</div> <div>NDE CHART</div>							Project N°		Unit	Doc. Type	Mat'l Code	Serial N°	Rev.	
												080557C001	000	PP	814		3		
Sl. No.	PIPING CLASS	LOCATION	RATING in #	BASIC MATERIAL (DESIGN CODE)	CORROSION ALLOWANCE (MM)	DESIGN CONDITIONS		DESCRIPTION	SPECIAL REQUIREMENT			OTHER REQUIREMENT	Visual in %	RT in %	DPT /MPT (Note-3)			Hardness Test	REMARKS
						P (Kg/Cm ² g)	T (Deg C)		NACE	HIC	PWHT (Note-4)				DPT /MPT (Note-3)				
															Socket welds	Branch Welds	External Attachment		
29	D31A	A/G	600	CARBON STEEL (ASME B31.1)	3.00	82.0 46.0 FV	150 280 280	BLOW DOWN HIGH PRESSURE CONDENSATE LOW PRESSURE CONDENSATE OILY WATER SEWER BOILER FEED WATER			B31.1 (Note-5)	IBR/FV	100	100	100	100	100		
30	D9D	A/G	600	ALLOY STEEL 1.25 Cr 0.5 Mo B31.1	1.50	52/FV	435	HIGH PRESSURE STEAM			YES	IBR / FV	100	100	100	100	100		
31	D9L	A/G	600	ALLOY STEEL 9 Cr 1 Mo V B31.1	1..50	46 FV	438 427	HIGH PRESSURE STEAM			YES	IBR /FV	100	100	100	100	100		

- Note 1

Random, 10% or 20% radiography" shall mean examining not less than one from each 10 welds or less in case of "Random 10% radiography", one from each five welds or less in case of "Random 20% radiography" made by the same welding procedure. Irrespective of percentage, no. of welds to be radiographed shall be minimum one. However first two welds made by each welder shall also be radiographed in case of "Random radiography". Welds selected for examination shall not include flange welds and shall be radiographed for their entire length.
- Note 2

100% of those which are locally heat treated shall be hardness tested.
All welds which are given heat treatment shall be hardness tested. Hardness test shall be performed after final heat treatment.
Hardness test where specifically called out in PMS, shall be carried out irrespective of thickness
- Note 3

MPT for CS & LAS and DPT for SS welds
DPT wherever applicable will be carried out at the root of welding and on finished weld both.
For stainless steel welds, the solutions used in DPT will be controlled halide category.
- Note -4

When mentioned "Yes" PWHT is applicable for all thickness and when code is mentioned like B31.3 or B31.1 stringent requirement of IBR/Welding procedure Specification/ Code shall govern.
- Note-5

Stringent requirement to be followed as per Welding Chart no 080557C-000-PP-815 / Code shall govern
- Note-6

100 % RT for Inner Pipes and 10% RT for out side pipes of Jacketing
- Note-7

In case of sour, amine, caustic & LPG services , wherever MPT indicated will be done by using yoke method, not Prod method.In case of other services, Prod method may be used.
- Note-8

Wherever MPT is not possible due to size restriction, PT can be used.
- Note-9

All NDE shall be performed after completion of PWHT, except for RT of carbon steels
- Note-10

100% RT except for Acid gas flare lines which will be in 10% RT category





 	PROJECT	Standby SRU & Additional Tanks IOCL Paradip Refinery		
	CLIENT	INDIAN OIL CORPORATION LIMITED		
WELDING SPECIFICATION CHARTS FOR PIPING CLASSES	Project No. 080557C001	Document No. 080557C-000-PP-815	Rev. No. 2	Page 2 of 5

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5. LIST OF SPECIFICATIONS CHARTS (Attached as Annexure-A).....	5

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery		
	CLIENT		INDIAN OIL CORPORATION LIMITED		
WELDING SPECIFICATION CHARTS FOR PIPING CLASSES	Project No. 080557C001	Document No. 080557C-000-PP-815		Rev. No. 2	Page 3 of 5

1. INTRODUCTION

INDIAN OIL CORPORATION LIMITED (IOCL) has awarded Fax of Acceptance (FOA) dated 29th August 2019 to M/s. Technip India Limited (TPIL) for Consultancy services (PMC/EPCM services) for overall project management, FEED Review / FEED, Detailed Engineering, Procurement & expediting services, Tendering & award, Construction Management & Supervision, Assistance in start-up, Commissioning & performance test runs for installation of a Standby SRU of 525 TPD capacity and execution of Additional tanks for Paradip Refinery, Odisha, India.

2. DEFINITIONS

2.1 Wherever used in this procedure, the following words shall have the meaning as given hereunder

“OWNER or IOCL” shall mean INDIAN OIL CORPORATION LIMITED

“CONSULTANT or PMC” shall mean TECHNIP INDIA LIMITED

“CONTRACTOR” shall mean the bidder selected by the OWNER for performing the scope of works specified in the tender documents.

“AUTHORISED REPRESENTATIVE” shall mean OWNER's/ CONSULTANT's representative authorized to act for and on behalf of OWNER/ CONSULTANT, as the case may be

“VENDOR” shall mean any third party supplying any of the equipment/materials for setting up the Plant.

“PROJECT” shall mean Sulphur Recovery Unit and Additional Tanks Project, Paradip Refinery



“PLANT” shall mean the units and facilities comprised in the project, and if divided into different packages for the award of Contracts.

“UNIT” shall mean a particular process unit etc. which forms a distinct operating system and a part of the plant.

“Sub- Contractor” shall mean Sub-Contractor engaged by Contractor

2.2 ABBREVIATIONS

a. GTAW - Gas Tungstan Arc Welding

		PROJECT	Standby SRU & Additional Tanks IOCL Paradip Refinery		
		CLIENT	INDIAN OIL CORPORATION LIMITED		
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- b. SMAW - Shielded Metal Arc Welding
- c. FCAW – Flux Cored Arc Welding
- d. SAW – Submerged Arc Welding
- e. WPS - Welding Procedure Specification
- f. PQR - Procedure Qualification record.
- g. AWS - American Welding Society
- h. QA/QC - Quality Assurance / Quality Control
- i. QAP - Quality Assurance Plan
- j. QCP - Quality Control Plan
- k. FQCP - Fabrication Quality Control Plan
- l. TPIA - Third Party Inspection Agency

3. SCOPE

This document describes the Welding Specifications for the piping classes covered by the Piping Material Specification issued for this Project. Contractor shall carry out Procedure Qualification under witnessing by PMC and submit the WPS with qualified PQR to OWNER /PMC for approval. Contractor shall consult with PMC for any additional essential variables to be considered or any additional qualification tests required over and above the normal qualification test requirements covered by ASME Section IX. Any deviation from this shall be approved through a deviation request specifically issued by Contractor and approved by PMC.

4. REFERENCES



- a. Indian Boiler Regulations
- b. ASME B31.3 – Refinery Piping
- c. ASME B31.1 – Power Piping
- d. ASME Sec IX – Qualification Standard for Welding, Brazing, and Fusing Procedures
- e. ASME Sec IIC - Specifications for Welding Rods, Electrodes, and Filler Metals

		PROJECT	Standby SRU & Additional Tanks IOCL Paradip Refinery		
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- f. ASME Sec V – Non Destructive Examination
- g. AWS D 10.8 – Recommended Practices for Welding of Chromium-Molybdenum Steel Piping and Tubing
- h. API RP 582 - Welding Guidelines for the Chemical, Oil, and Gas Industries
- i. NACE MR0103 – Petroleum, petrochemical and natural gas industries — Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments
- j. NACE SP0472 - Methods and Controls to Prevent In-Service Environmental Cracking of Carbon Steel Weldments in Corrosive Petroleum Refining Environments
- k. NACE TM0284 -Evaluation of Pipeline and Pressure Vessel Steels for Resistance to Hydrogen-Induced Cracking
- l. 080557C-000-JSD-1300-002 - Piping Material Specification
- m. 080557C-000-JSC-1300-001 - Standard Specification for Fabrication & Erection of Piping
- n. 080557C-000-PP-814 - Welding & NDE Specification for Fabrication of Piping



5. LIST OF SPECIFICATIONS CHARTS (Attached as Annexure-A)

1. WELDING CHART FOR CLASSES A3A, A17A, A23A, A29A, A30A, A53G
2. WELDING CHART FOR CLASSES A1A, A12A, A15A, A52A, A95A, B1A, B12A, D3A
3. WELDING CHART FOR CLASSES A2A, B2A, A31A, B31A, D2A, D31A
4. WELDING CHART FOR CLASSES A13A
5. WELDING CHART FOR CLASSES A8A, B19A
6. WELDING CHART FOR CLASSES A28A, A49A, B28A, B49A
7. WELDING CHART FOR CLASSES A1K
8. WELDING CHART FOR CLASSES A21N
9. WELDING CHART FOR CLASSES D9D
10. WELDING CHART FOR CLASSES D9L



