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BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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TYPE OF DOC.	TECHNICAL SPECIFICATION	NAME	SK	DKM	RS				
ILLUMINATION SYSTEM FOR 220/33KV SWITCHYARD			SIGN						
			DATE				18.04.16	18.04.16	18.04.16
			GROUP				TBEM	W.O. No	89004
CUSTOMER	NHPC LIMITED, FARIDABAD								
PROJECT	220/33KV SWITCHYARD FOR KISHANGANGA (3X110MW) HEP								
KISHANGANGA CONSORTIUM:	HINDUSTAN CONSTRUCTION COMPANY (HCC) LTD. HALCROW SUBCONTRACTOR: BHARAT HEAVY ELECTRICALS LTD.								
CONSULTANT	HALCROW NOIDA								

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LED FITTINGS IN BUILDING & STREET LIGHT
HPSV FITTINGS IN SWITCHYARD

Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS			
Distribution					To	TBCM	OC	
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SECTION-1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES

1.0 SCOPE

- 1.0.1 This technical specification covers the requirements of design, manufacture, testing at works, packing, dispatch, storage, erection, testing & commissioning of complete Illumination and associated electrical auxiliary system, complete with accessories and guarantee for two years from commissioning as per the specification hereunder.

The specification comprise of following sections:

- Section-1: Scope & Bill of Quantities.
Section-2: Standard Technical Specification
Section-3: General technical requirements for all equipment under the project.
Section-4: Guaranteed and Technical Particulars

In case of any conflict between various sections, order of precedence shall be in the same order as listed above. No deviation from the requirements specified in various clauses of this specification shall be allowed. A certificate to this effect shall have to be furnished along with the offer as per attached Annexure-1.

The equipment is required for the following project.

Name of Customer : NHPC Ltd.

KISHANGANGA CONSORTIUM:

Hindustan Construction Company (HCC) Ltd. / HALCROW

Subcontractor: Bharat Heavy Electricals Ltd.

Name of Consultant : HALCROW Noida

Name of the project : 220/33kV Switchyard for Kishanganga (3x110MW) HEP

Refer Section - 3 for Project Details and General Specifications.

- 1.0.2 The Contract shall be on Bill of Quantity basis for the package. In case of change in scope after award of the contract, the additions/ deletions to the scope shall be as per the breakup unit rates for all the equipment and services furnished by the bidder in his offer. The Contractor shall be responsible for the design and verification of the Illumination system, demonstration of lux levels and other criteria at site.
- 1.0.3 After placement of order, the bidder has to design the system as per relevant standard/codes to the satisfaction of BHEL/NHPC.
- 1.0.4 It is not the intent to specify herein all the details of design and manufacturing. The equipment and the system shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to Purchaser/Owner, who will interpret the meaning of drawings and specifications and shall be entitled to reject material, which in his judgment is not in full accordance herewith.
- 1.0.5 The Bidder shall have deemed to have understood completely all the Tender drawings and documents and quoted accordingly.

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- 1.0.6 The term "Owner" appearing in this specification shall refer to ultimate customer, the term "Purchaser" shall refer to BHEL and the term "Contractor" shall refer to the successful Bidder.
- 1.0.7 It is the responsibility of the successful Bidder to obtain necessary approval/clearance from statutory organizations wherever applicable for the equipment/systems under the scope specified.

1.1 ILLUMINATION & SMALL POWER SYSTEM REQUIREMENT FOR VARIOUS AREAS

The illumination system shall be provided for the following areas:

- (i) 220/33kV Switchyard area – Complete area inside fence of 220/33kV SWITCHYARD as per layout drawing (LAYOUT OF 220/33KV SWITCHYARD 02 SHEETS, Drg. No. TB-0-329-316-102).
- (ii) Street lighting area – 4.0 M wide road inside the 220/33kV SWITCHYARD and 7.0 M wide road outside the Switchyard Control Room as per layout drawing (LAYOUT OF 220/33KV SWITCHYARD 02 SHEETS, Drg. No. TB-0-329-316-102).
- (iii) Switchyard Control Building as per ARCHITECTURE LAYOUT OF CONTROL BUILDING LAYOUT (GENERAL LAYOUT PLAN and CROSS SECTION AND FRONT ELEVATION).

Note:

1. LED fittings shall be used in Switchyard Control Building and outdoor Street lighting.
2. HPSV fittings shall be used in outdoor Switchyard.

1.2 DESIGN CRITERIA FOR SWITCHYARD AREA

Since this switchyard is situated at an altitude of 1795M above MSL, the equipment shall be suitable for increased insulation level with an altitude correction factor of 1.1 times the normal values and shall be suitable for operation under prescribed conditions.

[The values of Impulse withstand Voltage & power frequency withstand voltage given in specific technical requirement below have been increased for the higher altitude taking a correction factor of 1.1].

Further the equipment being supplied shall be suitable for operation under subzero temp, with ice/snow considerations. The equipment shall be suitable for working in the temperature variation between (-) 12degree C to (+) 38degree C without reporting any malfunction.

Design Criteria for Switchyard shall be as per Section-2. The input drawings are enclosed at section 5.

1.3 SCOPE OF SUPPLIES & SERVICES

1.3.1 SCOPE OF SUPPLY MATERIAL & ERECTION MATERIAL

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- a) The main items to be furnished for Substation under this contract are detailed in Bill of Quantity (Annexure-2) and shall be read in conjunction with other clauses of this specification.
- b) All associated items, though not specifically mentioned but required for safe and satisfactory operation of equipment/ system will also be treated as included and the same shall be supplied at NO EXTRA COST to Purchaser.
- c) Further, in case any type of luminaries/ panels etc not included below but are required to meet the technical specification shall be specifically brought out in the offer/shall be supplied.
- d) 415V ACDB & 220V DCDB boards are being supplied and erected by the owner. Illumination contractor will terminate the cables in these panels.

1.3.2 FREE ISSUE ITEMS FROM PURCHASER

Power Cables: Following are the various cable sizes that may be used for project execution. Bidder shall estimate the cables required for successful completion of the full scope of works and furnish the breakup of quantity as an annexure to the un-priced schedule. The quantity of the cables shall be free issued to the successful bidder as per this annexure. The laying and termination of the estimated quantities of cables shall be in the scope of the bidder. No variation shall be admissible to the contractor so far the input remains unchanged.

- 1) 2core x 2.5 sq.mm (PVC/ Cu.)
- 2) 2core x 6 sq.mm (PVC/ Al.)
- 3) 4 core x 6 sq.mm (PVC/ Al.)
- 4) 4 core x 16 sq.mm (PVC/ Al.)
- 5) 3.5 core x 35 sq.mm (PVC/ Al.)
- 6) 3.5 core x 70 sq.mm (PVC/ Al.)
- 7) 3.5 core x 150 sq.mm (PVC/ Al.)
- 8) 3.5 core x 300 sq.mm (PVC/ Al.)
- 9) 1 core x 630 sq.mm (HR PVC/ Al.)

Earthing Flats: Galvanized Earthing Flat shall be available with the purchaser. Bidder shall estimate the GI Flats for successful completion of the full scope of works and furnish the quantity as an annexure to the un-priced schedule. The quantity of the GI Flat shall be free issued to the successful bidder as per this annexure. The installation of the estimated quantities of GI flats shall be in the scope of the bidder. No variation shall be admissible to the Contractor so far the input remains unchanged. Sizes available are 75x12mm and 50x6mm GI Flats.

1.3.3 SCOPE OF SERVICES

The bidder shall quote for ETC, civil works, cable termination & earthing against each item as applicable. The list is attached as Annexure-2 (BOQ)

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1.3.3.1 ERECTION COMMISSIONING AND TESTING

- a) The Contractor shall give the offer for Erection, Testing and Commissioning of the Illumination Equipment at Site.
- b) The scope of ETC shall include receipt of material from PSNR store at site, handling of equipment/ material at site, erection of equipment / material at site including fabrication, equipment and system testing, commissioning of the entire system.
- c) Conducting lux level measurement as per approved designs to the satisfaction of owner / purchaser.
- d) Laying and termination of power and control cables for the equipment under the scope of this specification.
- e) All material and consumables required for erection work shall be in Contractor's scope. Erection material shall cover, but not limited to, Clamps etc for Luminaries, Connections between Junction Boxes and Luminaries in outdoor area, All cable glands, lugs and ferrules required for cabling/ wiring. Any other material required for erection shall deemed to be in Contractor's scope. Holes shall not be drilled on the Galvanised substation gantry and LM structures.
- f) Earthing of all electrical equipment.
- g) Contractor shall arrange all machinery tools & tackles, instruments and consumables required for erection, commissioning and testing of the system.
- h) Contractor shall ensure that sufficient quantity of commissioning spares is made available for timely completion of commissioning of the system. The contractor shall furnish a list of Commissioning spares that will be brought by him. The unused commissioning spares shall be returnable to the Bidder.

1.3.3.2 Civil Works

Civil works such as foundation for Lighting Poles, etc. shall be done by the contractor. The rates for these civil works shall be included in the erection rates of respective items.

1.4 TYPE TESTS

The Illumination System and associated electrical auxiliary system should have been type tested as per relevant IEC/International Standards/Indian Standards.

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At contract stage, the reports for all type tests as per technical specification shall be submitted for BHEL/NHPC approval. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited base on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by the representatives(s) of NHPC or Utility. The test reports submitted shall be of the tests conducted within last 5 (five) years prior to the date of bid opening. In case In case the test reports are of the test conducted earlier than 5 (five) years prior to the date of bid opening, the bidder shall repeat these test(s) at no extra cost to the purchaser. **Date of Bid opening is 22.01.09.**

In the event of any discrepancy in the test reports i.e. any test report not acceptable to NHPC due to any design / manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification on any/all additional type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.

All acceptance and routine tests as per specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

All type tests as per relevant standards shall be submitted for each type rating of lighting fixtures and lamps with adequate details/drawings to establish equivalence with the offered type.

Type Tests reports for the following items as per relevant standards shall be submitted for

- a) Degree of protection on lighting panel of each type
- b) Degree of protection test on Junction boxes and receptacle boxes of each type
- c) Electronic ballast

For tests on LED luminaries, refer Section-2.

1.5 HANDING & TAKING OVER

It is the responsibility of the Contractor to run and maintain the system supplied by them for a period of 3 months and subsequently hand over the same to BHEL/owner. Contractor shall assist BHEL to hand over the system supplied by them to owner.

1.6 UTILITIES AVAILABLE

Construction water and 415V power shall be available at one point at substation. Bidder shall be required to make own arrangement for taking supplies from there.

1.7 MINIMUM TECHNICAL QUALIFYING REQUIREMENT

The bidder should have designed, supplied and commissioned similar kind and size of illumination system earlier during the last ten (10) years. The system so supplied should have been successfully commissioned at least at three power stations/sub stations.



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1.8 MANUFACTURING QUALITY PLAN

Quality Assurance Plan (Model) for Illumination System (Enclosed in Section-5) shall be followed.

1.9 FIELD TESTS

All field tests including tests during installation, pre-commissioning, commissioning and field acceptance tests shall be conducted by the Contractor, in presence of representative of the Employer as per Tests of Section -2.

Procedure to be adopted for conducting the operational, pre-commissioning, commissioning, performance and field acceptance test shall be submitted well in advance, at least six months before start of relevant testing, for approval by the employer.

1.10 INSPECTION & TESTING

Prior to dispatch, the Routine tests shall be carried out on Illumination System in accordance with the applicable IEC /IS and the material shall be offered for final inspection by BHEL and NHPC/HCC in accordance with quality assurance plan.
Inspection and Testing shall be as per Quality Assurance Plan of NHPC in Section-5.

Sno.	Item's Description	Unit	Main Quantity	Spare Quantity	ETC Quantity	Remarks
A Indoor Area						
1	Lighting Distribution Boards					
a	MLDB (1 no 630A,50kA MCCB Incomer and 13 nos.63A and 2 nos. 1000A,50kA MCCB Outgoing) with dry type 300KVA Transformer	Nos.	1	0	1	Incomers shall be suitable for 3.5Cx70sqmm PVC Aluminium cable and outgoing shall be suitable for 3.5Cx35sqmm PVC Aluminium cable
b	ELDB (1 no 200A,50kA MCCB Incomer and 5nos 63A,50kA Outgoing) with dry type 100KVA Transformer	Nos.	1	0	1	Incomers shall be suitable for 3.5Cx70sqmm PVC Aluminium cable and outgoing shall be suitable for 3.5Cx35sqmm PVC Aluminium cable
c	Inverter 50kVA	Nos.	1	0	1	-
2	LIGHTING PANELS :					
a	NLP/ELP (Indoor)	Nos.	8	0	8	-
c	DCLP	Nos.	2	0	2	-
3	RECEPTACLES :					
a	240 V, 5/15 A Receptacle (Decorative)	Nos.	48	3	46	-
b	240V, 32A Receptacle	Nos.	22	2	20	-
c	415 V, 53A, 3-PH, Receptacle (Industrial)	Nos.	8	1	6	-
d	Receptacle 300A 1PH 415V AC 3 PHASE 4 PIN INTERLOCKED PLUG AND SWITCH WITH EARTHING CONTACTS (INDUSTRIAL SUITABLE FOR OIL FILERATION MIC)	Nos.	1	1	1	-
e	Air Conditioner Points(1-Phase)	Nos.	2	1	2	-
4	LIGHTING FIXTURES :					
a	Surface Mounted LED, 43W	Nos.	77	16	77	-
b	Recess Mounted LED, 43W	Nos.	58	12	56	-
c	2 x 36W FTL type flameproof type fixture	Nos.	8	2	9	-
d	Bulk Head type lighting fixtures	Nos.	28	6	29	-
e	Downlighter type lighting fixture	Nos.	13	3	13	-
f	Exit Sign Board	Nos.	21	0	21	-
5	SWITCHBOARDS					
a	Modular switchboard with 4 nos. 5 Amp. Switches and 1 no 5/15 Amp. Receptacle	Nos.	12	2	12	-
b	Modular switchboard with 2 nos. 5 Amp. Switches	Nos.	5	1	5	-
c	Modular switchboard with 6 nos. 5 Amp. Switches and 1 no 5/15 Amp. Receptacle	Nos.	7	1	7	-
d	Control Points/Dimmers	Nos.	7	0	7	-
e	Occupancy based Infra Red Sensors	Nos.	7	0	7	-
6	POINT WIRING WITH CONDUIT & WIRES: Comprising of different sizes of GI Conduits, PVC Insulated wires, etc. as required to completion of job					
a	From LP to Switch Board/ Fans	Nos.	55	0	55	-
b	From LP/Switch Board to AC Lighting Fixtures	Nos.	244	0	244	-
c	From LP to DC Lighting Fixtures	Nos.	42	0	42	-
d	From LP to Receptacles	Nos.	79	0	79	-
7	Fans					
a	1400mm Sweep Ceiling Fans	Nos.	11	0	11	-
b	Exhaust Fans	Nos.	3	0	3	-
c	Wall fans	Nos.	13	0	13	-
B Outdoor						
1	LIGHTING PANELS :					
b	NLP (Outdoor)	Nos.	8	0	8	-
d	Street Lighting Panel	Nos.	1	0	1	-
2	STREET LIGHTING					
a	STREET LIGHTING : Steel Tubular Pole - 9mtrs. Height (MS Type)	Nos.	27	0	27	-
b	STREET LIGHTING : Street light LED type Lighting fixtures (70W)	Nos.	27	2	27	-
3	Outdoor Lighting					
a	2x400W HPSV,Floodlight Fixture	Nos.	178	9	178	-
b	30 mtr High Mast	Nos.	8	0	8	-
c	Outdoor JB	Nos.	55	0	55	-