 		PROJECT		Standby SRU & Additional Tanks, IOCL Paradip Refinery				
		CLIENT		INDIAN OIL CORPORATION LIMITED				
WELDING SPECIFICATION SHEET		NO :	PMS / 1300 / 01		Rev.	2	Date 27-Nov-19	
PIPING CLASS A3A, A17A, A23A, A29A, A30A, A53G								
MATERIAL SPECIFICATIONS		PIPES	ASTM A106Gr.B, IS - 3589 GR. 330 , GR.410, API 5L GR.B PSL2					
		FITTINGS	ASTM A 105, ASTM A 234 GR. WPB, ASTM A 234 GR. WPBW					
		FLANGES	ASTM A105N					
		OTHERS						
BASE METAL 'P' NO.		1						
WELDING PROCESS AND MATERIALS				GROOVE JOINTS (NOTE 1)				
BUTT				OTHER THAN BUTT				
PROCESS	GTAW	SMAW	FCAW		PROCESS	GTAW	SMAW	FCAW
PASS					PASS			
ROOT PASS (Note 2)	ER70S2	E 6010	NA		ROOT PASS (Note 3)	ER 70 S 2	E7018	NA
FILLER PASS	ER70S2	E 7016 / E 7018	E 71 T1		FILLER PASS	ER 70 S 2	E 7016 / E 7018	E 71 T1
WELDING PROCESS AND METALS				FILLET JOINTS/SW JOINTS				
PROCESS	GTAW	SMAW	FCAW					
PASS								
ROOT PASS (Note 2)	ER70S2	E7016/ E7018	NA					
FILLER PASS	ER70S2	E7016 / E7018	E 71 T1					
JOINT PREPARATION ASME B 31.3								
GASES		PURGING			SHIELDING			
PROCESS	GTAW	FCAW		PROCESS	GTAW	FCAW		
PURGING	NA	NA		SHIELDING	YES	Yes		
PURGING GAS NAME	NA	NA		GAS NAME	ARGON	Ar + CO2		
GAS COMPOSITION	NA	NA		GAS COMPOSITION	99.995	80% + 20%		
PREHEATING	PREHEAT TEMP	10° C MIN.	POST HEATING	NA				
CONTINUITY OF WELDING AND PREHEAT	YES		INTERPASS	250° C Max.				
POST WELD HEAT	HOLDING TEMP	NA	HOLDING TIME	NA				
TREATMENT	RATE OF HEATING	NA	MIN. HOLDING TIME	NA				
	METHOD OF COOLING	NA	RATE OF COOLING	NA				
MECHANICAL PROPERTY REQUIREMENTS				TEMP	MIN	AVERAGE		
CHARPY 'V' NOTCH IMPACT TEST VALUE				NA	NA	NA		
HARDNESS				NA				
CODE OF FABRICATION ASME B 31.3								
TECHNICAL NOTES								
NOTE 1: Any combination of welding process for groove weld can be used subject to qualification of the Welding Procedure								
NOTE 2: Entire welding of small bore piping, 2"NB and smaller shall be performed with GTAW.								
GTAW - GAS TUNGSTEN ARC WELDING FCAW - FLUX CORED ARC WELDING SMAW - SHIELDED METAL ARC WELDING								
(Prepared By)	(Checked By)	(Approved By)	CLIENT APPROVAL					



		PROJECT		Standby SRU & Additional Tanks, IOCL Paradip Refinery																																				
		CLIENT		INDIAN OIL CORPORATION LIMITED																																				
WELDING SPECIFICATION SHEET		NO	PMS / 1300 / 02		Rev.	2	Date	27-Nov-19																																
PIPING CLASS A1A, A12A, A15A, A52A, A95A, B1A, B12A, D3A																																								
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		FITTINGS	ASTM A234 WPB, ASTM A105N																																					
		FLANGES	ASTM A105N																																					
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PURGING		NA	NA		SHIELDING		YES	YES																																
PURGING GAS NAME		NA	NA		GAS NAME		ARGON	Ar + CO2																																
GAS COMPOSITION		NA	NA		GAS COMPOSITION		99.995	80% + 20%																																
PREHEATING (NOTE 3)																																								
PREHEAT TEMP		10° C MIN./ 100° C For thk. >25mm			POST HEATING		NA																																	
CONTINUITY OF WELDING AND PREHEAT		YES			INTERPASS		250° C Max.																																	
POST WELD HEAT TREATMENT		HOLDING TEMP			HOLDING TIME		NA																																	
		RATE OF HEATING			MIN. HOLDING TIME		NA																																	
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MECHANICAL PROPERTY REQUIREMENTS																																								
CHARPY 'V' NOTCH IMPACT TEST VALUE				TEMP		MIN		AVERAGE																																
				NA		NA		NA																																
HARDNESS				200 BHN Max , for PWHT Joints																																				
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TECHNICAL NOTES																																								
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NOTE 2: Entire welding of small bore piping, 2"NB and smaller shall be performed with GTAW.																																								
NOTE 3: Preheat Temperature of 50° C Shall be provided for the Root and next passes for thickness greater than 12.7mm and less than 25.4 mm																																								
NOTE 4 : Post Weld Heat treatment shall be performed as per ASME B31.3 for pipe wall thickness more than 19 mm at 620 +/- 20° C																																								
SMAW - SHIELDED METAL ARC WELDING				GTAW - GAS TUNGSTEN ARC WELDING																																				
FCAW - FLUX CORED ARC WELDING																																								
(Prepared By)		(Checked By)		(Approved By)		CLIENT APPROVAL																																		



 		PROJECT		Standby SRU & Additional Tanks, IOCL Paradip Refinery			
		CLIENT		INDIAN OIL CORPORATION LIMITED			
WELDING SPECIFICATION SHEET		NO :	PMS / 1300 / 03	Rev.	2	Date	27-Nov-19
PIPING CLASS A2A, A31A, B2A, B31A, D2A, D31A							
MATERIAL SPECIFICATIONS		PIPES	ASTM A106Gr.B, ASTM A672Gr.C65 Cl.12,				
		FITTINGS	ASTM A234 WPB, ASTM A105N				
		FLANGES	ASTM A105N				
		OTHERS					
BASE METAL 'P' NO. 1							
WELDING PROCESS AND MATERIALS				GROOVE JOINTS (NOTE 1)			
BUTT				OTHER THAN BUTT			
PROCESS	GTAW	SMAW		PROCESS	GTAW	SMAW	
PASS				PASS			
ROOT PASS (Note 2)	ER 70 S 2	E 6010		ROOT PASS (Note 2)	ER 70S 2	E7016 / E7018	
FILLER PASS	ER 70 S 2	E 7016 / E 7018		FILLER PASS	ER 70S 2	E 7016 / E 7018	
WELDING PROCESS AND METALS				FILLET JOINTS/SW JOINTS			
PROCESS	GTAW	SMAW					
PASS							
ROOT PASS (Note 2)	ER 70S2	E7016 / E7018					
FILLER PASS	ER 70S2	E7016 / E7018					
JOINT PREPARATION ASME B 31.1 + IBR							
GASES		PURGING		SHIELDING			
PROCESS	GTAW			PROCESS	GTAW		
PURGING	NA			SHIELDING	YES		
PURGING GAS NAME	NA			GAS NAME	ARGON		
GAS COMPOSITION	NA			GAS COMPOSITION	99.995		
PREHEATING (Note 3)							
PREHEAT TEMP		10° C MIN. / 100° C For thk. >25mm		POST HEATING		NA	
CONTINUITY OF WELDING AND PREHEAT		YES		INTERPASS		250° C Max.	
POST WELD HEAT		HOLDING TEMP 595°C to 620°C		HOLDING TIME		1 Hour/ Inch thk.	
TREATMENT (Note 4)		RATE OF HEATING 200° C / Hr Max.		MIN. HOLDING TIME		1 Hour	
		METHOD OF COOLING Controlled		RATE OF COOLING		200° C / Hr Max.	
MECHANICAL PROPERTY REQUIREMENTS							
CHARPY 'V' NOTCH IMPACT TEST VALUE		TEMP	MIN	AVERAGE			
		NA	NA	NA			
HARDNESS		200 BHN Max , for PWHT Joints					
CODE OF FABRICATION ASME B 31.1 & IBR							
TECHNICAL NOTES							
NOTE 1: Any combination of welding process for groove weld can be used subject to qualification of the Welding Procedure							
NOTE 2: Entire welding of small bore piping, 2"NB and smaller shall be performed with GTAW.							
NOTE 3: Preheat Temperature of 50° C Shall be provided for the Root and next passes for thickness greater than 12.7mm and less than 25.4 mm							
NOTE 4: For IBR Service, Post Weld Heat treatment shall be performed for pipe wall thickness more than 20mm							
GTAW - GAS TUNGSTEN ARC WELDING SMAW - SHIELDED METAL ARC WELDING							
(Prepared By)		(Checked By)		(Approved By)		CLIENT APPROVAL	