Sno.	Item's Description	Unit	Main Quantity	Spare Quantity	ETC Quantity	Remarks
4	Maintenance Ladders (each type)					
a	Aluminium ladder of 3m vertical height	Nos.	1	0	0	-
b	Cartwheel mounted aluminium ladder of vertical ht.7.5mts. when extended	Nos.	1	0	0	-
5	ASS selector switches,VSS selector switches,Auto manual selector switch,Aux. Contactor 6A,Power terminal block suitable for 35 and 70 Sqmm Al cable,Wooden screws	Lot	0	1	0	-
6	Illumination Erection Material for Indoor works: 3 way,G.I.,circular J.B.(20mm and 25mm),4 way,G.I.,circular J.B.(20mm and 25mm),90deg,G.I.,Inspection Bend(20mm and 25mm),90deg,G.I.,Normal Bend(20mm and 25mm),Heavy duty, Saddle without base(20mm and 25mm),M4X25mm, steel screw with nut and washer,G.I. check nut/lock nut(20mm and 25mm),PVC Rawl plug,6mm,Wooden screw,35mm,Earth clip/clamp(20mm and 25mm),Cleat fabrication out of 25x6mm M.S. flat(for hanging conduit in false ceiling areas, Anchor fastener(M10x75mm for cleats,M12x75mm for lighting panels),Rubber bush(20mm and 25mm),20mm,PVC ,flexible conduit,20mm,PVC ,Coupling,Swing out bracket,20mm,Heavy duty ball socket,Machina screw(for fixing surface mounting fixtures on circular J.B.), PVC closure(20mm and 25mm),Reducer (20mm and 25mm)	LOT	1	0	1	The list of items mentioned here is tentative. Quantity of items of Illumination Erection Material for indoor works required for complete erection work shall be estimated by vendor. Price of these items to be included in items at Sl. No. 6a to 6d of Indoor Area.
7	Illumination Erection Material for Outdoor works: 20x1.5mm Aluminium flat, M12x40mm, G.I. Bolt with nut and washer for fixing outdoor lighting panels,M6x30mm, G.I. Bolt with nut and washer for fixing control gear boxes,M8x30mm, G.I. Bolt with nut and washer for fixing outdoor J.B.s,SLP, M10x35mm, G.I. Bolt with nut and washer for fixing outdoor lighting fixtures,G.I., Earthwire, from J.B. to lighting fixtures,Mounting brackets for lighting fixtures for 2x400W,1x250W and 1x150W fixtures	LOT	1	0	1	The list of items mentioned here is tentative. Quantity of items of Illumination Erection Material for outdoor works required for complete erection work shall be estimated by vendor. Price of these items to be included in items at Sl. No. 6a to 6d of Indoor Area.
8	Civil works for Lighting Panel (other misc items as per cl.1.3.3.2 of Section-1)	Sets	45	0	45	-
9	GI Flat and GI Wire					
a	GI Flat (75x12mm)	M	0	0	100	GI Flat (75x12mm) shall be BHEL free issue
b	GI Flat (50x8mm)	M	0	0	100	GI Flat (50x8mm) shall be BHEL free issue
c	GI Flat (25x6mm)	M	100	0	100	Supply and ETC is in scope
d	8 SWG GI Wire (For earthing of junction boxes, lighting poles and High Mast)	M	1000	0	1000	Supply and ETC is in scope
e	14 SWG GI Wire (For earthing of Lighting fixtures, receptacles,conduits and switchboxes ,exhaust fans etc.)	M	1000	0	1000	Supply and ETC is in scope
10	32 dia MS Rod	M	0	0	100	32 dia MS Rod shall be BHEL free issue
11	Cable Laying					
a	Laying in trench/tray/structure/wall:3.5CX70SQMM Al cable	M	0	0	2000	Cable shall be BHEL free issue
b	Laying in trench/tray/structure/wall:1CX630SQMM Al cable	M	0	0	800	Cable shall be BHEL free issue
c	Laying in trench/tray/structure/wall:3.5CX35SQMM Al cable	M	0	0	300	Cable shall be BHEL free issue
d	Laying in trench/tray/structure/wall:4CX16 SQMM Al cable	M	0	0	4400	Cable shall be BHEL free issue
e	Laying in trench/tray/structure/wall:2CX6 SQMM Al cable	M	0	0	300	Cable shall be BHEL free issue
f	Laying in trench/tray/structure/wall:2CX2.5 SQMM Cu cable	M	0	0	8400	Cable shall be BHEL free issue
g	Laying in buried :3.5CX70SQMM Al cable	M	0	0	500	Cable shall be BHEL free issue
h	Laying in buried :4CX16 SQMM Al cable	M	0	0	1100	Cable shall be BHEL free issue
i	Laying in buried :2CX2.5 SQMM Cu cable	M	0	0	2100	Cable shall be BHEL free issue
NOTE: The above quantities(BOQ) is as per preliminary design only. The detail design will be submitted by Vendor and subject to approval by Customer. The BOQ quantities which are finalised after approval has to be supplied. BHEL reserves the right for quantity variation due to any reason upto + 25% of total value at same unit rate and terms during execution of contract .The quantity of individual items may however vary upto any extent.						

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ANNEXURE-1

It is confirmed that there are no deviations and the offer is in full compliance with the specification. It is also confirmed that there are no deviations in any other form such as comments, variations and/ or exceptions. Further it is confirmed that at all drawings / data sheets/QP/ type tests reports shall be submitted to BHEL for organising approval of ultimate customer. Also, furnishing of all relevant information / repetition of type tests (if required for meeting the specification requirement) shall be carried out by us at no extra cost to BHEL & without affecting delivery requirements.

Signature of the authorized representative of Bidder

Name _____

Designation _____

Place _____

Date _____

Company seal

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SECTION 2

2.1 The Equipment Specification and Design Criteria of Illumination System for Switchyard shall be as per the following:

- (i) NHPC Technical Specification: PTS_Chapter20: Illumination System(12 Pages)
- (ii) DESIGN PHILOSOPHY (MEMORUNDAM) FOR ILLUMINATION SYSTEM FOR KISHANGANGA HYDRO ELECTRIC PROJECT (3 X 110 MW) FOR NHPC LTD. (17 Pages)
- (iii) NHPC Technical Specification: Cabling System (Volume IIIB PTS): 09 Pages.
- (iv) NHPC Technical Specification: General Technical Specification (Volume 3A GTS): 98 Pages.
- (v) NHPC Technical Specification: General Technical Requirement (Volume IIIB PTS): 21 Pages.
- (vi) NHPC Technical Specification: Tests (02 Pages)
- (vii) NHPC Technical Specification: PTS: Chapter 13: DC System, 09 Pages.

2.2 List of Drawings attached in Section-5 are as follows:

Sl. No.	Project Document No.	BHEL-Docment No.	Doc. Designation
1	KSG-PYD01GA002	TB-0-329-316-102	LAYOUT OF 220/33KV SWITCHYARD (02 SHEETS)
2	KSG-PYD01DD004	TB-0-329-316-104	220 KV SWITCHYARD - LAYOUT OF TRENCH, ROAD, FENCE ,FOUNDATIONS & GATES
3	KSG-PYD01LO006	TB-3-329-316-106	SWITCHYARD - STRUCTURE LOADING DIAGRAM
4	KSG-PYD01DD007	TB-0-329-509-107	SWITCHYARD - EARTHMAT LAYOUT
5	KSG-PYD01WD009	TB-2-329-302-109	SWITCHYARD - LT AC/DC DISTRIBUTION SCHEME

2.3 Standards applicable for LED Luminaries:

LED Luminaries shall conform to the following Indian standards:

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LED Luminaries

16101:2012	General Lighting. LEDs and LED modules Terms and definitions
16102(Part 1):2012	Self Ballasted LED Lamps for General Lighting Services. Part-1 Safety Requirements.
16102(Part 2):2012	Self Ballasted LED Lamps for General lighting Services. Part-2 Performance Requirements.
16103(Part I):2012	LED modules for General lighting Safety Requirements.
15885(Part 2/Sec. 13) :2012	Lamp control gear Part 2 particular Requirements Section 13 d.c. or a.c. Supplied Electronic control gear for LED modules
16104:2012	d.c. or a.c. Supplied Electronic control gear for LED modules - Performance Requirements.
16105:2012	Method of Measurement of Lumen maintenance of Solid-state Light (LED) Sources.
16106:2012	Method of Electrical and photometric Measurements of Solid State Lighting (LED) Products
16107:2012	Luminaires Performance
16108:2012	Photobiological safety of Lamps and Lamp Systems
IS 513	Cold rolled low carbon steel sheets and strips
IS 12063	Classification of degree of protection provided by enclosures.
IS 14700	Electro magnetic compatibility (EMC) – Limits (Part 3/Sec. 2) for Harmonic current emission – THD < 15% (equipment, input current < 16 Amps. per phase.
IS 9000 (Part 6)	Environment testing: Test Z – AD: composite temperature/humidity cyclic test.
IS 15885	Lamp control gear: particular requirements for (Part 2/Sec. 13) DC or AC supplied electronic control gear IS 16004 – 1 and 2) for LED modules.
IS 4905	Method for random sampling

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LED Luminaires:

LED Luminaires shall be used for the lighting of all the indoor & outdoor areas in bidder's scope. However for DC lighting, hazardous areas & aviation lighting etc. conventional type luminaires shall be used. In false ceiling area LED luminaires shall be recessed mounting type & in non-false ceiling area the LED luminaires shall be surface mounting type.

The individual lamp wattage for LED shall be upto 3 watt. Fractional wattage LEDs are also acceptable. The LED chip efficacy shall be min 120 Lm/W. The luminaire efficacy shall be not less than 70 Lm/W. Suitable heat sink shall be designed & provided in the luminaire. The LED used in the luminaires shall have colour rendering index (CRI) of Min 70. Colour designation of LED shall be "cool day light" (min 5700K) type for indoor areas. However for outdoor areas, the colour temperature of LED shall be min. 4000K, including rough & dust prone areas. LED shall conform to the LM 80 requirements.

The max. junction temperature of LED shall be 85 deg C. Further the lumen maintenance at this temperature shall be min 90%. The THD of LED Luminaires shall be less than 10%. Further the EMC shall be as per IS 14700. The power factor of the luminaire shall not be less than 0.9. The marking on luminaire & safety requirements of luminaire shall be as per IS standards. Suitable heat sink with proper thermal management shall be designed & provided in the luminaire.

The connecting wires used inside the system, shall be low smoke halogen free, fire retardant type and fuse protection shall be provided in input side specifically for LED luminaires.

Care shall be taken in the design that there is no water stagnation anywhere in the housing of luminaire. The entire housing shall be dust and water proof protection as per IS 12063.

Driver Circuit

LED modules and drivers shall be compatible to each other. The LED module driver's ratings and makes shall be as recommended by corresponding LED chip manufacturer.

LED Drivers shall have following control & protections:-

- Suitable precision current control of LED.
- Open Circuit Protection
- Short Circuit Protection
- Over Temperature Protection
- Overload Protection

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TESTS

For LED Fixture

- a) The contractor shall carry out the type tests as listed in this specification on the following types of LED fixtures to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant price schedule of bid document and the same shall be considered for the evaluation of the bids.

LED fixtures (Type test shall be conducted on one rating each of following type of LED fixtures. Rating for test conduction shall be decided by the employer during detailed engineering)

- a) High bay fixture.
- b) Well glass fixture.
- c) Street light fixture
- d) Surface mounted type fixture.
- e) Recessed mounted type fixture.

The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.

- b) The type tests shall be carried out in presence of the employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.
- c) In case the contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the owner for waiver of conductance of such type test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The owner reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.



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All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

Selection of samples for type test, acceptance test & routine test and acceptance criteria for all the items shall be as per relevant I.S

Type test reports of the following items as per technical specification requirements/ standards shall be submitted for approval.

SL NO.	DESCRIPTION
--------	-------------

- | | |
|------|--|
| i. | Lighting fixtures of each type |
| ii. | Lighting panel of each type (Degree of Protection) |
| iii. | Junction Box of each type. |

Type test reports for LED as per standards for following shall be submitted for approval.

1. Visual and Dimension check
2. Proof of procurement of LEDs
3. Safety tests

a) Marking
b) Construction
c) Provision for Earthing
d) External and Internal wiring
e) Protection against electrical shock
f) Endurance and Thermal
g) Insulation resistance & electrical strength
h) Resistance to heat fire & tracking
i) Resistance to Humidity

4. Fire Retardant test
5. Performance tests (electrical, Photometric color and Life)
6. Burn-in Test
7. Power Cycling
8. Temperature rise test
9. Emission Tests
a) Radiated & conducted emission
b) Harmonics & flickers
10. Immunity tests

In addition, following test reports to be submitted for LED chip/LED luminaire:

- LED parameters like Lumen per watt, CRI, Beam angle from manufacturer.
- LM 80/IS: 16105 report.
- LM 79/IS: 16106 report.

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20. ILLUMINATION SYSTEM

20.1. Scope of Work

Scope of work under this section covers the provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, site storage and preservation, installation, commissioning, performance testing, acceptance testing, training of Owner's personnel, handing over to Owner and guarantee for two years of illumination system), as per the specifications hereunder, each complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation.

The scope of work shall be a comprehensive functional system covering all supply and services including but not be limited to following:

20.1.1. Normal lighting system

Normal lighting system shall include indoor and outdoor lighting of complete power house and adjoining areas, comprising following major components:

- ◆ Lighting cabinets,
- ◆ Lighting equipment, including the light fittings, lighting facta/panels, warning/direction sign boards,
- ◆ Power sockets of 5 A,
- ◆ Control points, including:
 - Push-buttons or switches,
 - Dimmers, smart switches/sensors,
 - Indicator lights on the main control panel indicating on-off circuits.
- ◆ Street light poles, masts for outdoor lighting,
- ◆ All cabling and wiring including conduits, racks, ducts, channels or any other media of cable runs and associated accessories / fixtures/ fasteners for normal lighting system.

20.1.2. Emergency lighting system

Emergency lighting system shall comprise of:

- ◆ Emergency lighting boards,
- ◆ Lighting equipment, including the light fittings,
- ◆ All cabling and wiring including conduits, racks, ducts, channels or any other media of cable runs and associated accessories / fixtures/ fasteners for emergency lighting system.



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1. GENERAL REQUIREMENTS

1.1. General

The Contractor shall strictly observe this General Technical Specification in conjunction with the Particular Technical Specifications. He shall carry out all work in a skilled and workman like manner in compliance with modern methods of engineering. All design, calculations, materials, works, manufacturing and testing shall conform to the latest applicable standards.

In addition, the Contractor shall conform to all applicable regulations regarding the execution of construction and installation work, and shall follow all instructions issued by the competent Authorities, and the Engineer.

The particular technical specifications shall take precedence over the general technical specifications in case of any contradiction.

Clause number cross-references refer to the volume in which they occur unless stated otherwise.

1.2. Scope of Work

The scope of work in this Contract covered by the Electrical-Mechanical Works General Technical Specification is established in the Particular Technical Specifications. In addition to this, the Contractor shall prepare the detailed design, construction and installation drawings as well as calculations, material specifications, operating and maintenance instructions, etc., for the works as stipulated in the Particular Technical Specifications.