 		PROJECT Standby SRU & Additional Tanks, IOCL Paradip Refinery																									
		CLIENT INDIAN OIL CORPORATION LIMITED																									
WELDING SPECIFICATION SHEET		NO	PMS / 1300 / 05 Rev. 3 Date 10-Mar-20																								
PIPING CLASS A13A																											
MATERIAL SPECIFICATIONS (NOTE 5)		PIPES ASTM A106Gr.B, ASTM A672Gr.C65 Cl.12, FITTINGS ASTM A234 WPB, ASTM A105N FLANGES ASTM A105N OTHERS																									
BASE METAL 'P' NO. 1																											
WELDING PROCESS AND CONSUMABLES		GROOVE JOINTS (NOTE 1, 3)																									
BUTT		OTHER THAN BUTT																									
<table border="1"> <tr> <th>PROCESS</th> <th>GTAW</th> <th>SMAW</th> </tr> <tr> <td>PASS</td> <td></td> <td></td> </tr> <tr> <td>ROOT PASS (Note 2)</td> <td>ER 70 S 2</td> <td>NA</td> </tr> <tr> <td>FILLER PASS</td> <td>ER 70 S 2</td> <td>E 7016 / E 7018</td> </tr> </table>	PROCESS	GTAW	SMAW	PASS			ROOT PASS (Note 2)	ER 70 S 2	NA	FILLER PASS	ER 70 S 2	E 7016 / E 7018	<table border="1"> <tr> <th>PROCESS</th> <th>GTAW</th> <th>SMAW</th> </tr> <tr> <td>PASS</td> <td></td> <td></td> </tr> <tr> <td>ROOT PASS (Note 2)</td> <td>ER 70S 2</td> <td>NA</td> </tr> <tr> <td>FILLER PASS</td> <td>ER 70S 2</td> <td>E 7016 / E 7018</td> </tr> </table>			PROCESS	GTAW	SMAW	PASS			ROOT PASS (Note 2)	ER 70S 2	NA	FILLER PASS	ER 70S 2	E 7016 / E 7018
PROCESS	GTAW	SMAW																									
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PASS																											
ROOT PASS (Note 2)	ER 70S 2	NA																									
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WELDING PROCESS AND CONSUMABLES		FILLET JOINTS/SW JOINTS (NOTE 1, 3)																									
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PROCESS	GTAW	SMAW																									
PASS																											
ROOT PASS (Note 2)	ER 70S2	E7016/ E7018																									
FILLER PASS	ER 70S2	E7016 / E7018																									
JOINT PREPARATION ASME B 31.3																											
GASES		PURGING																									
<table border="1"> <tr> <th>PROCESS</th> <th>GTAW</th> </tr> <tr> <td>PURGING</td> <td>NA</td> </tr> <tr> <td>PURGING GAS NAME</td> <td>NA</td> </tr> <tr> <td>GAS COMPOSITION</td> <td>NA</td> </tr> </table>		PROCESS	GTAW	PURGING	NA	PURGING GAS NAME	NA	GAS COMPOSITION	NA	<table border="1"> <tr> <th>PROCESS</th> <th>GTAW</th> </tr> <tr> <td>SHIELDING</td> <td>YES</td> </tr> <tr> <td>GAS NAME</td> <td>ARGON</td> </tr> <tr> <td>GAS COMPOSITION</td> <td>99.995</td> </tr> </table>		PROCESS	GTAW	SHIELDING	YES	GAS NAME	ARGON	GAS COMPOSITION	99.995								
PROCESS	GTAW																										
PURGING	NA																										
PURGING GAS NAME	NA																										
GAS COMPOSITION	NA																										
PROCESS	GTAW																										
SHIELDING	YES																										
GAS NAME	ARGON																										
GAS COMPOSITION	99.995																										
PREHEATING		POST HEATING																									
PREHEAT TEMP 10° C MIN 100° C For thk. >25mm		NA																									
CONTINUITY OF WELDING AND PREHEAT YES		INTERPASS 250° C Max.																									
POST WELD HEAT HOLDING TEMP 620 - 650 Deg C		HOLDING TIME 1 Hour/ Inch thk.																									
TREATMENT RATE OF HEATING 200° C / Hr Max.		MIN. HOLDING TIME 1 Hour																									
(Note 4) METHOD OF COOLING Controlled		RATE OF COOLING 200° C / Hr Max.																									
MECHANICAL PROPERTY REQUIREMENTS		TEMP																									
CHARPY 'V' NOTCH IMPACT TEST VALUE		MIN AVERAGE																									
NA		NA																									
HARDNESS 180 BHN Max for Weld deposit , HAZ & Base Metal 237 BHN (22HRC) Max. after PWHT																											
CODE OF FABRICATION		ASME B 31.3 + NACE MR0103+NACE SP0472																									
TECHNICAL NOTES																											
NOTE 1: Any combination of welding process for groove weld can be used subject to qualification of the Welding Procedure NOTE 2: Entire welding of small bore piping, 2"NB and smaller shall be performed with GTAW. NOTE 3 : Electrodes/Filler metal chemical composition shall have the limitations --> Ni<1%,Mn<1.5%, NOTE 4: PWHT is mandatory for all thickness NOTE 5: Material shall meet the Applicable Material specifications and NACE MR 0103																											
GTAW - GAS TUNGSTEN ARC WELDING		SMAW - SHIELDED METAL ARC WELDING																									
(Prepared By)		(Checked By)																									
(Approved By)		CLIENT APPROVAL																									



		PROJECT		Standby SRU & Additional Tanks, IOCL Paradip Refinery			
		CLIENT		INDIAN OIL CORPORATION LIMITED			
WELDING SPECIFICATION SHEET		NO	PMS / 1300 / 04		Rev.	2	Date 10-Mar-20
PIPING CLASS A8A,B19A							
MATERIAL SPECIFICATIONS		PIPES	ASTM A106Gr.B, ASTM A672Gr.C65 Cl.12,				
		FITTINGS	ASTM A234 WPB, ASTM A105N				
		FLANGES	ASTM A105N				
		OTHERS					
BASE METAL 'P' NO.		1					
WELDING PROCESS AND CONSUMABLES		GROOVE JOINTS (NOTE 1)					
		BUTT			OTHER THAN BUTT		
PROCESS	GTAW	SMAW		PROCESS	GTAW	SMAW	
PASS				PASS			
ROOT PASS (Note 2)	ER 70 S 2	NA		ROOT PASS (Note 2)	ER 70S 2	NA	
FILLER PASS	ER 70 S 2	E 7016 / E 7018		FILLER PASS	ER 70S 2	E 7016 / E 7018	
WELDING PROCESS AND CONSUMABLES		FILLET JOINTS/SW JOINTS (NOTE 1)					
PROCESS	GTAW	SMAW					
PASS							
ROOT PASS (Note 2)	ER 70S2	E7016 / E7018					
FILLER PASS	ER 70S2	E7016 / E7018					
JOINT PREPARATION		ASME B 31.3					
GASES		PURGING		SHIELDING			
PROCESS	GTAW			PROCESS	GTAW		
PURGING	NA			SHIELDING	YES		
PURGING GAS NAME	NA			GAS NAME	ARGON		
GAS COMPOSITION	NA			GAS COMPOSITION	99.995		
PREHEATING	PREHEAT TEMP	10° C MIN 100° C For thk. >25mm		POST HEATING	NA		
CONTINUITY OF WELDING AND PREHEAT		YES		INTERPASS	250° C Max.		
POST WELD HEAT TREATMENT	HOLDING TEMP	620 - 650 Deg C		HOLDING TIME	1 Hour/ Inch thk.		
	RATE OF HEATING	200° C / Hr Max.		MIN. HOLDING TIME	1 Hour		
(Note 3)	METHOD OF COOLING	Controlled		RATE OF COOLING	200° C / Hr Max.		
MECHANICAL PROPERTY REQUIREMENTS		TEMP	MIN	AVERAGE			
CHARPY 'V' NOTCH IMPACT TEST VALUE		NA	NA	NA			
		HARDNESS	200 BHN Max for Weld deposit , HAZ & Base Metal 237 BHN (22HRC) Max. after PWHT				
CODE OF FABRICATION		ASME B 31.3					
TECHNICAL NOTES							
NOTE 1: Any combination of welding process for groove weld can be used subject to qualification of the Welding Procedure							
NOTE 2: Entire welding of small bore piping, 2"NB and smaller shall be performed with GTAW.							
NOTE 3: PWHT is mandatory for all thickness							
GTAW - GAS TUNGSTEN ARC WELDING				SMAW - SHIELDED METAL ARC WELDING			
(Prepared By)		(Checked By)		(Approved By)		CLIENT APPROVAL	



 		PROJECT		Standby SRU & Additional Tanks, IOCL Paradip Refinery			
		CLIENT		INDIAN OIL CORPORATION LIMITED			
WELDING SPECIFICATION SHEET		NO	PMS / 1300 / 05	Rev.	2	Date	27-Nov-19
PIPING CLASS A28A,A49A,B28A,B49A							
MATERIAL SPECIFICATIONS (NOTE 6)		PIPES	ASTM A106Gr.B, ASTM A672Gr.C65 Cl.12,				
		FITTINGS	ASTM A234 WPB, ASTM A105N				
		FLANGES	ASTM A105N				
		OTHERS					
BASE METAL 'P' NO.		1					
WELDING PROCESS AND CONSUMABLES		GROOVE JOINTS (NOTE 1,3 & 4)					
		BUTT			OTHER THAN BUTT		
PROCESS	GTAW	SMAW		PROCESS	GTAW	SMAW	
PASS				PASS			
ROOT PASS (Note 2)	ER 70 S 2	NA		ROOT PASS (Note 2)	ER 70S 2	NA	
FILLER PASS	ER 70 S 2	E 7016 / E 7018		FILLER PASS	ER 70S 2	E 7016 / E 7018	
WELDING PROCESS AND CONSUMABLES		FILLET JOINTS/SW JOINTS (NOTE 1,3 & 4)					
PROCESS	GTAW	SMAW					
PASS							
ROOT PASS (Note 2)	ER 70S2	E7016 / E7018					
FILLER PASS	ER 70S2	E7016 / E7018					
JOINT PREPARATION		ASME B 31.3					
GASES		PURGING		SHIELDING			
PROCESS	GTAW			PROCESS	GTAW		
PURGING	NA			SHIELDING	YES		
PURGING GAS NAME	NA			GAS NAME	ARGON		
GAS COMPOSITION	NA			GAS COMPOSITION	99.995		
PREHEATING	PREHEAT TEMP	10° C MIN 100° C For thk. >25mm		POST HEATING	NA		
CONTINUITY OF WELDING AND PREHEAT	YES			INTERPASS	250° C Max.		
POST WELD HEAT TREATMENT	HOLDING TEMP	620 - 650 Deg C		HOLDING TIME	1 Hour/ Inch thk.		
	RATE OF HEATING	200° C / Hr Max.		MIN. HOLDING TIME	1 Hour		
(NOTE 5)	METHOD OF COOLING	Controlled		RATE OF COOLING	200° C / Hr Max.		
MECHANICAL PROPERTY REQUIREMENTS		TEMP	MIN	AVERAGE			
CHARPY 'V' NOTCH IMPACT TEST VALUE		NA	NA	NA			
		HARDNESS	180 BHN Max for Weld deposit , HAZ & Basemetal 237 BHN (22HRC) Max. after PWHT				
CODE OF FABRICATION		ASME B 31.3 + NACE MR0103 + NACE SP0472+ NACE TM0284					
TECHNICAL NOTES							
NOTE 1: Any combination of welding process for groove weld can be used subject to qualification of the Welding Procedure							
NOTE 2: Entire welding of small bore piping, 2"NB and smaller shall be performed with GTAW.							
NOTE 3 : Electrodes/Fillermetal chemical composition shall have the limitations --> Ni<1%,Mn<1.5%,							
NOTE 4: Welding consumable shall be used with H4 Hydrogen diffusion Designator in order to comply with Licensor requirements							
NOTE 5: PWHT is mandatory for all thickness							
NOTE 6: In addition to compliance to NACE, HIC tested materials shall be used for fabrication.							
SMAW - SHIELDED METAL ARC WELDING				GTAW - GAS TUNGSTEN ARC WELDING			
(Prepared By)	(Checked By)	(Approved By)	CLIENT APPROVAL				

 		PROJECT		Standby SRU & Additional Tanks, IOCL Paradip Refinery			
		CLIENT		INDIAN OIL CORPORATION LIMITED			
WELDING SPECIFICATION SHEET		NO	PMS / 1300 / 08	Rev.	2	Date	10-Mar-20
PIPING CLASS D9D							
MATERIAL SPECIFICATIONS		PIPES	ASTM A335 Gr.P11				
		FITTINGS	ASTM A182 Gr.F11 Cl.2				
		FLANGES	ASTM A182 Gr.F11 Cl.2,				
		OTHERS					
BASE METAL 'P' NO.		4					
WELDING PROCESS AND CONSUMABLES				GROOVE JOINTS (NOTE 1)			
BUTT				OTHER THAN BUTT			
PROCESS	GTAW	SMAW		PROCESS	GTAW	SMAW	
PASS				PASS			
ROOT PASS (Note 2)	ER 80 S B2	NA		ROOT PASS (Note 2)	ER 80 S B2	NA	
FILLER PASS	ER 80 S B2	E 8018 B2		FILLER PASS	ER 80 S B2	E 8018 B2	
WELDING PROCESS AND CONSUMABLES				FILLET JOINTS/SW JOINTS (NOTE 1)			
PROCESS	GTAW	SMAW					
PASS							
ROOT PASS (Note 2)	ER 80 S B2	NA					
FILLER PASS	ER 80 S B2	E 8018 B2					
JOINT PREPARATION		ASME B 31.3					
GASES		PURGING		SHIELDING			
PROCESS	GTAW			PROCESS	GTAW		
PURGING				SHIELDING	YES		
PURGING GAS NAME				GAS NAME	ARGON		
GAS COMPOSITION				GAS COMPOSITION	99.995		
PREHEATING	PREHEAT TEMP	120° C Minimum		POST HEATING	Refer Note 4		
CONTINUITY OF WELDING AND PREHEAT	YES			INTERPASS	315° C Max		
POST WELD HEAT TREATMENT	HOLDING TEMP	650°C to 705°C		HOLDING TIME	1 HOUR / INCH for thickness ≤ 2 Inch		
	RATE OF HEATING	200° C / HOUR MAXIMUM		MIN. HOLDING TIME	120 Minutes		
(NOTE 3)	METHOD OF COOLING	Controlled		RATE OF COOLING	200° C / HOUR MAXIMUM		
MECHANICAL PROPERTY REQUIREMENTS		TEMP		MIN		AVERAGE	
CHARPY 'V' NOTCH IMPACT TEST VALUE		NA		NA		NA	
HARDNESS		225 HBW Maximum					
CODE OF FABRICATION		ASME B 31.1 +IBR					
TECHNICAL NOTES							
NOTE 1: Any combination of welding process for groove weld can be used subject to qualification of the Welding Procedure							
NOTE 2: Entire welding of small bore piping, 2"NB and smaller shall be performed with GTAW.							
NOTE 3: PWHT is mandatory for all thickness							
NOTE 4: In the event of any interruption during welding, Clause 131.6 of ASME B31.1 shall be complied							
SMAW - SHIELDED METAL ARC WELDING				GTAW - GAS TUNGSTEN ARC WELDING			
(Prepared By)	(Checked By)	(Approved By)	CLIENT APPROVAL				





 		PROJECT		Standby SRU & Additional Tanks, IOCL Paradip Refinery			
		CLIENT		INDIAN OIL CORPORATION LIMITED			
WELDING SPECIFICATION SHEET		NO	PMS / 1300 / 09		Rev.	2	Date 10-Mar-20
PIPING CLASS D9L							
MATERIAL SPECIFICATIONS		PIPES ASTM A335 Gr.P91					
		FITTINGS ASTM A182 Gr.F91					
		FLANGES ASTM A182 Gr.F91					
		OTHERS					
BASE METAL 'P' NO.		P 15E					
WELDING PROCESS AND CONSUMABLES				GROOVE JOINTS (NOTE 1)			
BUTT				OTHER THAN BUTT			
PROCESS	GTAW	SMAW		PROCESS	GTAW	SMAW	
PASS				PASS			
ROOT PASS (Note 2)	ER 90 S B9	NA		ROOT PASS (Note 2)	ER 90 S B9	NA	
FILLER PASS	ER 90 S B9	E9018- B91		FILLER PASS	ER 90 S B9	E9018- B91	
WELDING PROCESS AND CONSUMABLES				FILLET JOINTS/SW JOINTS (NOTE 1)			
PROCESS	GTAW	SMAW					
PASS							
ROOT PASS (Note 2)	ER 90 S B9	E9018- B91					
FILLER PASS	ER 90 S B9						
JOINT PREPARATION		ASME B 31.3					
GASES		PURGING		SHIELDING			
PROCESS	GTAW			PROCESS	GTAW		
PURGING	YES			SHIELDING	YES		
PURGING GAS NAME	ARGON			GAS NAME	ARGON		
GAS COMPOSITION	99.995			GAS COMPOSITION	99.995		
PREHEATING	PREHEAT TEMP	200° C Minimum		POST HEATING	Refer Note 4		
CONTINUITY OF WELDING AND PREHEAT		YES		INTERPASS	315° C Max		
POST WELD HEAT	HOLDING TEMP	750 to 775		HOLDING TIME	1 HOUR / INCH		
TREATMENT	RATE OF HEATING	110° C / HOUR MAXIMUM		MIN. HOLDING TIME	120 Minutes		
(NOTE 3 & 5)	METHOD OF COOLING	Controlled		RATE OF COOLING	110° C / HOUR MAXIMUM		
MECHANICAL PROPERTY REQUIREMENTS		TEMP	MIN	AVERAGE			
CHARPY 'V' NOTCH IMPACT TEST VALUE		NA	NA	NA			
		HARDNESS	190 to 250 HBW				
CODE OF FABRICATION		ASME B 31.1+ IBR					
TECHNICAL NOTES							
NOTE 1: Any combination of welding process for groove weld can be used subject to qualification of the Welding Procedure							
NOTE 2: Entire welding of small bore piping, 2"NB and smaller shall be performed with GTAW.							
NOTE 3: PWHT is mandatory for all thickness							
NOTE 4: In the event of any interruption during welding, Clause 131.6 of ASME B31.1 shall be complied							
NOTE 5: Preheat, Interpass temperature and PWHT shall be done only with Electric coil heating with temperature chart recorder							
NOTE 6: Mn + Ni shall be 1.20% max for E9018-B91							
SMAW - SHIELDED METAL ARC WELDING				GTAW - GAS TUNGSTEN ARC WELDING			
(Prepared By)	(Checked By)	(Approved By)	CLIENT APPROVAL				

 		PROJECT		Standby SRU & Additional Tanks, IOCL Paradip Refinery			
		CLIENT		INDIAN OIL CORPORATION LIMITED			
WELDING SPECIFICATION SHEET		NO :	PMS / 1300 / 06	Rev.	2	Date	27-Nov-19
PIPING CLASS A1K							
MATERIAL SPECIFICATIONS		PIPES	ASTM A312TYP304L, ASTM A358 Gr.304L Cl.1				
		FITTINGS	ASTM A182F304L, ASTM A403Gr.WP304L				
		FLANGES	ASTM A182F304L				
		OTHERS					
BASE METAL 'P' NO. 8							
WELDING PROCESS AND MATERIALS				GROOVE JOINTS (NOTE 1)			
BUTT				OTHER THAN BUTT			
PROCESS	GTAW	SMAW		PROCESS	GTAW	SMAW	
PASS				PASS			
ROOT PASS (Note 1)	ER 308 L	NA		ROOT PASS (Note 1)	ER 308 L	NA	
FILLER PASS	ER 308 L	E 308L 15/16		FILLER PASS	ER 308L	E 308L 15/16	
WELDING PROCESS AND METALS				SOCKET/FILLET JOINTS			
PROCESS	GTAW	SMAW					
PASS							
ROOT PASS (Note 1)	ER 308 L	NA					
FILLER PASS	ER 308 L	E 308L 15/16					
JOINT PREPARATION ASME B 31.3							
GASES		PURGING (NOTE 2)			SHIELDING		
PROCESS	GTAW			PROCESS	GTAW		
PURGING	YES			SHIELDING	YES		
PURGING GAS NAME	ARGON			GAS NAME	ARGON		
GAS COMPOSITION	99.995%			GAS COMPOSITION	99.995%		
PREHEATING PREHEAT TEMP 10° C MIN. POST HEATING NA							
CONTINUITY OF WELDING AND PREHEAT			YES	INTERPASS		150° C Max.	
POST WELD HEAT TREATMENT		HOLDING TEMP	NA	HOLDING TIME		NA	
		RATE OF HEATING	NA	MIN. HOLDING TIME		NA	
		METHOD OF COOLING	NA	RATE OF COOLING		NA	
MECHANICAL PROPERTY REQUIREMENTS				TEMP	MIN	AVERAGE	
CHARPY 'V' NOTCH IMPACT TEST VALUE				NA	NA	NA	
HARDNESS							
CODE OF FABRICATION ASME B 31.3							
TECHNICAL NOTES							
Note 1: Entire welding of small bore piping, 2"NB and smaller shall be performed with GTAW.							
Note 2 - It is generally recommended that back purge gas shall be maintained for the first two fill pass welds							
<div style="display: flex; justify-content: space-around;"> SMAW - SHIELDED METAL ARC WELDING GTAW - GAS TUNGSTEN ARC WELDING </div>							
(Prepared By)		(Checked By)		(Approved By)		CLIENT APPROVAL	