The Contractor shall design, manufacture, supply, erect, test & commission and hand-over to owner and guarantee for two years after commissioning all works complete in every respect with all necessary accessories for reliable and continuous operation as per the detailed particular technical specifications.

These specifications include the performance of all works and the provision of all labours, materials, permanent and temporary equipment, tools, accessories for transport to the site, including loading, unloading, if necessary reloading at the port of arrival, intermediate storage, protection of the works from the effects of the weather, cleaning, drying, storage at site and preservation related works, complete installation, painting, testing and commissioning of all works and accessories of the works.



The Contractor shall make competent and experienced staff available for the training and assistance of the operating staff during commissioning and trial operation and, if required by the Owner, for a period after completion of the trial operation which shall be agreed separately.

The period provided for testing and commissioning is established in the Special Conditions.

The Contractor shall supply the Operation and Maintenance Instruction Manuals in a number and at a time as stated in the General and Special Conditions.

1.3. Standards

Although European or IEC standards for design, testing, workmanship, material and Works have been mostly selected in these specifications as a basis of reference, other standards and recommendations of standard international organizations will be acceptable provided they ensure equal or higher quality than those specified, and provided, furthermore, that the Contractor submits for approval detailed standards which he proposes to use.

When IEC or ISO recommendations or other Standards are referred to, the edition shall be that current at the time of issue of Tender Documents, together with any Amendments issued to that date.

If requested by the Engineer the Contractor shall supply at his own expense three copies in English and one in the original language of any national standards, which are applicable to the Contract.

Standard publications issued by the following organizations of standardization are considered being approved standards for the works:

1.3.1. Standards for General Application

- AISI American Iron and Steel Institute
- ANSI American National Standards Institute
- ASME American Society of Mechanical Engineers
- ASTM American Society for Testing and Materials
- AWS American Welding Society
- BS British Standards
- CECT European committee for Manufacturing of Boilers



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- CMAA Crane Manufacturers Association of America
- IEC International Electro technical Commission
- IEEE Institute of Electrical and Electronic Engineers
- IIW International Institute of Welding
- IS Indian Standards
- ISO International Standards Organisation

"Notwithstanding reference made to various standards all equipment and works as per provisions and requirements of relevant and latest Indian Standards shall be acceptable"

1.3.2. Material Standards

ASTM (American Society for Testing Materials), AISI (American Iron and Steel Institute)

Materials shall be new and of first-class quality, suitable for the purpose, free from defects and imperfections, and the classifications and grades in conformance with the latest issue of the respective ASTM, AISI, DIN or BS standard. Material to other standards may be used if approval by the Engineer has been obtained. Material specifications, including grade or class data, shall be shown on the appropriate detail drawings submitted for review.

If using stock material not specifically prepared for the works under this Contract, the Contractor shall submit evidence that the material complies with approved standards and that the material is adequate for the intended use.

The Contractor shall indicate in the Technical Data Schedules, the materials and applicable standards for all major parts of the supply.

The materials shall be carefully selected for the intended purpose and due consideration of the site conditions and the tropical environment. Higher-grade material shall be used where ordinary material is insufficient.

"Notwithstanding reference made to various standards all equipment and works as per provisions and requirements of relevant and latest Indian Standards shall be acceptable".

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1.3.3. Electrical Standards

The following basic standards for electrical works or any other approved standard shall be applied:

- IS (Indian Standards)
- Standards issued by IEC (International Electro technical Commission)

For specific standards see the Particular Technical Specifications.

1.4. Units Of Measurements

The international SI-system of units shall be used for documents, calculations, correspondence, drawings, etc., relevant to the Tender and the subsequent Contract.

1.5. Works Identification System

An approved, uniform Works identification system shall be applied for all mechanical, electrical and Instrumentation and Control (I&C) Works to be agreed upon during detailed design.

1.6. Time Schedule

According to the relevant articles in the General and Special Conditions of Contract, the progress of the work shall conform to the basic Programme of Work on which the Contract is based.

The "Programme" to be submitted shall include the following information

- Design work
- Shop work
- Testing and inspection of works
- Transport to the Site
- Storage at site
- Preparations at the Site
- Interdependence with work of other Contractors
- Erection and commissioning



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- Acceptance testing
- Handing over
- Removal of erection equipment and clearing of the Site



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2. TECHNICAL DOCUMENTS

2.1. General

This Chapter specifies the general scope and gives a definition of the documents which, together with those listed in the Particular Specifications, shall be delivered by the Contractor to the Engineer within the periods, and in a number and quality as specified in the General and Special Conditions.

The Engineer reserves the right to request the Contractor for additional documents as may be required for proper understanding and definition of constructional, operational, co-ordination or other matters.

All documents to be supplied shall be submitted in accordance with the agreed programme so that any comment and change requested by the Engineer can be taken into account before starting of the manufacture in the workshop and/or erection or installation at the Site.

If the Contractor fails to submit such documents, then the later execution of changes requested by the Engineer and the resulting additional cost and/or delays shall be the Contractor's responsibility. The Contractor shall not be released of his responsibility and guarantee after drawings and computations have been approved by the Engineer.

On drawings, catalogue sheets or pamphlets of standard Works submitted to the Engineer the applicable types, paragraphs, data, etc. shall either be marked distinctively or the non-applicable parts shall be crossed out. Documents not marked in such a manner will not be accepted and approved by the Engineer.

If required for proper understanding of the documents, additional descriptions/explanations shall be given on these documents or on separate sheets. All symbols, marks, abbreviations, etc., appearing on any document shall clearly be explained by a legend on the same document or on an attached sheet.

Each device appearing on any document (drawing, diagram, list, etc.) shall clearly be designated. The abbreviation mark used for an individual device shall be identical throughout the complete documentation so as to avoid confusion. All documents shall have a uniform title-block and agreed by the Engineer. Beginning with the very first submittal to the Engineer, the Contractor's drawings shall bear a serial number corresponding to a drawing classification plan to be agreed upon by the Contractor and the Engineer.



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Any comment given by the Engineer on a "I" type drawing shall have the same effect as if it were given on a "A" type drawing.

2.2. Drawings

2.2.1. Loading Drawings

For all larger pieces of Works which, due to their dimensions and/or weight and transport limitations, will require special means for their transportation, the Contractor shall submit binding loading drawings indicating dimensions, weights, etc., of the respective pieces of Works and the necessary trailer for its transportation to the site.

2.2.2. Foundation Drawings

If a piece of Works requires its own foundation or needs a special area for installation, the Contractor shall submit drawings indicating all pertinent dimensions, static and dynamic loads, etc. They shall include all essential details required for proper design and construction of the foundations and/or buildings.

In addition, they shall include openings, sleeves, slopes and the arrangement of any supporting structure, i.e. base-frames or other steel constructions for permanent fixing or erection purposes.

If conduits are to be installed in the foundations, the relevant information such as diameter, length, and purpose shall be indicated on the drawings.

2.2.3. Arrangement Drawings

All arrangement drawings shall be drawn to scale. The General Arrangement Drawings shall show the physical arrangement of Works (constructions, machines, complete switchgears, control panels, instrument cubicles, etc.), civil constructions (buildings, rooms, foundations, ducts, etc.) and reserved areas (for pipes, cables, lines, etc.) in relation to each other and to agreed co-ordinates and boundaries. Such drawings shall be prepared for the whole plot, for separate plots and for each building (building, hall, room, ducts and trenches, etc.).

The Arrangement or Layout Drawings of electrical and instrumentation and control equipment shall indicate the location of all apparatus wherever used, i.e. in or on machines, control boards, switchboards, cubicles, control desks and panels, etc. The apparatus shall be denominated with the same standardised abbreviations as used in all other documents.



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2.2.4. Outline Drawings

The Outline Drawing shall show all elements and the main dimensions of individual components where necessary in plan view, cross-section, side and top views. If reasonably possible such dimensions can be shown on Arrangement Drawings.

2.2.5. Design Drawings

The Design Drawings shall include the shop drawings, assembly drawings, erection drawings, piping diagrams and piping arrangement drawings, etc., showing the dimensions, design and data of all constructions, apparatus and Works to be furnished under this Contract. The drawings shall - where applicable substantially conform to the Tender Drawings and shall show:

- Details of manufacturing and treatment of major single work pieces specially manufactured for this Contract
- Assembly of the Works in plan and elevation with main dimensions
- Sub-assembly of the principal components of the Works with overall dimensions, adjustment and clearance tolerances, numbers of corresponding detail drawings
- Sub-assemblies in which the Contractor proposes to ship the Works
- All necessary details of the parts connecting to the Works supplied by others
- Location and sizes of auxiliary connections for oil, grease, water, air, electrical power etc.
- Location and size of the instruments and accessories provided
- Methods of lubrication and sealing
- Instructions for heat treatment, pressure tests, surface preparation and anti-corrosive protection
- Full details of parts for which adjustment is provided or which are subject to wear
- Method and sequence of installation, field joints, erection and lifting devices, jacks, grout plugs, anchoring details, etc., if not shown on foundation drawings.



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2.2.6. Installation Drawings

The construction, mechanical, electrical and Instrumentation and Control (I & C) Installation drawings shall provide detailed information on the disposition of the various items of a system (e.g. lighting fixtures, socket outlets, connection boxes, transmitters, actuators, loudspeakers, telephones, pipes, valves, pumps, compressors, etc.) and of the piping and wiring respectively included in the installation or assembly. They shall be based on dimension drawings of cubicles, rooms, buildings or areas containing the Works.

2.3. Diagrams

For electrical diagrams general reference is made to IEC 113-1.

"Notwithstanding reference made to various standards all equipment and works as per provisions and requirements of relevant and latest Indian Standards shall be acceptable".

2.3.1. Single-Line Diagrams

This is a simplified diagram of the essential electrical Works and their interconnections. Each circuit shall be represented by a single line only. It shall contain all required technical information of the Works represented, e.g. voltage, current, capacity, short-circuit level, ratios, voltage variations, positive and zero sequence impedances, measuring transformer and protection relay indices, interlocking, kind of switch drive, code designation, etc. as applicable.

Single-line diagrams of individual main components and switchboards shall additionally show the control, indicating, measuring, metering, protection, automatic, and other auxiliary electric devices separated for each individual installation site and location as applicable:

Local:	Switchboard control compartment, switch compartment, cable termination compartment, etc.
Remote:	Control room (from workstation). Unit control Board (from MMI) Relay (in auxiliary relay cubicle, UCB, LCB, protection cubicle) Separate energy meter cubicle.

Furthermore, the applied recommended setting of adjustable devices (protection and control elements, time relays, etc.) shall be indicated.



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2.3.2. Circuit Diagrams

The Circuit Diagrams shall show the power circuits in all the phases with the main apparatus as well as the pilot circuits (measuring and control circuits). It shall show in full the functioning of part or all installations, Works or circuits with all required technical information.

The control part shall be subdivided into separately drawn "current paths", each showing all its components regardless of their actual physical location. The individual circuits are to be drawn in a straight-line sequence, avoiding line crossings. The current paths (to be designated by numbers) shall be drawn starting from two horizontal lines, which represent the control voltage source. All devices belonging to the Works or forming part of the Works or control devices shall appear between these two lines.

Contact developments of the installed switches, contactors, relays and other apparatus which appear in the diagram shall be shown below the respective contactor coil, indicating by means of numbers and, if not on the same, also the page No., the current path in which the corresponding contact has been used.

Interconnections to other circuit diagrams shall be clearly marked by means of dotted line separations and the corresponding functional designation.

The power circuit portion of the installation shall be drawn at the left side of the drawing.

Circuit diagrams shall also contain all terminals and their correct designations. Terminals grouped together to terminal blocks of switchboards, distributors, etc. shall be shown on the circuit diagrams in one fictitious horizontal line surrounded by demarcation lines. If, for any reason, the current paths of circuit diagrams must be separated, the corresponding counter terminal has to be indicated by all means.

The representation of electrical Works and control circuits shall not be terminated at the limits of the scope of supply, but has to be extended beyond this limit by all switchgear, protective, measuring and monitoring equipment required for full comprehension of the whole circuit. All terminals and functions of Works to be supplied by others shall be taken over as well.

Standard Circuit Diagrams are patterns of circuit diagrams which have been standardised with regard to scope, arrangement, representation and allocation of Works with the aim of simplification and easy surveillance of electrical circuitry.



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2.3.3. Block Diagrams

The Block Diagrams shall be used to show in a simplified manner the main inter-relationships between the elements of a system by means of symbols, block symbols and pictures without necessarily showing all the connections. The symbols used for the individual kinds of components, e.g. servomotors, computing modules, etc., shall clearly be explained on the diagram or on an attached legend.

When recommendable, a Block Text Diagram may be prepared, consisting essentially of explanatory texts enclosed in outlines which are linked by lines showing the functional relationships that exist between the various parts of an installation, Works or circuit.

2.3.4. Logic Diagrams

The Logic or Functional Diagrams shall be used for representation of logic and sequence controls and interlocking by showing only binary logic elements and their effect on the various process equipment disregarding their electrical realisation. Logic function elements (AND, OR, NOR, NAND, STORAGE, etc.) shall be used for processing and combining binary signals.

2.3.5. Terminal Diagrams

Such diagrams shall be prepared for any type of terminal box, marshalling rack, control cubicle, switchboard, etc., and shall show the terminals (properly numbered) and the internal and/or external conductors (wires or cables) connected to them.

The terminal diagram of each individual switchboard, terminal box, panel, etc., shall contain, but not be limited to the following information:

Terminal number of terminal board with targets (terminal number and current path) of incoming and outgoing cables and wires

- Cable designation
- Type of cable
- Number and cross-section of conductors
- Assignment of conductors
- Number of spare conductors



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- Approx. length of cable and its destination.

2.3.6. Protection Co-ordination Diagrams

These diagrams shall show in a graphical manner separately for each power supply circuit:

- A simplified single-line diagram of the circuit with technical data of all instrument transformers and relays
- Co-ordinated tripping curves of related protection devices
- Setting of the protection devices.

2.3.7. Emergency Shutdown Diagram

This diagram shall show the sequential steps and interdependencies during emergency closure.

2.4. Specifications

2.4.1. Material Specifications

Such specifications shall be prepared for all principal Works and installations. They shall describe the performance (design, material, dimensions, corrosion protection, etc.) of the Works and include a list of components providing information on the manufacturer, type and technical data to obtain the following:

- Full information on the Works, completing the general requirements fixed in the Tender Specification by the data/information of the specific manufacture
- Proof of compliance with Contract Specification.

For standard Facilities (for example valves, switchgear, control gear, relays, transmitters, indicators, lighting fittings, etc.) catalogues or pamphlets shall be submitted.

The technical data of electrical Works shall include as a minimum:

- Max. Permissible ambient conditions (temperatures, humidity)
- Rated current and rated output/capacity



- Same data as above under specified severest site conditions
- Rated voltage and ratio or regulation/setting range
- Max. Service voltage (acc. to IEC)
- Power frequency and impulse withstand voltages
- Type and code No. of protection relays and of instantaneous or thermal releases directly attached to circuit breakers and contactors
- Power requirements for each voltage level (A.C./D.C.).

Specific requirements are described in the following paragraphs.