 		PROJECT		Standby SRU & Additional Tanks, IOCL Paradip Refinery			
		CLIENT		INDIAN OIL CORPORATION LIMITED			
WELDING SPECIFICATION SHEET		NO :	PMS / 1300 / 07	Rev.	2	Date	27-Nov-19
PIPING CLASS A21N							
MATERIAL SPECIFICATIONS		PIPES	ASTM A312TYP316L, ASTM A358 Gr.316L Cl.1				
		FITTINGS	ASTM A182F316L, ASTM A403 Gr.WP316L				
		FLANGES	ASTM A182F316L				
		OTHERS					
BASE METAL 'P' NO.		8					
WELDING PROCESS AND MATERIALS				GROOVE JOINTS (NOTE 1)			
BUTT (NOTE 1)				OTHER THAN BUTT			
PROCESS	GTAW	SMAW		PROCESS	GTAW	SMAW	
PASS				PASS			
ROOT PASS (Note 1)	ER 316 L	NA		ROOT PASS (Note 1)	ER 316 L	NA	
FILLER PASS	ER 316 L 15/16	E 316 L 15/16		FILLER PASS	ER 316 L 15/16	E 316 L 15/16	
WELDING PROCESS AND METALS				SOCKET/FILLET JOINTS			
PROCESS	GTAW	SMAW					
PASS							
ROOT PASS (Note 1)	ER 316 L 15/16	NA					
FILLER PASS	ER 316 L 15/16	E 316 L 15/16					
JOINT PREPARATION		ASME B 31.3					
GASES		PURGING (Note 2)		SHIELDING			
PROCESS	GTAW			PROCESS	GTAW		
PURGING	YES			SHIELDING	YES		
PURGING GAS NAME	ARGON			GAS NAME	ARGON		
GAS COMPOSITION	99.995%			GAS COMPOSITION	99.995%		
PREHEATING		PREHEAT TEMP	10° C MIN.	POST HEATING	NA		
CONTINUITY OF WELDING AND PREHEAT		YES		INTERPASS	150° C Max.		
POST WELD HEAT TREATMENT		HOLDING TEMP	NA	HOLDING TIME	NA		
		RATE OF HEATING	NA	MIN. HOLDING TIME	NA		
		METHOD OF COOLING	NA	RATE OF COOLING	NA		
MECHANICAL PROPERTY REQUIREMENTS				TEMP	MIN	AVERAGE	
CHARPY 'V' NOTCH IMPACT TEST VALUE				NA	NA	NA	
HARDNESS				22 HRC Max. for NACE/H2S Service			
CODE OF FABRICATION		ASME B 31.3					
TECHNICAL NOTES							
NOTE 1: Entire welding of small bore piping, 2"NB and smaller shall be performed with GTAW.							
Note 2 - It is generally recommended that back purge gas shall be maintained for the first two fill pass welds							
<div style="display: flex; justify-content: space-around;"> SMAW - SHIELDED METAL ARC WELDING GTAW - GAS TUNGSTEN ARC WELDING </div>							
(Prepared By)		(Checked By)		(Approved By)		CLIENT APPROVAL	

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PIPING -FLUSHING, TESTING & REINSTATEMENT- PROCEDURE

			 NAVNEET KUMAR	 Signed By	 Authorized By	 Authorized By
0	16/10/2019	ISSUED FOR INFORMATION	NVK	PKP	LA	JMC
REV.	DATE	DESCRIPTION	PREPARED	CHECKED	APPROVED	AUTHORIZED

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1. INTRODUCTION

INDIAN OIL CORPORATION LIMITED (IOCL) has awarded Fax of Acceptance (FOA) dated 29th August 2019 to M/s. Technip India Limited (TPIL) for Consultancy services (PMC/EPCM services) for overall project management, FEED Review / FEED, Detailed Engineering, Procurement & expediting services, Tendering & award, Construction Management & Supervision, Assistance in start-up, Commissioning & performance test runs for installation of a Standby SRU of 525 TPD capacity and execution of Additional tanks for Paradip Refinery, Odisha, India.

2. DEFINITIONS & ABBREVIATIONS

Abbreviation	Definition /Expanded form
IOCL/ CLIENT	Indian Oil Corporation Limited
PMC/ CONSULTANT	Technip India Limited
LICENSOR	Party selected by IOCL for process technology ownership for any UNIT
CONTRACTOR	Party whose services are obtained for performing the works specified as part of LSTK / packages.
EPCM	Engineering, Procurement & Construction Management Services.
LSTK	Lump Sum Turn Key portion of the work to be executed by CONTRACTOR
FEED	Front End Engineering Design
AUTHORISED REPRESENTATIVE	IOCL's/ CONSULTANT's representative authorized to act for and on behalf of them.
VENDOR	Any third party supplying the equipment/materials for setting up the Plant
PROJECT	Indicates Standby SRU and Additional tanks Project, Paradip Refinery
UNIT	Indicates any particular portion of the project to be built which can be Process related or Utilities/Offsites related
SRU	Sulphur Recovery Unit

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3. **SCOPE**

This specification covers the minimum requirements for flushing, pressure testing, draining, drying and reinstatement of piping systems.

4. **REFERENCE DOCUMENTS**

Contractor shall meet all requirements of federal, state and local laws and regulations, which maybe specified by Owner / TPIL.

4.1 **CODES**

ASME B31.1	Power Piping
ASME B31.3	Process Piping
IBR	Indian Boiler Regulations.

4.2 **STANDARDS**

The version valid on the date of contract award shall be used.

ASME B16.34 Valves Flanged, Threaded and Welding Ends.



4.3 SPECIFICATIONS/DRAWINGS, ETC.

5. **PRESSURE TESTING SCOPE**

- 5.1 Piping systems subject to pressure testing shall be indicated on test diagrams & line list which shall be prepared by CONTRACTOR using the P&ID's as the basis.
- 5.2 Prior to testing, CONTRACTOR shall provide documentation (test packages) in which the test system limits, type of testing and the test pressure are defined.
- 5.3 Test systems shall be divided into:
 - 5.3.1 **Systems, which require pneumatic testing.**

Pneumatic testing always needs approval from OWNER / TPIL and shall be limited to:

 - a. High-pressure Nitrogen lines.
 - b. Flare lines and overhead vapor lines not designed for full of water testing.
 - c. Lines in cryogenic service (cold packs) where freezing of water in cavities may damage piping or valves (e.g. ball valves).
 - d. Lines where introduction of water damages piping systems or product to be conveyed after start-up (oxygen lines, EO lines etc.).

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5.3.2 Systems, which require service testing.

Service test always needs approval from OWNER / TPIL

Service testing shall be limited to piping systems as defined in ASME B31.1 / B31.3. Instrument air, plant air and nitrogen lines shall be service tested to avoid presence of water in the lines.

5.3.3 Systems, which require "full of liquid testing".

"Full of liquid testing" shall be limited to pressure-less sewer systems and all other systems under atmospheric pressure (vent lines etc.).

5.3.4 Systems, which require hydrotesting

All systems except those mentioned under 5.3.1, 5.3.2 and 5.3.3, require hydro-testing

5.4 All testing for piping subject to authority approval as identified in "test packages" shall be in accordance with authority rules and additional requirements of this specification.

In case requirements of this specification are in contradiction with authority requirements, authority requirements are governing.

5.5 Piping not subject to authority approval shall be tested in accordance with this specification and ASME B31.1/B31.3 (depending on selected design code) as a minimum.

5.6 Test pressures listed in test packages shall be determined in accordance with one of the applicable codes, as mentioned above

6. GENERAL REQUIREMENTS

6.1 Prior to testing CONTRACTOR must have inspected the piping system for completeness and conformity to piping drawings and specifications.

6.2 Test packages for piping systems are to be released by Owner / TPIL prior to start of pressure testing and flushing.

6.3 All welds shall be free of painting, coating or insulation to enable visual inspection of all welds.



6.4 Welds of piping spools, which have been pressure tested in the piping prefabrication shop and have been painted afterwards, may remain painted during field pressure testing after erection.

6.5 For stainless steel piping, the duration of the hydrotesting, flushing and draining/drying sequence shall be kept as short as possible, to reduce the possibility of chloride attack.

6.6 Testing against a closed valve is not permitted, unless specifically approved by Owner / TPIL and under the condition that the test pressure is not higher than the maximum allowable pressure at ambient temperature of subject valve as indicated in ASME B16.34.

The pressure test certificate of subject valves must be included in the test package.

6.7 Test systems without equipment or closed valves may be combined when specifically approved by TPIL

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7. SAFETY AND ENVIRONMENTAL CONTROL

- 7.1 Before starting any pressure test or flushing operation, adequate measures for safety and environmental control shall be established. All code requirements, local regulations and recommendations from OWRN and TPIL shall be complied with.

7.2 SAFETY



- 7.2.1 Test pressure shall not be applied until the piping system and its contents are at approximately the same temperature.
- 7.2.2 Pressure testing shall be executed under supervision of an experienced piping supervisor to prevent accidents
- 7.2.3 The testing area shall be marked with signs indicating risk boundaries.
- 7.2.4 It is recommended to limit access to test area to authorized personnel only.
- 7.2.5 All piping systems shall be provided with a protective device to relieve excess pressure due to thermal expansion of the test fluid.
- 7.2.6 Actions, which may cause damage to pipe under pressure, are prohibited.
- 7.2.7 Test pressure shall be increased gradually in steps as shown below providing sufficient time between each step to check for leaks or unacceptable deformation and to allow the piping to equalize strains during testing.

Acceptable steps are:

- Increase to half the intended test pressure with a maximum of twenty-five (25) bars.
 - Increase with one (1) quarter of the intended test pressure with a maximum of twenty- five (25) bars.
 - Repeat step "b" until the intended test pressure has been reached.
- 7.2.8 Test pressure shall be released immediately if piping shows changes in form or size, which are not normal.
- 7.2.9 After completion of the pressure test, the pressure shall be released so as not to endanger personnel or damage equipment.
- 7.2.10 Care shall be taken that as little water as possible is spilled over the paving to prevent muddy and/or wet roads, or damage to equipment, instrumentation or insulation. A hose shall be used to drain water to a gutter or sewer system to avoid any damage to equipment and personnel or contact with electrical systems.
- 7.2.11 Pneumatic Testing
- As pneumatic testing presents special risks, utmost care shall be taken during pressurization and inspection of the systems to prevent any danger to personnel or equipment.
- 7.2.12 Following additional safety measures shall be taken:
- Access to test area shall be limited to test personnel only.
 - Compressor and pressure gauge for checking the test pressure shall be in a sheltered area.
 - Contractor shall prepare a procedure detailing steps to be taken for pneumatic testing.

7.3 ENVIRONMENTAL CONTROL

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- 7.3.1 The use of chemical additives, i.e. wetting agents, biocides, inhibitors, etc., shall only be allowed when an environmentally acceptable disposal has been agreed with OWNER / TPIL and local authorities.
- 7.3.2 A wastewater disposal plan, which will specify the handling of the water used for flushing and pressure testing, shall be prepared and agreed upon between OWNER & TPIL
- 7.3.3 Disposal of flush and test water via the plant sewer system shall only be allowed after written approval from OWNER / TPIL at specified flow rates.
- 7.3.4 Subcontractor shall estimate the expected quantities, flow rate and composition of the wastewater.

8. TEST EQUIPMENT

- 8.1 Equipment used for testing shall be approved by Owner / TPIL and authority inspectors prior to use.
- 8.2 Contractor shall supply hydrostatic testing equipment, including filters, fill pump, pressurizing pump, test gauges, relief devices, storage tanks, and test and flushing medium.
- 8.3 For pneumatic testing, an air compressor suitable to supply dry, clean air at the pneumatic test pressure shall be supplied by contractor.
- 8.4 The test pressure shall be checked by means of gauges having a range from zero up to a minimum of 1.5 and a maximum of 4 times the required maximum test pressure.
- 8.5 All test pressure gauges shall be calibrated within a tolerance of 1% accuracy prior to testing. Calibration certificates shall be available at the work site and all gauges shall be properly identified to enable traceability to the calibration certificates.
- 8.6 Calibration of gauges shall be repeated every 6 months or whenever requested by the inspection team (representatives from the authorities, OWNER & TPIL).
- 8.7 Temperature measuring equipment to measure metal temperature and content temperature shall have a tolerance of + 0.5°C.
- 8.8 CONTRACTOR shall prove by means of calculations that supplied test blanks are suitable for the intended test pressure. Contractor shall supply test blanks test gaskets & water. Design and dimensions shall be in accordance with piping standards.



9. TEST MEDIUM

- 9.1 The test medium for hydrostatic testing shall be clean water (maximum chloride content 20-25 ppm) without foreign matter such as sand, rust or other particles.

A filter shall be provided in the water fill lines.

Prior to use the water shall be analysed and the results shall be reported to TPIL. Testing of the water quality shall be repeated once every week.

- 9.2 Where the test packages indicate that a pneumatic test must be performed, air shall be used for pressure testing.



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9.3 Service tests shall be performed with the intended service medium.

10. TEST PROCEDURE

10.1 PREPARATIONS FOR PRESSURE TESTING

- 10.1.1 Blind flanges, blanks, caps or plugs with adequate pressure rating shall be installed to isolate piping systems and equipment as indicated on the test diagrams.
- 10.1.2 All temporarily installed items (blanks, gaskets, spools, strainers, etc.), shall be adequately marked using paint or tags for easy traceability.
- 10.1.3 Items not to be subjected to the pressure test shall be removed. Items to be removed or blanked off prior to testing/flushing shall include, but shall not be limited to:
 - Equipment not included in the test system.
 - Relief valves and rupture discs.
 - Orifice plates, flow nozzles or other similar restrictions.
 - Venturi type flow meters (flanged).
 - Internals of equipment (trays, demisters, level instrument floats, float cages, etc.), if included in the test system.
 - Flanged control valves (for welded-in type control valve internals shall be removed).
 - Flanged check valves unless internals are removed (for butt-weld check valves internals shall be removed).
 - All in-line instruments (unless otherwise approved by TPIL) .
 - Any items not designed to withstand the test pressure (e.g. pressure gauges).
 - Internals of strainers and filters.
- 10.1.4 Instrument piping shall be tested together with the piping system up to the piping block valve nearest to the instrument.
- 10.1.5 When a union is provided downstream of an instrument block valve, it shall be broken to prevent dirt or foreign matter from being introduced into the instrument.
- 10.1.6 If the test pressure on both sides of flanged control valves is equal and when block valves and bypass are installed, the block and bypass valves shall be left open with the control valve removed and with blinds or a spool piece installed.
- 10.1.7 If test pressures up and downstream of a control valve are not equal, the spool piece between the control valve and the downstream block valve shall be tested in combination with the upstream part.
- 10.1.8 Piping supported by counterweight or spring without "down travel stop" shall be temporarily supported prior to filling of the line with water.
- 10.1.9 A spring with "down travel stop" shall have the "stop" (wedges or block) inserted prior to filling of the line with water.

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10.1.10 Piping designed for vapor or gas shall (when necessary) be provided with additional temporary supports, as indicated on isometrics, to support the additional weight of the test liquid.

10.1.11 All open valves in the test system, which have a back seat (gate and globe valves) shall be fully opened until the stem seat contacts the back seat and then the hand wheel shall be turned twice in the direction of closing to assure that gland packing is subjected to full line test pressure.

10.1.12 Open ends of atmospheric lines to be "full of liquid" tested shall be left open during testing.

10.1.13 For pneumatic testing or service testing with air or nitrogen, screwed and flanged joints shall be prepared for soap testing by taping with masking tape and punching a 3 mm diameter hole through the tape.

When electronic leak testing will be applied, taping with masking tape will not be required.

10.2 PRESSURE TESTING

10.2.1 After acceptance of the preparations for pressure testing by TPIL, the piping system will be released for pressure testing.

10.2.2 All systems shall be properly vented (at the high points) while filling.

10.2.3 Test pressure shall be applied by means of a suitable test pump or other pressure source. This pump shall be positively isolated from the system except when being used to pressurize the system (the hose should be disconnected after filling).

10.2.4 At least two (2) pressure gauges per test system shall be installed: one (1) at the test pump discharge and one (1) at or near the highest point of the test system. The pressure recorded at the pump is governing (lowest point). Other gauges shall indicate same pressure with a correction for static head. For large systems, more pressure gauges shall be installed at suitable locations, in coordination with TPIL.

10.2.5 An authorized person shall constantly attend the test pump during the test. Before the pump is left unattended, it shall be positively disconnected from the system, while the pressure gauge remains connected to the test system.

10.2.6 The test pressure shall be as indicated in the Line List as prepared by CONTRACTOR

10.2.7 Retesting of a system (when required) shall be performed at the same pressure as originally specified for the test.

10.2.8 The outside surface of the test system shall be dry and free from grease and dirt before and during testing. Testing during rain periods can't be performed.



10.2.9 The test pressure shall be maintained for at least half an hour prior to start of inspection and long enough to enable a visible inspection of the complete test system by the inspection team.

10.2.10 Atmospheric lines to be "full of liquid" tested shall be filled with water for at least 24 hours before visible inspection of the complete test system by the inspection team.

Water level in the test system shall be checked and marked at the start of the test and rechecked after twenty-four (24) hours during visible inspection of the system.

10.2.11 In case hydrotesting through equipment is required, LSTK/EPC Contractor shall provide special instructions & approved by Owner / TPIL (e.g. maximum differential pressures on shell and tube side of heat exchangers) where applicable.

10.3 ADDITIONAL REQUIREMENTS FOR SERVICE TESTS

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10.3.1 A service test shall be performed with the line in service i.e. with the service medium and at service pressure.

10.3.2 Visual inspection, and/or (in case of air or nitrogen lines) soap leakage tests shall be carried out.

10.4 **ADDITIONAL REQUIREMENTS FOR PNEUMATIC TESTING**

10.4.1 For systems being pneumatically tested, a preliminary check of the test system shall be made at a pressure not exceeding 1.7 barg (25 psig).

10.4.2 A visual inspection, and soap leakage tests shall be carried out.

10.4.3 Care shall be taken to avoid a temperature drop which could cause failure of metal and thermoplastics due to embrittlement. The metal temperature during testing shall not be below the minimum allowable temperature indicated in the "test package".

10.5 **FLUSHING**

Requirements described in this paragraph are for construction flushing only. Whenever flushing, cold commissioning and hot commissioning are part of the scope of the CONTRACTOR a separate specification shall be developed to describe flushing methods and cleanliness requirements for the piping systems involved.

10.5.1 After acceptance of testing reports by TPIL, the piping system will be released for flushing.

10.5.2 Flushing will be carried out to remove all trash and construction debris from the piping systems.

10.5.3 Flushing through equipment is not allowed unless specifically approved by TPIL

10.5.4 During flushing of pump suction/discharge lines, the elbow close to the pump shall be turned away and the pump inlet shall be adequately covered to prevent contamination of pumps. This applies also for equipment nozzles, which shall be blinded off during the flushing operation.

10.5.5 Commissioning team representatives from TPIL shall witness each flushing operation.

10.5.6 Flushing shall be performed against open pipe ends. Flushing via small openings like vents, drains, etc., is regarded as insufficient.

10.5.7 Stainless-steel lines shall be flushed with DM water or clean condensate to prevent chloride stress corrosion cracking.

10.5.8 After completion of the flushing operation, equipment which is welded in-line and included in the test system, shall be inspected internally for cleanliness.

10.5.9 For a better flushing effect, it is recommended to use special water/air flushing tools.



10.5.10 Trash and construction debris in air or nitrogen systems, which will not be hydrotested, shall be removed from the piping systems by air blowing.

10.6 **DRAINING AND DRYING**

10.6.1 Immediately after flushing, all lines and systems shall be completely drained.

10.6.2 After draining, all test systems not subject to chemical cleaning shall be dried with air.

Contractor shall provide a suitable air compressor with drier.

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The system shall be pressurized with air up to the system operating pressure with a maximum of 6 barg and expanded abruptly to atmospheric pressure.

10.6.3 After dry out, the systems shall be presented to TPIL for acceptance

10.7 REINSTATEMENT

10.7.1 After completion of testing, chemical cleaning (where applicable) and drying, all systems shall be reinstated as per drawings and specifications.

This also includes but shall not be limited to:

- Removal of all temporary materials such as spades, blinds, gaskets, pipe spools, temporary supports, etc.
- Replacement of all damaged gaskets and all test gaskets.
- Positioning of spectacle blinds to the correct position.
- Reinstallation of all items removed for hydrotesting.
- Reinstallation of unions downstream of instrument block valves.
- Inspection of the completed system for correct flow direction of instruments, check and control valves, etc.