2.4.1.1. Motor Specifications

The motor specifications shall include the thermal motor characteristic both for cold and hot condition, the start-up characteristic when running with the driven machine and all data required for selection of the appropriate motor protection relay (both for cold and hot condition) and for locked rotor protection. Construction type, class of protection and insulation shall also be given.

2.4.1.2. Cable Specifications

The General Cable Specification shall include the calculation of the derating factors for the individual modes of installation at applicable ambient temperatures and grouping of cables, and furthermore, for each cross section:

- The rated current carrying capacity
- The max. Short-circuit capacity
- The voltage drop
- Type, insulation serving, armouring and sheathing of cable
- Type, description and catalogue/pamphlet of cable termination.

Separate specification(s) shall be prepared for cable trays, conduits, supporting structures and other accessories.

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2.4.1.3. Measurement And Control Apparatus Specifications

The accuracy of performance with respect to variable ambient conditions and the power supply requirements shall be included.

2.5. Lists And Schedules

2.5.1. Motor Lists

The motor lists shall be prepared according to the power distribution boards. The motors are connected to, and shall contain at least the following information/data:

- Works identification number
- Description
- Manufacturer, type, rated data of driven machine
- Manufacturer and type of electric motor/consumer
- Rated capacity
- Service factor (ratio between motor output and power requirement of the driven machine)
- Rated speed
- Rated voltage
- Rated current
- Ratio of starting current to rated current
- Ratio of pull-out torque to rated torque
- Power factor at rated capacity
- Efficiency at rated capacity
- Power consumption at machine design loading
- Total weight
- Design/enclosure/cooling (acc. to IEC)

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- Duty (continuous/intermittent/start-up)
- Starting method/permmissible starting frequency
- Denomination of feeder
- Motor protection
- Applicable Standard Circuit Diagram (Category)
- Maximum number and overall diameter of power cable(s)
- Manufacturer and type of bearing(s)
- Manufacturer, type and quantity of lubricant, service interval
- Manufacturer, type, number, size, spring pressure and service interval of brushes (if applicable).

2.5.2. Motor Starter Lists

The motor starter lists shall include all starters and contactors used for motors and contain the following technical information as a minimum:

- Works identification number
- Electrical design data as nominal and actual current rating, voltage rating, coil rating, making and breaking capacity, mode of operation
- Maximum power cable size
- Maximum control cable size
- Current transformer ratio, class and capacity
- Type of protection relaying and catalogue number
- Setting of protection relays and maximum continuous rating of the protected circuit
- Type and current rating of the back-up fuses/MCBs for the main and control circuits.

Note: Motor Starter Lists can be substituted by part lists, already forming part of switchgear manuals



2.5.3. Cable Lists/Interconnection Lists

The Cable Lists shall include for each individual cable the following as a minimum:

- Cable number, in accordance with Identification System.
- Cable type
- Rated voltage
- Number and size of conductors
- Overall diameter
- Cable termination at each end
- Connection point at each end with cubicle/Works identification and terminal numbers
- Cable routing

In case interconnecting cubicles are used, the lists shall be prepared to show:

- Cable termination for incoming and out coming cables
- Interconnection wiring

2.5.4. List Of Measurements

This list shall indicate all measurements, local as well as remote, and shall contain at least:

- Item/code number, function code
- Description and denomination of measuring loop
- Data of tapping point
- Data of local devices (as detectors, instrument transformers, transmitters)
- Data of remote devices.

**2.5.5. Alarm Lists**

These lists shall indicate all alarms and shall contain at least:

- Item/code number and function code
- Description and denomination of alarm
- Data of alarm detector (contact) referring to applicable circuit diagram
- Data of alarm annunciator (location and clear text labeling)

2.5.6. List Of Final Control Elements

This list shall indicate all control actuators and control valves and shall contain at least:

- Item/code number
- Data of pipe and valve connections
- Data of valve layout
- Maximal required and rated power

2.5.7. Workshop Test Schedules

Individual Workshop Test Schedules shall be prepared for Works/installations (such as pipes, cranes, machines, switchgears, control gear, cables) and shall contain at least:

- Works identification number
- Manufacturer
- Place of manufacture
- Place of test
- Date of test
- Objective of test (all individual tests)
- Standards applied
- Certification

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- Inspection (by Engineer / Independent Test Authority / Contractor/ Subcontractor)
- Release for shipment
- Remarks

On the above schedule or on separate sheets the Test Procedure shall be specified giving for each test item (kind of test) a description, test method / Standards, used instruments, sample/routine test, test judgment.

2.5.8. Site Test Schedules

Testing at site shall include tests specified in the Model Quality Assurance Plan (Volume- 3-D) and any tests recommended by the manufacturers as per their standard practices.

2.5.9. List of Tools and Appliances

Lists of Tools and Appliances shall detail for all tools and appliances included in the scope of supply:

- Item and code number
- Description
- Quantity
- Weight
- Gross storage requirements (separate for open-air, indoor, air-conditioned) for individual component sets.

2.5.10. Spare Part Lists

Spare part lists shall detail for all spare parts included in the scope of supply:

- Detailed drawing (where possible)
- Item and code number
- Description
- Quantity

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- Weight
- Gross storage requirements (separate for open-air, indoor, air-conditioned) for individual component sets.

2.5.11. List Of Works Identification Numbers

This list shall contain the used Works identification numbers in alphanumeric order and for each of them a description (the defined Works denomination, for example as written on the Works label) and the location (short definition of outdoor area and level elevation or building/room with elevation and room number).

2.6. Calculations

In addition to the drawings or whenever the contractual documents do so require, the Contractor shall submit to the Engineer for checking, the appropriate calculations for determining the main sizes, stress levels, dimensions and operational characteristics, safety factors, clearly indicating the principles on which the calculations were based. The calculations shall include the formulae, standards, test results, basic assumptions, etc. Submission of computer calculations without baseline information such as derivation of the calculation method, applied formulas, definition of variables and constants, explanation of abbreviations etc., will not be accepted.

2.6.1. Short-Circuit Calculations

The short-circuit calculations shall be performed in accordance with VDE Standard 0102, part 1.

2.7. Installation And Commissioning Procedures

2.7.1. Installation Procedures

The installations procedures shall describe in sequential steps the erection of major equipment and shall contain sufficient details such as equipment preparation on erection bay, handling of large and heavy pieces, leveling, anchoring, site welding, site painting, erection checks, site pressure tests, site flushing and cleaning of hydraulic systems, alignment and run out checks to allow the Engineer/Owner to plan and supervise the Works at site, if required.

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2.7.2. Pre-Commissioning Tests and Procedures

Pre-commissioning tests and procedures shall be described in sequential steps for the pre-commissioning of all electrical and mechanical equipments and shall also contain sufficient details viz. checking of installations, ratings, cable terminal checking and operation test of all auxiliary equipments etc.

2.7.3. Commissioning Procedures

The commissioning procedures shall sequentially and in sufficient detail describe activities and tests for all systems covered by the Contract Document.

2.7.4. Commissioning Test

Commissioning acceptance tests shall be carried out, on all generating units to verify the rating characteristics of generating units and other equipment's in accordance to relevant standards. The complete field acceptance test reports shall be prepared by the Contractor and submitted to NHPC for approval.

2.7.5. Test Run

The test run on generating units shall be carried out as per relevant provisions of IEC standards.

2.8. Operation And Maintenance Manuals

2.8.1. Contents

The Operation and Maintenance Manuals shall be provided in five (5) hard copies along with CD-ROM (eight sets), and shall contain the following information in sufficient detail to enable the Owner to maintain, dismantle, reassemble, adjust and operate the Works with all its items of Works and installations:

- Table of Contents
- List of Illustrations
- Introduction



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The Introduction shall contain:

- A brief general description of the Works items
- A brief description of the use of the Works items
- Definitions of technical terms used in subsequent graphs of the instruction book
- A complete list of all items used in accordance with the Works Components Identification System.

▪ Detailed Description

Detailed description shall contain a complete and accurate description of the Works, all components and ancillaries, their assembling and dismantling. An accurate list stating clearances, tolerances, temperatures, fits, etc. shall be included.

▪ Operating Principles and Characteristics

A brief summary of the technical operating principles of the Works, including diagrams, circuit diagrams, sequence diagrams, piping, etc.

▪ Operating Instructions

The instructions shall be accurate and easy to understand, and shall contain the sequence of individual manipulations required for operation. The information shall be presented in such a manner that the contents of this paragraph can be used for instructing personnel in the operation of the Works. Tables, lists and graphic presentations should be used whenever possible for making the description readily understandable. An appropriate trouble-shooting list shall be included in this chapter.

▪ Testing and Adjustment

The entire testing and adjustment procedure required for the Works after overhauls and during operation shall be described.

▪ Maintenance Instructions

This section is divided into five paragraphs:

- 1) Preventive maintenance, indicating the inspections required at regular intervals, the inspection procedure, and the routine cleaning and lubricating operations, the regular safety checks and similar steps.



- The maintenance instructions shall include a tabular (or in other approved form) summary of the required activities sorted according to
 - Daily
 - Weekly
 - Monthly
 - Quarterly
 - Yearly
 - (Or other) cycles as applicable.

This document shall provide the maintenance engineer with brief and yet fully comprehensive information including all references to the applicable, detailed service and maintenance instructions.

2) Repair and adjustment, describing the inspections, fitting and dismantling of parts, fault tracing as well as repair and adjustment procedures.

3) Spare part lists, containing all the necessary data for ordering spare parts. These lists shall include all spare parts, those to be supplied and those not to be supplied under the present Contract. The prices for spare parts shall be indicated in the list. Detailed drawing for each item of spare parts shall be supplied. The above list should include minimum and maximum quantities of spares to be maintained by the project.

4) Tool lists, containing all necessary data for identification of tools to be delivered under the present Contract.

5) List of suppliers and alternative suppliers and addresses.

- As-built drawings

2.8.2. Performance

Each kind of drawing aforementioned shall have a uniform size. The final size of drawings for the Operation and Maintenance Manual shall be decided by the Engineer. Catalogue sheets, illustrations, printed specifications, etc., shall be checked and prepared by the Contractor in such a way that the figures, statements and data valid for the delivered sizes and types of the Works concerned are clearly marked. All figures, statements and data valid for sizes and types not delivered must be crossed out.

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2.8.3. Revisions and Supplements

The completeness of the manuals shall be checked during installation, testing, commissioning and trial operation jointly by the Contractor and Engineer.

If it becomes evident during the installation, commissioning trial operation and defects liability period of the Works that the Operation and Maintenance Manuals are inadequate or incorrect, the Contractor shall supply immediately the necessary supplements and corrections. This shall be handled in the following manner:

- Deletions:

One sheet of errata, printed on pink paper, shall be issued indicating the pages and date of issue of those pages, which are to be deleted, and are no longer valid.

- Corrections, Revisions, Replacements:

New sheet or sheets shall be issued to replace the wrong pages. Whenever a new sheet is added to the instruction manuals, this sheet shall be given the new date of issue and a revision symbol, and an indication "Substituted for ... " and a marking of the corrected/revised items.

- Insertions, Supplements:

Insertions or supplements shall be accompanied by a new respective "Table of Contents" page, where the latter shall be handled as described above under replacements.

The revisions and supplements requested by the Engineer shall be made by the Contractor at the Site as far as possible and shall be submitted in each case to the Engineer for checking and revision as stated above.

Before issuing the "Completion Certificate", the revised copies of the Operation and Maintenance Manual shall be submitted together with the specified number of complete sets of drawings of the Works as completed. The Works shall not be considered complete for purposes of completion certificate over under the terms of the General Conditions of the Contract until the above documents have been supplied by the Contractor.



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2.9. Progress Reports During Design And Manufacturing

During design and manufacturing the Contractor shall quarterly submit four (4) copies of the progress reports in a format acceptable to the Engineer, detailing the progress of the work during the preceding period. The report shall contain (but not be limited to) the following information:

- A general description of the Works performed during the reporting period on each main activity, and include any notable problems, which were encountered.
- The total overall percentages of design and manufacturing works completed, with reference to the Master Control Network programme. Appropriate comments shall explain any differences.
- The percentages of each main work activity completed during the reported quarter with reference versus the scheduled programme. Appropriate comments shall explain any differences.
- A list of all activities of scheduled and actual progress during the reporting period including actual starting dates versus scheduled starting dates and actual completion dates versus scheduled completion dates for each activity. Appropriate remarks shall explain any differences, and also methods/actions prepared to be taken for making up the deficiencies in actual design and manufacturing process.
- A list of activities scheduled to be started within the next period of two (2) months, with expected starting and completion dates. If the expected starting and/or completion dates are different from those shown on the Master Control Network, an explanation shall be given.

2.10. Progress Reports During Installation At Site

During erection the Contractor shall, before the tenth (10th) day of each calendar month, submit four (4) copies of the monthly progress reports in a format acceptable to the Engineer, detailing the progress of the work during the preceding month. The report shall contain (but not be limited to) the following information:

- A general description of the Works performed during the reporting period on each main activity, and include any notable problems, which were encountered.
- The total overall percentages of erection works completed, with reference to the Master Control Method programme. Appropriate comments shall explain any differences.

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- The percentages of each main work activity completed during the reported month with reference versus the scheduled programme. Appropriate comments shall explain any differences.
- A list of all activities of scheduled and actual progress during the reporting period including actual starting dates versus scheduled starting dates and actual completion dates versus scheduled completion dates for each activity. Appropriate remarks shall explain any differences.
- A list of activities scheduled to be started within the next period of two (2) months, with expected starting and completion dates. If the expected starting and/or completion dates are different from those shown on the Master Control Network, an explanation shall be given.
- A list of local manpower (by trade classification) employed during the reporting period.
- A list of expatriate personnel (by position) employed during the reporting period.
- A list of the Contractor's Equipment and materials presently located at the Site. Also a list of equipment and materials, which arrived at Port of entry and is in the process of being cleared through customs.
- Progress photographs of significant events. The Engineer may direct the inclusion of specific photographs if deemed necessary.
- Main items of temporary facilities constructed during the reporting period.
- A statement detailing the status of progress on the overall programme and how to regain any lost time or setbacks, which may have occurred.
- A list of inoperable temporary equipment, and the estimated date when the repair will be completed.
- A statement about labour relations & an explanation of an actual or potential problems
- A listing of each accident at the site involving the hospitalization and/or death of any person
- A listing of the amount & date of any payments received during the reporting period & the amount of any monthly invoice, which has been submitted but not yet paid.

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- A list of claims (if any) submitted during the reporting period including the claimed cost & extension of time.
- A statement concerning potential problems and recommendations on how they could be resolved.



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3. SPARE PARTS AND TOOLS

3.1. Spare Parts

All spare parts to be supplied shall be interchangeable with the corresponding parts of all the Works supplied under these Specifications and shall be of the same material and workmanship. They shall be replaceable without cutting or destruction of adjacent components. Before issue of the Completion Certificate the spare parts shall be checked at the Site by the Contractor in presence of the Engineer/Owner.

Acceptance of any spare parts will not take place before the Contractor has submitted the complete final detailed list of all spare parts and tools.

All spare parts shall be protected against corrosion and shall be marked with identification labels in the English Language. The identification shall be in accordance with the agreed Works Identification System.

All spare parts, tools and materials shall be delivered in marked boxes of sufficient sturdy construction to withstand long term storage.

3.1.1. Specified Spare Parts

The required specified spare parts are listed separately in the Particular Technical Specifications. The price for each listed special spare part shall be quoted individually in the Price List; the total price shall be included in the Total Tender Price.

3.1.2. Recommended Spare Parts

The contractor shall give a list of additional spare parts recommended for five (5) years operation. The list of these spare parts shall be finalised during detailed engineering.

The cost of such spare parts shall be deemed to be included in the quoted rates of the contract.

3.2. Tools and Appliances

The scope of work shall include all customary and special tools, as well as auxiliary devices including lifting devices, ropes, etc. necessary for total assembly and disassembly of all parts of the supplied Works. Furthermore, all accessories for maintenance shall be supplied and

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included in the Tender. The total price for tools and devices as required by this article shall be included in the Total Tender Price.

The tools, wrenches, etc. shall be unused. Customary tools for erection shall be of the forged and polished chrome-vanadium type. Use of special tools and devices for erection shall be allowed, but shall be approved by the Engineer in each case. Special tools and devices shall be provided with means for ready identification.

All lifting devices and wire ropes slings to be used at site shall be tested at works and test certificate shall be supplied to the Engineer.

Suitable hardwood or steel boards arranged for wall mounting as well as tool carts and/or toolboxes shall be included in the delivery. An itemised list and description of all provided tools, auxiliary devices, storage equipment, etc. shall be included in the Tender. Acceptance of any tool or device shall not take place before the Contractor has submitted the complete final detailed List of Tools and Appliances.

Ropes, slings etc. shall be handed over in new condition. The Owner shall be entitled to take over from the Contractor the entire erection tools, appliances, instruments at mutually agreed conditions.



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4. DESIGN AND MANUFACTURE

4.1. General

Design, manufacture and construction requirements shall generally be as described below besides complying with the specific requirements elaborated in particular technical specification

4.2. Design And Construction Requirements

The following directions, information and technical requirements for layout, design and erection shall be observed as far as they are applicable to the Works to be offered. The technical requirements of the General Technical Specifications are valid for all parts of the Works except where they are modified by additional and/or special requirements, specified in the Particular Technical Specifications.

Whenever a Contractor deviates from these Specifications, he shall furnish the data called for in the Technical Data Schedules and give a summary of and the reasons for all deviations in the "List of Deviations". Failure to accomplish this may cause the elimination of his Tender, especially when a major deviation is involved.

Any changes of the design of any part of the Works, which may become necessary after signing the Contract have to be submitted in writing to the Engineer for approval, being sufficiently substantiated and justified.

Additional cost can only be accepted, in case of a basic design change, by the Engineer after award of Contract.

The Works shall be designed, manufactured, arranged and installed to provide functional design and neat appearance. All parts of the Works shall be arranged to facilitate surveillance, maintenance and operation. All control sequences shall be simple and rational.

The parts of the Works shall be designed and arranged so that they can be easily inspected, cleaned, erected and dismantled without involving large scale dismantling of other parts of the Works. They shall be designed, and manufactured in accordance with the latest recognised rules of workmanship and modern engineering practice.

The regulations, standards and guidelines listed in these Specifications shall be observed in the design, calculation and manufacture of the Works.



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All parts of the Works shall be suitable in every respect for continuous operation at maximum output under the climatic conditions and operating conditions prevailing at the Site.

Special attention shall be given to Works, parts of which are delivered by different manufacturers. Problems arising in this conjunction shall be solved by the Contractor and be defined in writing.

For individual items of the Works, materials and design are to be selected which are best suited for the operating conditions to which the parts in question will be subjected. Only such design and types of Works shall be offered which has confirmed its reliability in long-term continuous operation.

All live, moving and rotating parts shall be adequately secured in order to avoid danger to the operating staff. All electrical components shall be electrically earthed.

Manufacturers shall take appropriate measure to prevent the ingress of dust into any Works (such as bearings, relays, control and measuring equipment, etc.), which may be endangered thereby.

Suitable lifting eyes and backing-out bolts shall be provided where required or where they will be useful for erection and dismantling.

Pockets and depressions likely to hold water shall be avoided, and if not avoidable they shall be properly drained.

Parts of the Works principally intended for standby purposes shall be protected from corrosion by careful choice of material and if necessary, by additional means; these should not reduce their continuous standby readiness.

All design details and layout matters shall be discussed in periodic meetings with the Engineer. The first design meeting between the Contractor and the Engineer shall take place within 60 days after the date of signing of the contract or placement of the order. Further design meetings shall take place as agreed between the participants until the design work is completed.

4.3. Allowable Stress

The layout of the parts of items of Works shall fundamentally consider the most severe conditions to which they will be subjected during testing and operation.



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If different stress values are given in the General/Particular Technical Specifications or in the relevant standards and regulations, then the more stringent values shall be applicable.

The dimensions of the parts which are exposed to repetitive and alternating stresses as well as to impacts and vibrations shall take into account the safety measures approved in practice.

4.4. Design Criteria

The plant equipment shall be designed for the worst possible combination of the following loading conditions as applicable:

- All static and dynamic hydraulic loads,
- All loads due to dead weight and frictional forces,
- Seismic or wind loads, and
- Other loads

4.4.1. Seismic Loads

The forces being caused by earthquake including hydraulic loads, which may occur additionally, shall be taken into account for the computations.

The project area lies in seismic zone V of India which corresponds to the highest seismically active area in India.

Stresses resulting after including these loads shall not exceed permissible stresses.

4.5. Standardisation Of Works

Every effort shall be made to standardise parts and minimise costs of the Works throughout the Works in order to facilitate keeping stocks, maintenance, replacement, interchangeability, etc.

The Engineer, therefore, reserves the right to request the different Contractors to use uniform types or makes of works & materials. The Contractor shall not be entitled to claim extra payment due to this request. This request shall especially be applicable to small mechanical and electrical works such as:

- Valves



- Thermometers
- Pressure gauges
- Flow meters
- Water level gauges
- Terminals & terminal racks
- Indicating instruments & meters
- Auxiliary relays
- Contactors, fuses
- Motor protection switches
- Control devices
- Lights, bulbs, plugs, sockets
- Limit switches
- Level switches

The types or makes to be used shall be decided later by the Engineer. All instrument scales shall be written in the ruling language of the contract and in the international SI- System of units.

4.6. Noise

The noise level caused by the installed Works shall not exceed the following values if not otherwise stated in the Particular Technical Specifications:

- Machine hall, workshops, etc. max. 85 dB (A) at any place 1 m distant from operating equipment.
- Offices, control rooms, first aid max. 55 dB (A) rooms, canteens, etc.
- Residential areas, daytime max. 50 dB (A) nighttime max. 35 dB (A)

The noise level definition and measurement shall be in accordance with ISO and IEC. The values stated shall be adhered to taking a normal civil construction into account.

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"Notwithstanding reference made to various standards all equipment and works as per provisions and requirements of relevant and latest Indian Standards shall be acceptable".

4.7. Identification Plates

4.7.1. General

Each important part to be delivered under this Contract shall be equipped with permanent identification plates in readily visible locations. Whether a part shall be considered as important in this respect shall be decided by the Engineer.

The identification plates shall be protected during erection and especially during painting. Damaged or illegible identification plates shall be replaced by new ones. The identification plates of non-corroding, non-disintegrating material (except manufacturer's nameplates of small standardised components) shall be inscribed in the Contractual language.

The inscription shall be printed, stenciled, or hand-written, but in any case, waterproof, oil-proof and wear-resistant. Works (machines, transformers, etc.) nameplates shall be either of the enamelled type or be of stainless steel covered after stamping with a transparent paint. Wording, size and material of all labels and plates shall be subject to the Engineer's approval.

4.7.2. Manufacturer's Nameplates

The following data shall be shown in accordance with the relevant standards:

- Manufacturer's name and address
- Work's serial number and date of manufacture
- Main design data.

As a general rule, standardised components, such as small or medium-sized electric motors, transformers, instruments, etc., may be delivered with the manufacturer's standard nameplate.

The design of the Manufacturer's nameplates for the main components such as gates, cranes, valves, hoists, servomotors, pumps etc., shall be submitted for the Engineer's approval sufficiently in advance.

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4.7.3. Functional Plates

Each part appearing under a certain symbol or number in functional diagrams, piping diagrams, in the Operation and Maintenance Instructions, etc., shall be equipped with a plate showing the same symbol or number.

4.7.4. Instruction Plates

All plates showing designations or instructions for operation, safety, lubrication, etc. shall have a uniform design.

4.7.5. Nomenclature

Bay & LCC shall be named specifically for ensuring safety and clarity in operation.

4.8. Colour Code

4.8.1. Colour Coding For Electrical Connections

Live parts of electrical connections shall be colour coded as follows:

Conductor Designation	Coding Alphanumeric	Symbol	Colour
A.C. NETWORK 3 PHASE	Phase 1	R	Red
	Phase 2	Y	Yellow
	Phase 3	B	Blue
	Neutral	N	Black
a.c. single phase	Phase	P	Red
	Neutral	N	Black
	Earth	E	Green-yellow
d.c. Network	POSITIVE	a	Red
	Negative	b	Black

4.9. Workmanship

The Contractor shall level and adjust all parts of the equipment on the foundations and after each item is set up and the Engineer's approval obtained, grouting or concreting will be carried out by other Contractors

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and verified by the Contractor. The Contractor shall be responsible for ensuring that such work is carried out to his satisfaction and that levels and adjustments made by him are not disturbed by the grouting operation. The Contractor shall be responsible for ensuring that the positions, levels and dimensions of the Works are correct according to the drawings notwithstanding that he may have been assisted by the Engineer in setting out the said position, levels and dimensions.

4.9.1. Finished Surfaces

Where the finish is not indicated or specified, the type of finish shall be most suitable for the surface to which it applies and shall be consistent with the class of fit required.

Surfaces to be machine-finished shall be indicated on the shop drawings by symbols. Compliance with the specified surface shall be determined by the sense of feel and by visual inspection of the work compared to applicable "Standard Roughness Specimens", or with roughness feeler gauge instruments. Both "Standard Roughness Specimens" and feeler gauge instrument shall be procured by the Contractor at the request of the Engineer.

4.9.2. Unfinished Surfaces

As far as practicable, all work shall be laid out to secure proper matching of adjoining unfinished surfaces. Where there is a large discrepancy between adjoining unfinished surfaces, they shall be chipped and ground smooth, or machined to secure proper alignment.

Unfinished surfaces shall be true to the lines and dimensions shown on the drawings and shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts shall be filled in a manner approved by the Engineer.

4.9.3. Protection Of Machined Surfaces

Machine-finished surfaces shall be thoroughly cleaned of foreign matter. Finished surfaces of large parts and other surfaces shall be protected with wooden pads or other suitable means. Unassembled pins or bolts shall be oiled or greased and wrapped with moisture-resistant paper or protected by other approved means.



4.9.4. Roundings, Chamfers, Edges

The edges of surfaces to be painted shall be rounded (minimum radius 2 mm) or chamfered accordingly. This requirement must be stated in all shop drawings for the relevant parts.

4.10. Corrosion Protection

4.10.1. Scope of Work

The Contractor's services shall cover the procurement of all materials, and the preparation and application of the painting and other protective coats as specified; all costs shall be included in the Tender Price.

4.10.2. Painting Materials

The Contractor shall provide a complete, reliable coating system. Coating materials shall be standard products of a paint manufacturer with proven experience in the field of corrosion protection of the type of works to be supplied.

The Contractor shall submit for the Engineer's approval full details of the preparation, type of materials, methods and sequences he proposes to use to comply with the requirements for the protection of the Works.

Paint material shall be delivered in unopened original containers bearing the manufacturer's brand name and colour designation, storage directions and handling instructions. The entire paint material for a particular specified paint system shall be supplied by one manufacturer only; who shall guarantee the compatibility and quality of the paint material. A complete list of the proposed paint material shall be submitted to the Engineer. For multicoated painting systems each coat shall have a different colour.

With regard to materials, the Contractor shall submit full details including the source of the basic raw materials, volatile matter content, nature of solvent, number of components, type of coat, coverage, time interval between coats and number of coats, compatibility of each coat with the previous coat, toxic properties, physical properties, shelf life, resistance against chemical attack, resistance against ozone and UV-radiation, compatibility with drinking water standards, etc.

He shall describe in detail the treatment he proposes to apply in order to give adequate protection during transport, site storage, building and concreting and subsequent erection.



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The different coats of primer and subsequent coats shall be each of different shades of colour where practicable.

The Contractor shall submit to the Engineer for approval an overall colour scheme in accordance with the Particular Technical Specifications, Volume - III 3-B, for the finished surfaces of all Works. All final coats shall be in the colours approved by the Engineer. On request of the Engineer, painting samples for the different coats and colours shall be provided.

All pigment, paints and primers shall be delivered to Site in sealed containers packed by the manufacturer. The manufacturer's instructions for preparation and application of all painting and protective coats shall be strictly observed.

Paint materials shall be stored and mixed by the Contractor in strict accordance with the manufacturer's instructions. Paint material shall be used before the expiration of the shelf life. All safety regulations shall be observed, especially with regard to fire.

4.10.3. Painting Systems

Annex 1 "Painting Schedule", indicates painting materials considered suitable for the various parts of the Works.

4.10.4. Workmanship

4.10.4.1. Contractor's Equipment

The Contractor shall observe all safety and health precautions to protect his workers and others. The necessary equipment, such as fans, air-conditioning units, safety masks, nets, etc. shall be provided by the Contractor. All equipment shall be in strict accordance with the respective safety codes and regulations assuring efficient work of high quality.

The Contractor shall be responsible for the collection and disposal of empty containers, dirty rags and other wastes. It shall also be the Contractor's entire responsibility to protect equipment and structures not being painted such as nameplates, instruments, panels, floors, walls, etc. and he shall provide and install all necessary drop cloths and screens.

4.10.4.2. Preparation Of Paint Material

Paint shall be delivered ready mixed wherever possible. Adding of diluting agents and mixing of two or multi-component systems shall be done in the



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field in accordance with the directions of the manufacturer. Mixing and homogenising of the paint material shall be done by a mechanically driven paddle or agitator in the original container. After mixing, the paint shall be poured into a clean container to ensure that no settled pigments are at the bottom.

The Contractor's equipment shall be of perfect quality and servicing and maintenance must be guaranteed. Cleaning of equipment shall be consistently carried out at each working interval.

4.10.4.3. Application

The most commonly used methods of application are painting by brush, roller, pressure and airless spraying equipment. Selection of the application method depends on the surface to be painted. The quality of the paint shall in no way be negatively influenced. The manufacturer's directions shall govern the choice of application method. Inaccessible surfaces shall be painted prior to erection with prime and finish coats according to the specification. Areas inaccessible to spraying equipment shall be painted by brush. Corners and edges shall be pre-coated. Bolts, screws, studs, rivets etc. shall be painted as a whole with the complete paint system after erection.

The primer shall be applied to an absolutely clean and dry surface only. Temperature and dry-out time shall be in accordance with the manufacturer's directions. Whenever possible the prime coat as well as one intermediate coat shall be applied in-doors at the Contractor's shop.

During painting the air temperature shall be at least +5°C and the temperature of the items being painted must be at least 3°C above the dew point. During drying of the paint, the temperature shall not be below 0°C. For all paints the surface temperature of the metal shall not be higher than +50°C during the painting. Concerning special paints, the requirements set by the paint manufacturer shall be followed.

Cleaning and painting work shall be interrupted outdoors and in non-conditioned rooms under the following conditions: rain, fog, dew, polluting winds, sand and other dusts. Surface preparation and application of the first paint layer are parallel operations to be carried out within a maximum delay of 4 hours.

All painting shall be free of cracks and blisters and all runs shall be brushed out immediately. After application of the last coat the paint system shall be free of pores. After erection of the equipment all damages to painted surfaces shall be repaired. Welds, rusty spots, slags, beads, flux deposits etc. shall be repaired and repainted. For touching up, the

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same materials shall be used as for the main painting work. Repaired finish coats shall be of the same appearance as the original coating.

Remove electrical plates, surface hardware, fittings and fastenings before starting painting operations. Carefully store, clean, and reinstall after completion of work.

Equipment requiring special knowledge, skills and tools shall be prepared to receive field coating and painting to meet requirements of the painting schedule.

Parts, which are embedded in concrete, must not be protected against corrosion. However, transition zones of large steel pipes and of steel linings shall be painted over a length of 1 m within the concrete, all other concreted in steel surfaces over a length of 200 mm within the concrete.

In linings surrounded by concrete, surface preparation and painting works shall be carried out after all Works such as concreting, welding, grouting and cleaning have been completed. The Contractor shall take into account the local climatic conditions and use adequate installations for sandblasting, dust control and sand extraction.

A properly equipped paint shop shall be set up at the Site with a crew of specialists experienced and skilled in the preparation and application of protective coatings, to deal with all site-protective treatment.

4.10.5. Guarantee

The guarantee period for all painting shall be 2 years, starting from the issue of the "Completion Certificate". This painting guarantee period shall be effective regardless of any other guarantee periods for the project or parts of the project, or any "Defects Liability Certificate", issued prior to the elapse of the painting guarantee period.

At the end of the painting guarantee period the anti-corrosive protection of the painted or galvanised surfaces shall not have a degree of rusting higher than RE 1 (one) on the European scale of degree of rusting for anti-corrosive paints, (the corrosion committee of the Royal Swedish Academy of Engineering Sciences, Stockholm).



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4.10.6. Priming

4.10.6.1. Primer

The primer serves, in the first place, as protection against corrosion. In addition, adherence between base, primer and finish paint is achieved. Primers have only a limited weather resistance. The specified dry film thickness shall be applied to all surfaces of the equipment as required. After the aforesaid has been done, the equipment or parts thereof may be stored in the open air for a limited time only until the finish coat is applied. Only 2-component epoxy resin zinc rich primer shall be used for priming on sandblasted surfaces.

4.10.6.2. Galvanising

Unless otherwise specified, all structural steel including ladders, platforms, hand rails and the like and all exterior and interior steel surfaces of outdoor Works, as well as bolts and nuts associated with galvanised parts shall be hot-dip galvanised, electrolytically galvanised or sheradized, as may be appropriate to the particular case.

Material:

For galvanising, only original blast furnace raw zinc shall be applied, which shall have a purity of 98.5%.

The thickness of the zinc coat shall be:

- For bolts and nuts, approx. 60 micrometer
- For all other parts, except for hydraulic steel structures or parts intermittently or permanently submerged in water, approx. 70 micrometer
- For hydraulic steel structures or parts intermittently or permanently submerged in water, approx. 140 micrometer, in accordance with "VDEW, Druckrohrleitungen -Association of German Electricity Utility Companies, Steel Penstocks".

Cleaning:

All material to be galvanised shall be cleaned carefully of rust, loose scale, dirt, oil, grease, and other foreign matters. Particular care shall be taken to clean slag from welded areas.

Galvanising of plates and shapes:



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Where pieces are of such lengths that they cannot be dipped in one operation, great care shall be exercised to prevent warping.

Finished compression members of steel structures shall not have lateral variations greater than one-thousandth of the axial length between the points, which are to be supported laterally. Finished tension members shall not have lateral variations exceeding 3 mm for each 1.50 m of length. Materials with sharp kinks or bends shall be rejected. All holes in material shall be free of excess spelter after galvanising.

Galvanising of hardware:

Bolts, nuts, washers, locknuts and similar hardware shall be galvanised in accordance with the relevant standards. Excess spelter shall be removed by centrifugal spinning.

Straightening after galvanising:

All plates and shapes, which have been warped by the galvanising process, shall be straightened by being re-rolled or pressed. The material shall not be hammered or otherwise straightened in a manner that will injure the protective coating. Materials that have been harmfully bent or warped in the process of fabrication or galvanising shall be rejected.

Repair of galvanising:

Material on which galvanising has been damaged shall be redipped unless the damage is local and can be repaired by soldering or by applying a galvanising repair compound; in this case, the compound shall be applied in accordance with the manufacturer's instructions.

Soldering shall be done with a soldering iron using 50/50% solder (tin and lead). Surplus flux or acid shall be washed off promptly and the work shall be performed so as not to damage the adjacent coating or the metal itself. Any member on which the galvanised coating becomes damaged after having been dipped twice shall be rejected.

4.10.7. Painting

4.10.7.1. Surface Preparation (Primed, Galvanised Or Stainless Steel Surfaces)

All surfaces to be painted shall be thoroughly cleaned by suitable means before application of paint. After cleaning the surfaces shall be rinsed in a manner that no residues will remain.



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Primed surfaces contaminated with oil or grease shall be de-greased in a manner not affecting the quality of the primer. Two-component coatings older than six (6) months shall be roughened prior to the application of the next coat.

Hot-dip galvanised surfaces, which are to be painted, shall be lightly sandblasted prior to through cleaning.

4.10.7.2. Finishing Coats

Whenever specific colouring is required or where priming is not sufficient for protection against corrosion a finishing coat shall be applied. If not otherwise specified, finishing coats shall be applied to primed surfaces. The primed surface shall be prepared as specified above. Selection of finishing coats with regard to quality and quantity shall be governed by the ambient conditions and its effect on the painted surface.

The Engineer will select the type and shade of colouring in accordance with a standard colour code (e.g. VSLF, RAL, Munsell etc.). For this purpose the Contractor shall submit colour cards or colour samples. On request of the Engineer colour samples shall be applied to selected surfaces to be painted.

4.10.7.3. Painting Systems

The specified painting systems including surface preparation and the permissible application methods are listed on the enclosed charts (Painting Systems) Annex 1.

4.10.7.4. Cutting And Welding Of Painted Structures

All painted structures to be cut by torch or blade for fitting and welding purposes and all field-welds shall be prepared.

Reason for this preparation work is the development of aggressive residue when the paint is burned. This residue cannot be removed and thus a proper surface preparation is not warranted.

Repair of the damaged surface protection shall be executed according to "Repair of Primer and Finish Coats" described below.

4.10.7.5. Repair Of Primer And Finish Coats

General



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For touching up, the same paint shall be used as for the original painting work. Repaired finish coats shall be of identical appearance with the original and no difference in the colour shall occur.

Galvanised and Painted Structures

Repairs on galvanised and painted structures shall be carried out as follows:

- Damages to painting and galvanisation:

Surface Preparation: Scraping, wire brushing or grinding to Grade ST 3 according to SIS 055 900-1967.

Repair of Coatings: One coat of 2-component epoxy resin zinc-chromate primer. Dry film thickness minimum 0.050 mm.

Two coats of 2-component epoxy-resin micaceous iron oxide (mio) paint. Total film thickness min. 0.160 mm.

The colour of the paint shall be the same as originally applied.

- Damage to Painting only:

Surface Preparation: Thorough cleaning of the damaged surface i.e. removal of oil, grease, dust, etc.

Repair of Coatings: Two coats of 2-component epoxy-resin micaceous iron oxide (mio) paint. Total film thickness min. 0.160 mm. The colour of the paint shall be the same as originally applied.

Painted Structures

Repairs on painted structures shall be carried out as follows:

Surface Preparation: Scraping, wire brushing or grinding to Grade ST 3 according to SIS 055 900-1967.

Prime Coat: One coat of 2-component epoxy resin zinc-chromate primer. Dry film thickness minimum 0.050 mm.

Intermediate and finish Coats: Type, number of coats and dry film thickness, shall correspond to the specified 'Painting Schedule' in Annexure-1.



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4.11. Metal Work

4.11.1. Embedded Metal Work

The Contractor shall supply & install all anchors, fasteners, embedded metal work, piping, & sleeves associated with & required for the equipment to be installed under this contract, except if otherwise mentioned in the specifications.

As far as practicable, the supports shall be of consistent design throughout and preferably of an approved proprietary type.

Attachments to concrete shall wherever practicable be by means of embedded inserts of an approved proprietary type.

The Contractor will be responsible for the determination and details of all loads and forces exerted by his equipment and transferred to the foundation.

The Contractor shall show the location and full details of all embedded components on his drawings and shall be responsible for the completeness and accuracy of his drawings and the information supplied to others.

Any steel work which is to be built into the concrete foundations shall not be painted or coated unless otherwise approved or specified.

4.11.2. Miscellaneous Metalwork

Except where otherwise indicated elsewhere in the Particular Technical Specifications, the Contractor shall supply the following:

- All platforms, ladders, guards and handrails necessary for easy and safe access to Works supplied under the Contract. Handrails shall be of tubular steel construction except that the top rail shall be of flat bar, fitted with a formed plastic covering.

The use of ladders shall be kept to a practicable minimum. Where ladders are approved for use they shall be of steel, have an inclination of 70° to the horizontal and a minimum width of 450 mm.

- Safety guards at each point where normal access provision would permit personnel to come within reach of any moving equipment to be provided under the Contract.



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All covers for pipe and cable trenches, required for completing the floors around and over Works supplied under the Contract will be supplied and installed. Unless otherwise approved, floor plates shall be of an angular pattern.

Covers and curbing for dismantling hatches in main floors will be provided by the Contractor.



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5. MECHANICAL WORKS AND STEEL STRUCTURES

5.1. General

All mechanical Works and steel structures of any mechanical or electrical installation shall comply with this General Technical Specification and the requirements of the Particular Technical Specification.

The Works shall be of an approved, reliable design providing the highest possible degree of uniformity and interchangeability.

The design and arrangement of Works and installations shall facilitate erection, test, operation and maintenance.

All Works shall be pre-assembled in the manufacturers premises to an utmost extent.

Revolving parts shall be truly balanced both statically and dynamically that when running at normal speed and at any load up to the maximum, there will be no vibration due to lack of such balance.

Unless otherwise stipulated in Volume -III 3-B, all materials subjects to hydraulic pressure shall have an impact strength (Charpy V-notch) of not less than 35 J/cm^2 (at 0°C) whereby this figure shall be the minimum of each of 3 specimens. For steel plates this figure shall be understood for the transverse direction.

5.2. Bolts, Screws, Nuts, etc.

All bolts, studs, screws, nuts, and washers shall be to the ISO metric system except other standards will be considered for specific applications. The extent to which other standards are proposed shall be indicated by the Contractor. Bolts and nuts shall be hexagonal or socket headed. Sizes smaller than 4 mm shall be used only for instrument and relay internal connections.

Where mild steel bolts and nuts are used, they shall be of the precision cold forged washer faced type if commercially available in the size required. Alternatively, approved hot forged bolts and nuts, machined so that the undersides of bolt head and nut are faced and parallel to one another when assembled, may be used. In the latter case, a suitable fillet shall be machined between the bolt head and shank. All parts, other than structural steel work, bolted together, shall be spot faced on the back to ensure that nuts and bolt heads bed down satisfactorily. Bolts machined



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from bar stock shall not be used without approval of the Engineer. All bolting material shall be adequately treated against corrosion before dispatch from the workshop. Mild steel nuts and bolts shall be zinc or cadmium plated. Stainless steel bolts, nuts washers and screws shall be used in water or when exposed to high humidity, for holding renewable parts and parts made of stainless steel.

All bolts or studs which will be subject to high stress and/or temperature shall be of approved high tensile material with nuts of approved material. All bolts and studs larger than 60 mm in diameter, which are not accessible for tightening, and untightening by commercially available pneumatic impact wrenches shall be drilled for heaters or shall have an extension for pre-tensioning by hydraulic tools.

Washers shall be provided under bolt heads and nuts unless otherwise approved by the Engineer. All ferrous nuts and bolts on Works items where dismantling may be required during the life of the Works shall have their threads coated with an approved anti-seize compound. When in position, all bolts or studs shall project through the corresponding nuts by at least one thread, but this projection shall not exceed three threads, unless more length is required for adjustment. All nuts and set screws shall be securely fastened, to prevent loosening due to vibrations, using spring washers, lock nuts, split pins, self-locking inserts or 'Loctite' as appropriate for the purpose and material used.

The Contractor shall supply the net quantities plus 5 percent of all permanent bolts, screws and other similar items and materials required for installation at the Site. Any such rivets, bolts, screws, etc., which are surplus after the installation of the Works has been completed shall become spare parts and shall be wrapped, marked and handed over to the Owner.

5.3. Seals

The material for large gate seals shall be of first quality non-ageing rubber material, which shall be unaffected by wetting and drying or temperature changes. The degree of hardness according to Shore shall be 50-55 for sill sealings and 60-80 for lateral sealings. In case the Contractor intends to supply synthetic rubber material, with or without fluoro-carbon cladding, he shall furnish the name of the manufacturer and technical data of the material for the Engineer's approval.

Rubber Seals

Seals shall be designed and mounted in such a manner that they are adjustable, water tight and shall be readily removed and replaced.



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Seals shall be moulded. Extruded seals will not be permitted. Where seals are installed curved, they shall be clamped in a jig, which shall form them to the proper radius before the holes are laid out and drilled, and the ends trimmed. Holes in related parts of the seal assemblies shall be carefully drilled, using a template, to assure proper matching when the seal units are assembled. Arrangements shall be made to provide effective continuity of sealing at the corners.

All adjusting screws and bolts for securing the seals and seal assembly in place shall be of stainless steel.

Seals shall be made of synthetic rubber suitable for the temperature ranges of equipment and conditions at the Site and shall be of a material that has proven successful in similar applications. Joints shall be watertight and seal materials shall have following physical properties as determined by tests made in accordance with the relevant Standards.

Property	Limits
Tensile strength	21.0 MPa minimum
Ultimate elongation	450% minimum
Durometer hardness (Shore, Type A)	60 - 70
Specific gravity	1.1 to 1.3
Water absorption (70°C for 48 hours)	5% by weight (max.)
Compression set	30% maximum
Tensile strength after oxygen bomb ageing (48 hours at 70°C)	80% (min.) of tensile strength before ageing

5.4. Drives And Gears

All moving parts of machinery including shafts, couplings, collars, projecting key heads, gear wheels, rope/belt-drives shall be completely guarded to provide full protection. All setscrews on revolving shafts shall be countersunk or suitably protected. The guards shall be of approved design and shall be fitted, where necessary, with inspection doors/openings. All guards shall be arranged so that they can be removed without disturbing the parts of the gears and works, which they protect.

Gears shall be designed so that all stresses are within allowable limits when the maximum loads are being handled. All gears shall be designed and calculated in accordance with DIN, or equivalent international standards, or widely approved methods and to the individual experience of the manufacturer. On request of the Engineer, the manufacturer shall submit the calculation of the gears.

Where worm gears are used as a direct drive, they shall have the same load and time rating as the motors driving them. The gears shall work in oil and the temperature rise of the oil bath shall not exceed 40-50 degrees



C under normal working conditions at Site. The materials of the mating faces of worm wheel and worm shall be of a bronze/steel alloy.