10.7.2 During the activities described above, measures shall be taken to avoid dirt, debris, etc., entering the piping system. Each pipe spool shall be inspected for cleanliness prior to reinstallation.

OWNER, TPIL and CONTRACTOR shall witness this inspection.

10.7.3 After inspection and acceptance by Owner / TPIL, the system shall be released for further activities, e.g. steam tracing, painting, insulation, etc.



10.7.4 The "stop" of pipe support springs with "down travel stop" placed prior to flushing, shall be removed during pre-commissioning or commissioning stage.

11. INSPECTION AND REPORTING

Contractor shall prepare a final report, giving positive documented evidence that subject systems are pressure tested in accordance with the requirements.

Documentation shall be maintained in accordance with the code and/or authority requirements for piping systems. The report will have to include as a minimum:

- All information required by the applicable code and/or authority requirements.
- Reference to documents and specifications.
- Applicable:
- Hydrotest diagrams.
- P&ID's.
- Isometrics, duly marked up with all weld joints.

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- Internal cleaning reports
- Line History Sheets & NDT reports.
- Agreed punch lists.
- Authority approvals.
- All required certificates.
- A continuous log of operation, if applicable.
- Test results and duration.
- Pressure.
- Temperature (metal and content).
- Duration.
- Ambient temperature.
- Signature of local authority (when applicable), OWNER, TPIL and CONTRACTOR.

**PROJECT****Standby SRU & Additional Tanks****IOCL Paradip Refinery****CLIENT****INDIAN OIL CORPORATION LIMITED****JOB CONSTRUCTION
SPECIFICATION FOR WELDERS
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JOB CONSTRUCTION SPECIFICATION FOR WELDERS MANAGEMENT

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1. INTRODUCTION:

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2. DEFINITIONS & ABBREVIATIONS

Abbreviation	Definition /Expanded form
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CONTRACTOR	Party whose services are obtained for performing the works specified as part of LSTK / packages.
EPCM	Engineering, Procurement & Construction Management Services.
LSTK	Lump Sum Turn Key portion of the work to be executed by CONTRACTOR
SUBCONTRACTOR	Any person/ Company / Person or Body who may be engaged by Contractor / LSTK for works and services connected with construction/ Installation/ Erection /commissioning of the facilities for the project with or without the supply of equipment and material.
FEED	Front End Engineering Design
VENDOR SUPPLIER	Any third party supplying the equipment/materials for setting up the Plant
LLI	Long Lead Item – Any equipment / Package / Work order taking 16 months or more completion time from the date of award
PROJECT	Indicates Standby SRU & Additional tanks Project,Paradip Refinery
SITE	Indicates ,Paradip Refinery,Odisha

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UNIT	Indicates any particular portion of the project to be built which can be Process related or Utilities/Off sites related
ENGINEER-IN-CHARGE	PMC represented looking over the CONTRACTOR's/ LSTK Job or Part thereof
MR	Material Requisition
PURCHASER	The Party That Issues the Purchase Order for The Package
KOM	Kick Off Meeting
AUTHORISED REPRESENTATIVE	OWNER's/CONSULTANT's representative authorized to act for and on behalf of OWNER/CONSULTANT
PLANT	the units and facilities comprised in the project, and if divided into different packages for the award of LSTK Contracts

3. **SCOPE**

The purpose of this specification is to define:

- the activities and the documents to be adopted to confirm, evaluate and monitor qualification and performance of welders and welder's operator.
- the Q.C. activities to be carried out and forms to be adopted for the welding inspection procedure;
- duties and responsibilities of the parties involved.

For this specification "welder" has the meaning of welder and welder operator.

4. **FIELD OF APPLICATION**

The present specification is prepared to be applied to project IOCL- Paradip Standby SRU & Tankages LSTK packages.

5. **CORRELATION WITH OTHER PROCEDURES/SPECIFICATION**

This specification is to be correlated with the following documents:

- | | |
|---|----------------------------|
| • Welding & NDE Specification for Fabrication of Piping | 080557C-000- PP- 814 |
| • Quality Control Plan for Welders Management | 080557C-000- -QCP-1399.01 |
| • Standard Specification for Fabrication and Erection of Piping | 080557C-000- -JSC-1300-001 |

All other documents referenced in these specifications shall be considered applicable.

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6. ACTIVITIES AND DOCUMENTATION

6.1 WELDER'S QUALIFICATION AT PREFABRICATION SHOP

Before they are proposed to PMC / OWNER all Contractor welders shall already have a qualification certified by an Independent Recognized Third-Party Organization (I.R.T.P.O.) according to ASME IX, AWS D1.1

- For all the other welders is necessary a confirmation with "test coupon" as per para.6.3

During production at Prefabrication Shop, all the welders will be evaluated according the "Periodical Evaluation" procedure (applicable Form W22) as specified in para. 6.5.2 and will be monitored according to para. 6.5.3.

6.2 Transfer of welders from "Prefabrication Shop" to "Site"

All the welders that have worked at Prefabrication Shop having good performances could be transferred for working at Site after a confirmation (Control Evaluation) as specified in para. 6.5.1

6.3 Confirmation of Welder's Qualification at Site

Confirmation of welder's qualification consist of one welding test coupon execution, one per each qualification type (i.e. materials, range of thickness and diameter, processes, positioning, etc.), to be checked by visual and radiographic examination. See APPENDIX "A".

Welding execution on test coupons must be done at CONTRACTOR Welding Inspector presence.

If examination result is acceptable:

- welder's qualification is confirmed;
- welder's identification is assigned;
- welder's list is up-to-date.



If examination result is not-acceptable:

- welder's qualification is not confirmed.

6.3.1 Test Coupons

Welded Test Coupons must be marked by Contractor with the welder name and progressive numbering and made available for visual check and evaluated by PMC/OWNER Welding Inspector (see attached Form W 19).

After visual inspection, the welded test coupons are verified by radiographic examination tests at Contractor care.

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Test results shall be recorded on Form W 19 and submitted to PMC /OWNER Welding Inspector for approval.

6.3.2 Categories

Welders shall be classified into three categories:

- **Piping Welders**

These welders must be qualified according to ASME IX.

These qualified welders are authorized for the butt welding of piping in the selected ASME IX ranges including tack, temporary, repair welds and for any kind of fillet welds for this category.

- **Equipment Welders**

These welders must be qualified according to ASME IX.

These qualified welders are authorized for the butt welding of plates with selected ASME IX ranges including tack, temporary, repair welds and for any kind of fillet welds for this category.

- **Structural Welders**

These welders must be qualified according to AWS D1.1 or ASME IX.

Welders qualified for full penetration welding are authorized to perform repair, fillet and tack welds of structural assemblies and for piping supports.

In addition to piping, equipment and structural welders' categories, it's possible to qualify tack welders as follows:

- **Structural tack welders**

Tack welder's qualification consists of test coupon execution in position 3F and 4F with visual examination and bend (or fracture) test as per ASME IX.



Welding and bend (or fracture) test execution on test coupons must be done at CONTRACTOR welding inspector presence.

These qualified tack welders are authorized for tack welding of structural assemblies and piping supports.

- **Piping tack welders**

Piping tack welder's qualification is applicable for carbon steel material P-Number N° 1 Group 1 & 2 only.

Piping tack welder's qualification follows the same requirements as per structural tack welders.

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REMARK:

Concerning equipment and piping other than carbon steel materials P-Number N°1 Group 1 & 2, tack welds must be done by welders qualified in accordance to ASME IX.

6.4 Identification and Registration

6.4.1 Identification Stamp

Contractor shall assign to each approved welder an identification number (stamp) that will be approved by PMC

Such identification number (stamp) shall be marked or punched by the welder, close to each weld he has carried on. The identification number shall be used to record the welding activities of the related welder

6.4.2 Registration

For all approved welders all data relevant to confirmation examinations (visual and radiographic examination) shall be recorded by Contractor on Form W19.

Contractor shall also fill-in the main data of the welder qualification made by Independent Recognized Third-Party Organization in the attached Form W07 - Welders List.

The Contractor will register all historical information about each welder (i.e. confirmation, penalty, etc.) in the attached Form W21.



For all approved tack welders, visual examination and bend (or fracture) test shall be recorded on a dedicated form like form W19 proposed and fulfilled by Contractor. That form shall be additionally approved by PMC /OWNER welding inspector.

6.5 Inspection and Evaluation on Production

6.5.1 Control Evaluation (at site only)

To check the welders ability at site the initial welding production of piping and equipment welders after their qualification confirmation is controlled by the CONTRACTOR Welding Inspector as below specified: first two production welded joints of each confirmed welder are 100% radiographically examined and evaluated according to the applicable codes; the following criteria of acceptance are applied:

- When the production welds are acceptable, the welder is confirmed.
- If one production weld is rejected, two additional joints, made by the same welder, shall be 100% radiographically examined. If additional joints are acceptable, the welder is confirmed. If any of the penalty joints reveal defects requiring repair, the welder is rejected.
- If both production welds are rejected, the welder is rejected.

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- After a welder passes the initial evaluation, he shall be monitored as per ASME B31.3 by “WELDER’S RT%” weekly report (FORM W22).

6.5.2 Periodical Evaluation

Contractor must continuously control the welder’s production through periodical performance evaluation, as per the percentage explained below.

The welder’s performance evaluation is based on the “Repair Rates” (RR). The Repair Rates shall be calculated on linear basis.

The maximum weekly repair rate for each welder should not exceed 2%.

$$RR(\%) = \frac{L_r}{L_w} \times 100$$

L_r = welder’s total length of repairs in one week, mm

L_w = welder’s total length of weld radiographed in one week, mm

The results of the radiographic examinations relevant to each welder are summarized in the Welder Repair Rates Weekly Report (FORM W22) which is kept by Contractor and delivered to PMC /OWNER Welding Inspector on weekly basis.



Welders are confirmed or disqualified according to the results summarized in the

Welder RR Weekly Report and criteria given below:

RR	ACTIONS TO BE TAKEN
RR ≤ 2%	Welder is confirmed.
2% < RR ≤ 10%	Increase control + 1 penalty shall be registered on Welder Historical Report (Form W 21)
RR > 10%	Welder is rejected.