Where practicable gear wheels shall be forced fit on the shaft and in addition, shall be keyed adequately to prevent any relative motion between the wheel and shaft. Where gears and couplings are secured in position by means of keys, they shall be easily accessible for tightening or removal. All keyways shall be machine cut. Couplings and collars shall be the shrouded or protected-type, free from projections of any kind.

All bearings shall be mounted in dust-proof housings. Base of bearing supports shall be machined, and shall rest on machined-surfaces.

5.5. Lubrication, Lubricants, Fuel

Efficient means of lubrication, suitable for use under Site conditions, shall be provided for all moving parts.

The contamination of the air, water and soil by lubricants and fuel shall by all means be avoided by applying of an appropriate design and layout of the Works in conformity with the latest recognised standards for modern engineering practice.

The number of different lubricants, transformer oils, oils for pressure systems, etc., used in the items of Works throughout the Works shall be limited to a minimum in order to facilitate keeping stocks and maintenance.

The Owner reserves the right to request the use of certain types of lubricants, oils, etc. The Contractor shall not be entitled to claim extra payment for this request. All different types of oils, lubricants, etc., shall be subject to the written approval of the Engineer.

Unless otherwise stated in the Particular Technical Specifications, the first oil or grease filling for bearings, pressure oil systems, transformers, etc., including the necessary quantity for flushing and for the first oil change shall be included in the Tender Price.

5.6. Piping, Fittings, Valves, Gates and Heat Exchangers

5.6.1. General

Unless otherwise stated, all piping shall be designed for a "nominal pressure" PN 10. All piping shall be tested with 1.5 the design/nominal pressure. All required piping shall be furnished complete with flanges,



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joints, expansion joints, gaskets, packing, valves, drains, vents, pipe suspensions, supports, etc.

Welding as well as application of corrosion protection coats shall be done in the manufacturer's shop as far as possible.

Metric flanges shall be used throughout. Welded flanges shall be weld-neck or slip-on flanges. The raised face shall be machined.

Joints between stainless and normal steel flanges shall be of the insulated type.

If the piping crosses over joints of civil structures of different settlement, the piping shall be provided with flexible joints to allow for vertical, horizontal, and angular deviations.

Piping installation shall be sloped to prevent trapping of air bubbles. Where required suitable venting system shall be provided.

Adequate clearance shall be given to parallel pipes to allow for easy maintenance without disturbing other lines. All overhead piping shall have a minimum clearance of 2.00 m from operating floors and platforms.

Where required water piping shall be provided with anti-condensation insulation.

5.6.2. Valves, Gates

Small valves and gates shall conform to relevant IS, "Conditions and Terms for Delivery of Valves."

Generally, valves shall be leak-proof in either flow direction (except for non-return valves) when the nominal pressure is applied.

All valves with design pressures higher than PN 10 and diameters larger than DN 100 shall be workshop-tested to relevant IS for tightness and soundness of materials.

The change of the disc seals of butterfly valves shall be possible without dismantling of disc and body.

Valves shall close clockwise and be provided with position indicators. The drive units of motor-driven valves shall also be provided with hand wheels for manual operation. The hand wheel shall be operable under all conditions and shall be independent of the motor drive. Further, it shall not be rigidly coupled to the motor drive and shall not compulsory turn when the motor is energised.



To facilitate operation, large valves and gates shall be provided with by-pass lines for pressure balancing, if required.

All valves shall be readily accessible for both operation and maintenance, and where necessary for ease of operation the spindles shall be extended and an approved form of pedestal hand-wheel provided at convenient operating floor level.

Shut-off valves shall be suitable for opening and closing against full unbalanced pressure, including closure against free discharge. If necessary, bypasses are to be provided to meet these requirements.

Valves spindles and pins shall be of stainless steel, spindle nuts and bushes of bronze, the body at least of improved C.I. (e.g. Mechanite).

All pressure reduction valves; safety valves and similar components shall be workshop-tested and provided with a work certificate 2.3 to DIN 50049.

5.6.3. Piping

Piping shall be of heavy duty class carbon steel conforming to ASTM A53/ ASTM A106. Pipe sizes < 100 mm shall be seamless type and for other sizes, it shall be as per the Owner's approval conforming to the requirement.

All piping shall be acid-treated to guarantee clean surfaces, completely free from welding residues.

This treatment shall be applied to workshop and site manufactured piping respectively.

The entire piping arrangement shall be subjected to the pressure test after complete assembly at the site.

Oil pipes shall not be embedded in concrete. Oil pipes crossing civil structures shall be routed through sleeves embedded in the concrete. All oil piping shall be hydrostatically tested at a pressure 100 % greater than the maximum working pressure. As far as possible, oil pipes shall be prefabricated in the Contractor's workshop. They shall be welded except at terminal points and as necessary for erection and future dismantling.

5.6.4. Pipe Supports And Hangers

All pipe work and accessories shall be mounted and supported in a safe and neat manner.



All brackets, stays, frames, hangers and supports for carrying and staying the pipes, including their fasteners shall be included in the supply and completed by the Contractor at the Site. Pipes and fittings shall be supported at or near flanges wherever possible.

Supports and hangers shall be designed and arranged so that any pipe can be withdrawn without disturbing the others.

All heavy valves and other mountings shall be supported independently of the pipes to which they connect, to the satisfaction of the Engineer.

The Contractor shall supply drawings showing the location of each major anchor and support and the weight to be carried by that support.

5.6.5. Heat Exchangers

Unless otherwise stated, all the heat exchangers shall be designed for a nominal pressure PN 10. All piping shall be tested with 1.5 times the design/ nominal pressure. Specification of the material of the heat exchanger shall be:

- | | |
|-----------------------------|--|
| ▪ Cooling tube | Cupro-nickel having chemical
Composition of 90:10 |
| ▪ Thickness of cooling tube | 1mm or more |
| ▪ Frame/body | Mild/cast steel |

5.7. Mechanical Instruments

All mechanical parts of instruments shall be suitably protected against shocks and vibrations, heat, humidity and splash water, etc.

Pressures gauges shall be provided with a damping liquid, e.g., glycerine, to compensate vibrations. Pressure gauges without damping means are not permitted, unless approved by the Engineer.

5.8. Pressure Oil Systems

Pressure tanks shall be designed, fabricated and tested in accordance with approved standards. The appropriate inspection certificates shall be furnished. If the pressure is held by compressed air, then the requirements outlined in "Compressed Air Systems" of these General Technical Specifications shall also be applicable.

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Oil sump tanks shall be provided with:

- Suitable access openings
- Fine mesh strainer combined with a magnetic filter through which all oil returning from the servomotors shall pass. The strainer shall be readily removable for cleaning.
- Dehumidifying air filter
- Flush-mounted oil-level indicator
- Filling connection with a suitable strainer
- Drain connection with hand operated shut-off valve.

Sump tanks shall be installed so that the bottom of the tank and the drain connection are at least 40 cm above the floor. The bottom of the tank shall be inclined in the direction of the drainage. The pumps shall be removable without the necessity of emptying the tank.

Servomotors shall be provided with suitable connections for pressure gauges on the pressure and suction sides of the piston. Servomotor piston rods shall be of stainless steel provided with a hard chromium layer of approximately 0.04 mm thickness. A suitable protection for the piston rod seal shall be provided.

5.9. Compressed Air Systems

The provisions for safety of the entire compressed air system shall conform to internationally accepted standards. The standards proposed by the Contractor will in any case be subject to approval of the Engineer.

Vessels shall be of the cylindrical, vertical type and shall be mounted on a structural steel base. The inner surfaces of the vessels shall be protected with an appropriate paint coating or the vessels shall be hot dip galvanised. Each vessel shall be equipped with the following devices:

- 2 inlet sockets with valves
- 2 outlet sockets with valves
- 2 pressure safety valves
- 2 dial pressure gauges, one of the gauges with 4 electrical contacts
- 1 manhole or inspection hole

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- 1 drain valve.

In case the pressure vessel is used for pressurised oil or water systems, the vessel shall further be equipped with:

- 1 transparent level gauge with shut-off valves at both ends
- Level indicators with electrical contacts in a number as required or specified.

Compressors shall be provided with:

- Automatic lubrication
- Air-intake filter and silencer
- Thermometer for measuring temperature of the compressed air
- Automatic shut-down if the discharge air temperature exceeds a predetermined, adjustable value
- Discharging valves
- Water drain valves
- Water/oil separator
- Pressure safety valve
- Compressed air cooler
- Non-return valve
- Inlet pressure valve
- Outlet pressure valve
- Automatic moisture trap

The water / oil separator shall be equipped with an automatic solenoid-operated drain valve to achieve automatic draining during standstill. The compressor stages shall be equipped with discharge valves, which shall close time delayed after start to avoid compressor start against full pressure.

The compressors shall be delivered as package units on common frame with the appropriately sized AC squirrel cage motor and the respective motor starter panels, ready for operation.



Each vessel shall pass a pressure test at 1.5 x maximum working pressure for 8 hours in the manufacturer's workshop before coating is applied.

If requested by the Engineer, each compressor shall pass a performance test in the manufacturer's workshop to a standard mutually agreed upon, e.g., DIN 1945, VDMA 4362, without extra cost. The readily assembled compressors, controls, and switchgear shall be subjected to functional tests.

Each vessel shall be furnished with a test certificate of an independent, reputable underwriters' society.

5.10. Pumps

Non- submersible pumps & motors

Non-submersible pumps and motors shall be mounted on common frames.

Materials of the pumps shall be:

- Impeller stainless steel
- Shaft stainless steel
- Sleeves stainless steel
- Wear rings bronze
- Keys stainless steel

The impeller diameters shall be neither maximum nor minimum impeller size for the selected pump size.

The pumps shall withstand corrosion and wear by abrasive matters within reasonable limits.

Shafts sealed by packing glands shall be fitted with sleeves. Seals shall be exchangeable without extensive disassembly of the pump. Leakage water shall be directed to suitable drainage facilities.

Each pump shall be fitted with:

- Check valve at the discharge side
- Air and drain valve



- Pressure gauge.

The size of the pump motor shall be 15 % higher than the maximum power required by the pump at any operation point

Submersible pumps & motors

For submersible pumps, pump and motor shall be contained in the same casing and designed as a package unit with incorporated suction strainer and check-valve.

The impeller shall be of stainless steel and the material for the other parts as specified for the non-submersible pumps above. For dirty water pumps, the water passages of corrosive material shall be rubber-lined.

The motors of submersible pumps operating in potable water shall not be filled with oil or other media detrimental to potable water. Motors of submersible pumps operating in dirty water may be filled with oil.

Dirty water submersible sump pumps with the motors mounted on top of the pump shall be suitable for running dry continuously, without damage to seals, bearings, or motors.

For all other items, the requirements described for non-submersible pumps shall apply.

For any pump, the overall pump-motor efficiency for the specified rated head and discharge shall not be less than 60%.

Prior to the test, the manufacturer shall provide certified motor performance curves.

5.11. Lifting Equipment

5.11.1. General Design Particulars

Nameplates stating the nominal capacity in tons shall be attached to both sides of the lifting equipment structure and to both sides of the tackle. The printing shall be clearly legible from the floor.

Hoists, ropes, drums, sheaves and related Works shall be calculated to relevant IS or equivalent standards.

Flexible couplings shall be installed to relieve the bearings and shafts from any stresses due to misalignment and to facilitate the removal of



motors, wheels and gears. The motor couplings also shall be of the flexible type.

All couplings drive wheels and gears shall be press fit and keyed to the shaft.

All wheels shall have a hardened tread with a minimum Brinell hardness number of 400, and shall be made of carbon steel or low-alloy steel forgings. They shall have double flanges, shall be machined to a uniform diameter concentric with the hub bore.

All bearings shall preferably be anti-friction bearings designed to permit easy shaft disassembly and easy replacement. The minimum average lifetime under design load conditions shall be 5000 hours.

All sleeve bearings except those for the hooks and rope sheaves shall be lubricated by central lubrication systems. An independent system for the trolley and one or two independent systems for the bridge will be acceptable. These central lubrication systems shall satisfy the following requirements:

- The lubricant quantity for each bearing shall be variable
- Lubricant filters shall be installed in every lubricating pipe
- The lubrication piping shall be arranged to be easily accessible for maintenance

Gears shall preferably be designed as bevel gears. For all high-speed gears and pinions, oil bath lubrication shall be provided. Low-speed gears may be lubricated with soft grease. Suitable oil and grease drip pans shall be installed and be readily accessible for draining and cleaning.

Bridge and trolley drives shall be equipped with a spring-set, electrically (solenoid or electro-hydraulic) released shoe or disc brake, with capacities of at least 1.5 times the full operating torque of the drive.

The brake shall be applied when the motor control switch or the main switch is in the "off" position and/or in case of power failure in any phase. The braking action shall be gradual and the brake shall become fully effective after a certain time lag.

5.12. Steel Structures

Generally, design and stress calculation shall conform to prevailing IEC /IS:

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- Steel Structures, Construction
- Welded Steel Structures, Calculation and Design
- Stress Calculation of Steel Structures
- Steel Structures, Calculation and Construction

For standards applicable to steel structures of lifting equipment, refer to "Lifting Equipment".

The permissible design stresses for materials, bolts, rivets, etc. are given in relevant IS.

Adequate clearance of at least 2 m shall be provided at overhead steel structures to allow unobstructed passage.

Stairs and ladders shall have an inclination of approximately 30 degrees and 75 degrees respectively. Stairs shall be complete with handrails, min. 90 cm high, and kickboards of 8 cm height.

Vertical ladders shall be installed alternating left hand/right hand side to horizontal platforms placed approx. every 10 m of vertical height. Vertical ladders of more than 2.5 m height shall be guarded.

Unless otherwise specified or stipulated in the applicable standards.

Platforms and stairs shall be provided with anti-slip checker plates.

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6. ELECTRICAL WORKS

6.1. General

The electrical items of Works of any electrical or mechanical installation to be provided under this Contract according to the Particular Technical Specifications shall - if not stated otherwise therein-fulfill the requirements of this Section.

All components shall be of an approved and reliable design. The highest extent of uniformity and interchangeability shall be reached. The design shall facilitate maintenance and repair of the components.

The Works shall be pre-assembled to the highest possible extent in the Contractor or Sub-Contractor's workshop, complete with all devices and wired up to common terminal blocks.

The power supply and control cables shall be laid up to these common terminal blocks. The required control and protection devices, instruments, etc., within the different scopes of work shall be supplied and connected by the relevant Contractor.

Unless otherwise agreed, ratings of main electrical Works (infeeds, bus-ties) as selected or proposed by the Contractor, whether originally specified or not, shall generally include a safety margin of 10% under consideration of the worst case to be met in service. Prior to approval of such basic characteristics, the Contractor shall submit all relevant information such as consumer lists, short circuit calculations, de-rating factors, etc.

Short-circuit calculations shall be evaluated giving full evidence that every electrical component can withstand the maximum stresses under fault conditions, for fault levels and durations obtained under the worst conditions, e.g., upon failure of the corresponding main protection device and time delayed fault clearing by the back-up protection device.

All Works shall be suitable for the prevailing climatic conditions.

Outdoor installations needing protections shall be protected against solar radiation by means of adequate covers, where required.

The Contractor shall ensure that all the supplied Works is insensitive to any signals emitted by wireless communication equipment.



6.2. Standards

The design, manufacture and testing of all Works and installations shall strictly comply with the latest edition of the relevant IEC publications.

6.3. Colour Code

In general, the colour code for electrical Works shall be as described in the Particular Technical Specifications.

The manufacturer's painting systems shall be used to the maximum possible extent, but shall by all means be subject to the approval of the Engineer. Final coats of paint shall be matching adjacent installations, where required.

6.4. Electric Motors

6.4.1. General

All motors shall be of approved manufacture and shall comply with the requirements of this Chapter. Motors of the same type and size shall be fully interchangeable and shall comply - as far as applicable - to IEC standard motor dimensions.

The general construction shall be stiff and rigid; no light metal alloy casings will be accepted. All precautions shall be taken to avoid any type of corrosion.

All motors shall be fitted with approved types of lifting hooks or eyebolts as suitable.

AC motors shall have squirrel cage type rotors.

Motor Voltages and Power Ratings

The service voltages and corresponding power ratings for electric motors to be used in the Project shall be as follows:

- Motors up to 100 kW
 - Service voltage : 3-phase a.c. 415/240 V, 50 HZ
 - Mode of starting : direct-on-line up to 50 kW
above 50 kW with suitable starters

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- Motors up to 0.75 kW
 - Service voltage : single-phase a.c. 240 V, 50 HZ
 - Mode of starting : condenser
- Motors intended to work on the d.c. System
 - Service voltage : 220 V D.C.
 - Mode of starting : resistor

6.4.2. Rating

The rating of the motors shall be adequate to meet the requirements of its associated equipment. The service factor, being the ratio of the installed motor output to the required power at the shaft of the driven machine at its expected maximum power demand, shall be applied as follows:

Power Demand of Driven Machine	Service Factor
Up to 5 kW	1.2
More than 5 kW	1.1

A.C. motors shall be capable of operating continuously under rated output conditions at any frequency between 95% and 105% of the rated frequency and/or with any voltage variation between 90% and 110% of the nominal voltage. A transient overvoltage of 130% of the nominal voltage shall as well be sustained.

Further, the motors shall be capable of maintaining stable operation when running at 70% nominal voltage for a period of 10 seconds. The pullout torque for continuously loaded motors shall be at least 160% of the rated torque and for intermittently loaded motors 200% of the rated torque.

D.C. motors shall be capable of operating continuously under rated output conditions at any voltage between 90% and 110% of the nominal voltage with a fixed brush setting for all loads. Unless otherwise approved, the speed drop between no-load and full-load shall not exceed 10% of no-load speed.

6.4.3. Starting

A.C. motors shall be designed for direct on-line starting. They shall be capable of being switched on without damage to an infinite busbar at



110% of the nominal voltage with an inherent residual voltage of 100% even in phase opposition. For starting the motors from the individual main and auxiliary busbars, a momentary voltage drop of 20% referred to nominal voltage should be taken into consideration. With 85% of the nominal voltage applied to the motor terminals, each motor shall be capable of accelerating its associated load to full speed with a minimum accelerating torque of 5% of full load torque.

The maximum starting currents (without any tolerance) shall not exceed the following values: -

- 5 times of rated current for L.V. motors rated 100 kW or above
- 2 times of rated current for D.C. motors (by means of starting resistors)

Generally, all motors shall be able to withstand three cold starts per hour, equally spaced. In addition, each M.V. motor shall be capable of enduring two successive starts with the motor initially at operating temperature. Each L.V. motor shall be capable of withstanding three successive starts under the same conditions or once every twenty minutes without detrimental heating.

Motors for frequent automatic starting shall have an adequate rating. In the motor list the Contractor shall state the frequency of starts permitted in compliance with the motor design.

6.4.4. Windings and Insulation Class

The insulation of all motors shall be of class F but maintain in operation the temperature limits of class B materials. It shall be suitable for operation in damp locations, for occasional contact with corrosive gases and vapours and for considerable fluctuations in temperature.

The stator winding shall be suitably braced to withstand the forces due to direct-on-line starting and transfer conditions as mentioned before. The winding envelopment and tails shall be non-hygroscopic. The stator winding shall withstand the maximum fault current for the period determined by the associated protective devices.

The rotor winding (if applicable) shall be designed to give trouble-free continuous service including repeated direct-on-line starting. The rotor shall be subjected to a 120% overspeed test for 2 minutes without showing any winding dislocation.

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6.4.5. Ventilation and Type of Enclosure

All motors shall be of the totally enclosed fan-cooled type, protection class IP 54 according to IEC Recommendation 144. Cable termination points shall be of class IP55.

They shall have a closed internal cooling air circuit recooled by an external cooling air circuit drawn from the opposite side of the driving end.

Where motors are installed outdoors, a weatherproof design shall be chosen. L.V. motors of IEC size 132 and above shall be equipped with automatically controlled heating elements for protection against internal condensation of moisture during standstill periods. Such A.C. heater shall be suitably fixed inside the motor casing; the leads shall be led to a separate L.V. terminal box.

Motors installed outdoors and directly subjected to solar radiation shall be rated such as not to exceed a maximum metal temperature of 85°C. Where necessary, such motors shall be provided with sun shields.

Vertical motors shall be provided with a top cover to prevent the ingress of dirt, etc.

6.4.6. Bearings

As far as possible, the motors shall have sealed ball or roller bearings lubricated for life. All other motors with ratings of about 1 kW and above shall be equipped with lubricators permitting greasing while the motor is running and preventing over-lubrication. Additionally, the bearings shall be fitted with grease nipples permitting the use of a universal grease gun.

Vertical motors shall have approved thrust bearings.

Where sleeve bearings are being used, they shall be of the self or forced lubricating type. If forced lubrication is required, it shall be arranged common to both the motor and the driven machine and provisions shall be made to ensure lubrication during start-up and shutdown operations without the necessity to start an auxiliary lube oil pump. Self-lubricated bearings shall be equipped with an easily accessible oil reservoir with overflow pipe and oil collecting vessel.

All bearings shall be easily controllable during operation or standstill without dismantling the bearings. The bearings shall further be protected and sealed against dust penetration and oil leakage.

In case of independent bearings, motor and bearing pedestals shall be fitted on a common base plate.



For the transport of motors equipped with ball or roller bearings, special bearing inserts shall be provided to prevent transport damage.

Service hour meters shall be installed in the motor control centres if maintenance work such as regreasing, oil change etc. depend on the operation time of the motors.

6.4.7. Shafts and Couplings

The motors shall be provided with a free shaft extension of cylindrical shape with key and keyway according to IEC Recommendation 72-1 and with the motorside-coupling, which shall be pressed on the motor shaft and be balanced together with it. A coupling guard shall be provided.

6.4.8. Brushgear and Commutators

Brushgear for D.C. motors shall be designed to ensure constant brush pressure. Carbon brushes shall be provided which stand at least 6 months of operation without replacement. Each brush shall be independently adjustable but should not require adjustment throughout its life. A design of brushgear which permits the brush holder to touch the commutator as the brushes wear or which passes current through the pressure fingers will not be accepted.

A sufficient number of brushes, not less than two per pole, shall be fitted to ensure that vibrations do not affect the commutation.

The minimum safe wearing margin of commutators shall not be less than 20 (twenty) per cent of the total thickness of the commutator bars and the minimum safe diameter shall be clearly marked on it.

6.4.9. Terminal Boxes and Earthing

The terminal leads, terminals, terminal boxes and associated equipment shall be suitable for terminating the respective type of cables as specified in these General Technical Specifications and in the Particular Technical Specifications.

The terminal boxes shall be of ample size to enable connections to be made in a satisfactory manner. Supports shall be provided at terminal boxes as required for proper guidance and fixing of the incoming cable.

The terminal boxes with the cables installed shall be suitable for connection to supply systems with the short-circuit current and the fault clearance time determined by the motor protective devices.



A permanently attached connection diagram shall be mounted inside the terminal box cover. If motors are provided for only one direction of rotation, this shall be clearly indicated.

Terminal boxes shall be totally enclosed and designed to prevent the ingress of moisture and dust. All joints shall be flanged with gaskets of neoprene or similar material. For motors above 1 kW, the terminal box shall be sealed from the internal air circuit of the motor.

Depending on the size, the terminal box of L.V. motors shall be fitted either with an approved cable sealing-end or with a gland plate drilled as required and provided with suitable fittings for cable fixing and sealing. Such openings shall be temporarily plugged or sealed during transportation.

For earthing purposes, each motor shall have adequately sized bolts with washers at the lower part of the frame. In addition, each terminal box shall contain one earthing screw. Each equipment/panel shall be earthed by at least two separate earthing strips.

The cable termination philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field-mounted group. JB'S at strategic locations (where large concentration of signals are available, e.g switchgear) is done. Termination / Junction boxes shall have either maxi- terminal or cage clamp type terminals

6.4.10. Noise-Level and Vibrations

Under all operating conditions, the noise level of motors shall not exceed 85 dB (A).

In order to prevent undue and harmful vibrations, all motors shall be statically and dynamically balanced.

Vibration displacements or velocity shall be measured in accordance with relevant IS for IEC motor sizes 80 to 315. The results for all motors shall be within the "R" (reduced) limits.

6.4.11. Tests

Each motor shall be factory tested and shall undergo a test at site. The following tests shall be performed under full responsibility of the Contractor.

- Workshop Tests:



- Measurement of winding resistances
- No-load and short-circuit measurements
- Measurement of starting current and torque
- Efficiency measurement (type test)
- Heat test run
- Dielectric test
- Measurement of insulating resistance
- Overspeed test
- Site Tests:
 - Measurement of insulation resistance
 - Measurement of motor vibrations
 - Measurement of starting time.

6.5. M.V.and L.V Switchgear, Cubicles and Panels

6.5.1. Starters and contactors

Motor starters and contactors shall be equipped with short circuit protection and local disconnecting devices. Preferably, all starters shall be from one manufacturer. The control circuit voltage shall be obtained from a 415/240 V isolating transformer with primary circuit breaker and secondary fuse. The secondary winding of this transformer shall be grounded. The operating coils of the contactor shall be connected between the grounded side of the transformer and the control contacts.

Starters and contactors shall comply with IEC 292.1 or NEMA IC 1 and be suitable for direct on-line starting, uninterrupted electrical duty, and capable of 30 operations per hour. They shall be installed in ventilated enclosures for indoor installation and weatherproof enclosures for outdoor installation, unless otherwise approved by the Engineer. The enclosures shall be complete with locks, cable sealing boxes, conduit entries, cable gland plates, bus bars, internal wiring, terminal boards, etc. as required by the duty of the starter or contactor.



Starters and contactors shall be of minimum size compatible with motor size and capable of satisfactory operation, without damage, for a period of 5 minutes at a voltage 25 percent below nominal, at nominal frequency.

Thermal type overload and phase failure relays shall be supplied with starters for motors of 7.5 kW or greater. For motors of less than 7.5 kW, suitable rated 3-phase thermal overloads will be acceptable. Ammeters to read current in one phase shall be provided for motors above 7.5 kW.

Each starter shall have sufficient number of auxiliary contacts required for interlocking and indication purposes plus two spare convertible contacts for Owner's use.

6.5.2. Moulded case circuit breakers

All moulded case circuit breakers shall be of 2 or 3-pole type as required, having thermal time delay and instantaneous trips with "On-Trip-Off", indicating/operating mechanism. Circuit breakers used in combination type motor starters or contactors shall have the operating mechanisms interlocked with the starter or contactor cover so that the cover cannot be opened unless the circuit breaker is open. The breakers shall comply with applicable section of IEC 157/1 or equivalent standards.

6.5.3. Control relays

Relays used as auxiliary control devices in conjunction with motor starters and magnetic contactors shall be of the type designed for machine tool application featuring contact convertibility. All contacts shall have a minimum thermal current rating of 10A over a range of 6 to 600 V AC.

6.5.4. Pilot devices

Pilot devices such as selector switches, push-button starters and thermostats shall be of heavy duty type and, where mounted outdoors, shall be housed in weather proof enclosures specially designed for the environment.

All electrical contacts for control, alarm and shutdown shall have a thermal current rating of not less than 10 A at 220 V DC.

6.5.5. Terminal blocks

All terminal blocks shall be mounted in an accessible position with the spacing between adjacent blocks not less than 100 mm and space



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between the bottom blocks and the cable gland plate being a minimum of 200 mm. Sufficient terminals shall be provided to allow for the connection of all incoming and outgoing cables, including spare conductors and drain wires. In addition, 20 percent spare terminals shall be provided. In enclosed cubicles, the terminal blocks shall be inclined toward the door for facilitating terminations.

Terminals shall be of the channel mounting type and shall comprise a system of individual terminals so that terminal blocks can be formed for easy and convenient cabling consistent with the high reliability required of the circuits.

Terminal blocks shall be provided with shorting links and paralleling links where applicable and mounting identification numbers and/or letters.

Terminal blocks shall disconnecting link type for CT, PT and incoming supplies AC/DC & for balance fixed link type conforming to the applicable standards. The smallest size to be used shall be designated for 2.5-sq. mm wire and not more than two conductors shall be connected under one terminal clamp.

Terminal identification shall be provided corresponding to wire number of connected leads.

Circuit terminals for 415 V AC shall be segregated from other terminals and shall be equipped with nonflammable, transparent covers to prevent contact with live parts. Warning labels with red lettering shall be mounted thereon in a conspicuous position.

6.5.6. Equipment wiring

All wiring connections shall be readily accessible and removable for test or other purposes. Wiring between terminals of the various devices shall be point to point.

Splices or tee connections between terminal points are not acceptable. Wire runs shall be neatly trunked inside the panels or in wiring troughs. Whenever possible, unused areas of the panels shall be kept free of wiring to facilitate the installation of future equipments.

Multiconductor cables shall be connected to the terminal blocks in such a manner as to minimise crossovers. Approved claw washers of crimp type connector shall be used to terminate all small wiring. Each conductor shall be individually identified at both ends through a system providing ready and permanent identification, utilising slip-on ferrules approved by the Engineer.



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Markers may be typed individually or made up from sets of numbers and letters firmly held in place. Open markers will not be accepted.

Markers must withstand a tropical environment and high humidity and only fungus proof materials will be accepted. Ferrules of adhesive type are not acceptable.

All trip circuits shall employ markers having a red background.

Sensitive control circuits shall be effectively shielded against extraneous signals and interference. A separate terminal shall be provided for termination of individual cable shields, which will be grounded at source end only.

6.5.7. Cubicles and control panels

Cubicles and control panel enclosures shall be of cold rolled sheet steel with minimum thickness for load bearing members as 2.5mm and non load bearing as 2 mm, of rigid, self-supporting construction and supplied with channel bases made to ensure no bulging takes place.

Cubicles shall be fitted with close fitting, gasketed, hinged, lift-off doors capable of being opened through 180 deg. The doors shall be provided with integral lock and master key.

Cubicles and panels shall be vermin proof. Removable gland plates shall be supplied and located to provide adequate working clearance for the termination of cables. Under no circumstances shall the floor/roof plate be used as a gland plate. The cables and wiring shall enter from bottom or top as approved or directed by the Engineer.

The cubicles and panels shall be adequately ventilated, if required, by vents or louvers, and shall be so placed as not to detract from the appearance. All ventilating openings shall be provided with corrosion-resistant metal screens or a suitable filter to prevent entrance of insects or vermin. Space heating elements with thermostatic control shall be included in each panel.

Where cubicles are split between panels for shipping, terminal blocks shall be provided on each side of