Note 1: Welders that cumulate two penalties in 10 weeks are rejected or downgraded at PMC / OWNER Welding Inspector decision.

Note 2: Radiographic increase shall be at Contractor expense. PMC/OWNER Welding Inspector will decide the number of the joints to be checked in accordance with the ASME B 31.3/B31.1 and AWS D1.1 requirements.

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6.5.3 Monitoring

Contractor is responsible that the welders are operating according to their qualifications and to the approved welding procedures.

PMC / OWNER Welding Inspector that has found a welder not applying the welding procedure or working outside of his qualification can issue a notice to the Contractor requesting the cut-out of the incorrectly executed joints and the application of penalty note to the welder in his historical data report.

Welders that have two recorded penalties notices in 10 weeks are rejected or downgraded at PMC / OWNER Welding Inspector decision.

6.5.4 Welders Card

Contractor shall provide a Welders Card (to each welder) which shows the welder name, stamp and photo and essential data of welder qualification.

Welders Card shall be coloured to permit an easy identification of the job category and welding process for which welder is qualified.

LABEL COLOUR (*)	JOB CATEGORY
WHITE/material code	PIPING
YELLOW	EQUIPMENT
RED	STEEL STRUCTURES (FULL PENETRATION)
BLUE	TACK WELD – S. STRUCTURES / C. S. PIPING

7. ATTACHMENTS

ATT. 1 - APPENDIX “A” PROCEDURE FOR WELDERS CONFIRMATION



ATT. 2 - FLOW DIAGRAM FOR WELDERS Q.C. ACTIVITY

ATT. 3 - QCF W07 WELDERS LIST

ATT. 4 - QCF W19 TEST COUPONS VISUAL & RADIOGRAPHIC EXAMINATION

ATT. 5 - QCF W21 WELDER HISTORICAL REPORT

ATT. 6 - QCF W22 WELDER'S RT% & WELDER REPAIR RATES - WEEKLY REPORT

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ATTACHMENT 01

APPENDIX "A"

PROCEDURE FOR WELDERS & TACK WELDERS QUALIFICATION

1. PREPARATION OF TEST COUPON

Pipe/Plate test coupon for confirmation of welder and tack welder qualification shall be prepared by Contractor, according to ASME IX, AWS codes standard.

Machining, oxygen-acetylene flame cutting, or proper methods shall bevel test coupons. Test coupon shall be ground after flame cutting to match WPS joint preparation.

Each test coupon shall be marked as follows:

- Progressive test number (+ "TW" for tack welding)
- Coupon identification number (+ "TW" for tack welding)
- Welder Identification / Tack Welder Identification

2. TEST COUPON EXECUTION

Before starting the weld of test coupon Contractor's Welding Inspector shall verify and check the followings:

- Marking of test coupon;
- Material, Position, Range of thickness and diameter, etc. according to the qualification;
- WPS requirements.

All welding requirements as welding rods and shielding shall be in accordance with the applicable approved WPS.



3. TEST ACCEPTANCE CRITERIA

PMC /OWNER Welding Inspector shall witness the welder test.

PMC /OWNER Welding Inspector shall authorize the coupon radiographic examination only after his visual check and approval of welding by Form W19.

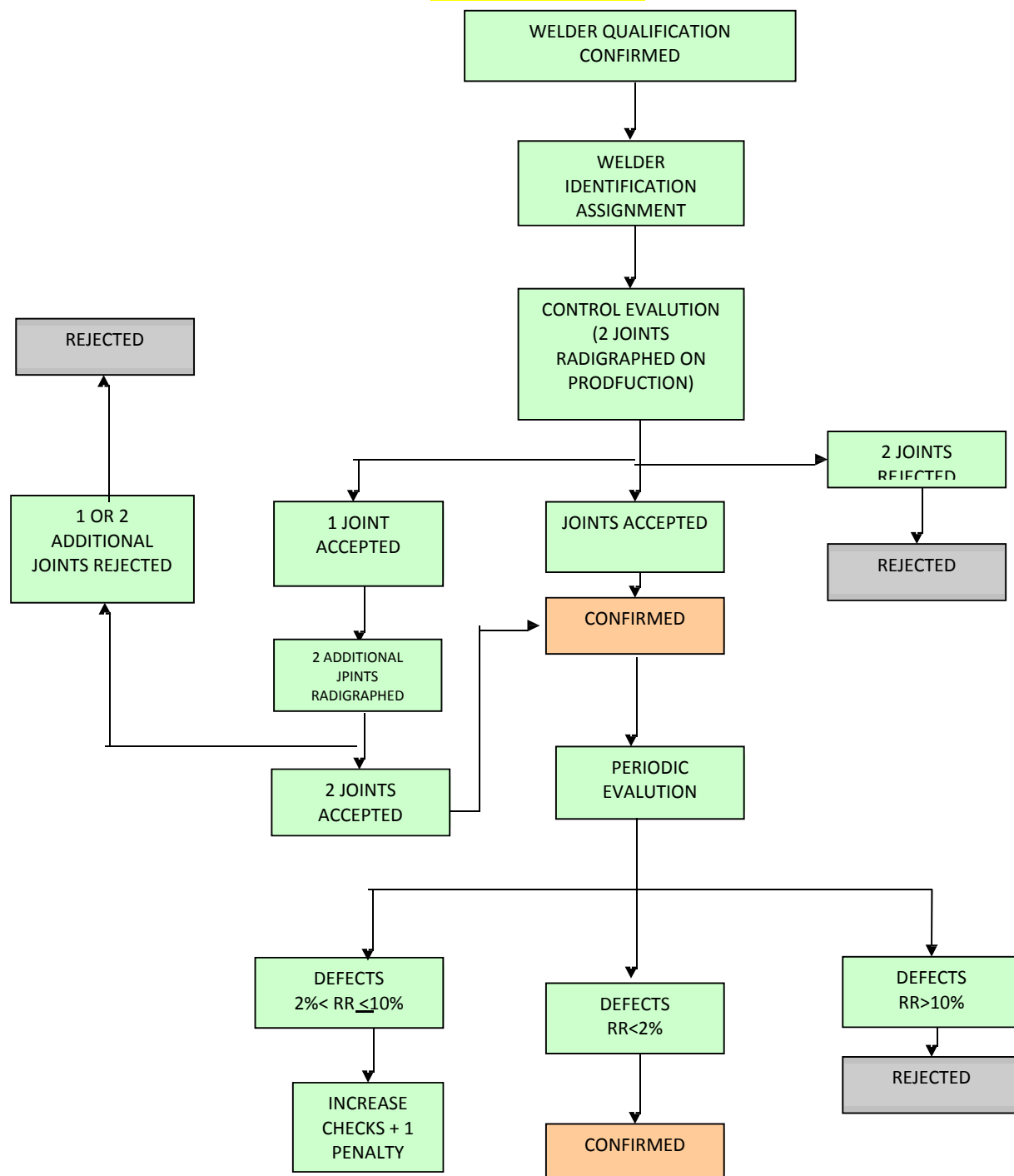
Acceptance criteria for visual inspection and radiographic examination shall be in accordance to ASME IX, ASME VIII, ASME B31.3 and ASME B31.1.

Visual and bend (or fracture) test acceptance criteria for tack welding shall be in accordance to ASME IX.

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ATTACHMENT 02

LOW DIAGRAM FOR WELDERS Q.C. ACTIVITY WELDERS EMPLOYED FOR PRESSURE RETAINING WELDS



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COMPANY:

W 19

QCF REV. 0

SH. OF

TEST COUPONS VISUAL & RADIOGRAPHIC EXAMINATION

CONTRACTOR:

W 19 N° _____

[illegible]

NOTE: (1) YES MEANS APPROVAL FOR RADIOGRAPHIC EXAMINATION

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				PROJECT: Standby SRU & Additional Tanks					
				COMPANY:					
QUALITY CONTROL FORM W 21				PROJ. No.:		QCF REV. 0		SH. 1 OF 1	
WELDER HISTORICAL REPORT				CONTRACTOR:				W 21 N° _____	
WELDER NAME _____				WELDER STAMP _____		WELDER PERFORMANCE QUALIFICATION (WPQ) N° _____			

AT WORK SHOP AT SITE	WEEKS PERIOD EVALUATION (Note 2)	PENALTIES		PENALTIES				WELDER		REMARKS											
		RR (%) = REPAIR RATES (W 22)		OTHER (MONITORING)				DISQUALIF. DATE	DOWN GRADED DATE												
		DATE	DATE	DATE	(*)	DATE	(*)														
1. TEST COUPON EXAMINATION (W 19 N°) : _____	From Week N° ____ To Week N° ____																				
2. CONTROL EVALUATION ON PRODUCTION <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <tr> <th colspan="2">FIRST TWO JOINTS</th> <th colspan="2">ADDITIONAL JOINTS</th> </tr> <tr> <th>(Note 1)</th> <th>DATE</th> <th>(Note 1)</th> <th>DATE</th> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>	FIRST TWO JOINTS		ADDITIONAL JOINTS		(Note 1)	DATE	(Note 1)	DATE													
	FIRST TWO JOINTS		ADDITIONAL JOINTS																		
	(Note 1)	DATE	(Note 1)	DATE																	

(*) PENALTY NOTE:

W = INCORRECT WPS APPLICATION

Q = INCORRECT WPQ APPLICATION

(1) ACC = ACCEPTABLE UN-ACC = UNACCEPTABLE A = APPLICABLE N.A. = NOT APPLICABLE (2) From the first welder working week									



PROJECT: **Standby SRU & Additional Tanks**

COMPANY:

QUALITY CONTROL FORM

W 22

PROJ. No.:

QCF REV. 0

SH. OF

WELDER'S RT % & WELDER REPAIR RATES (RR) WEEKLY REPORT

SUBCONTRACTOR:

W 22 N° _____

MATERIAL : _____ PIPING CLASSES: _____ RT% _____

WEEK N°	FROM	TO
---------	------	----

CUMULATIVE DATA

[illegible]

Filled up by:

Date:

Received by:

Date: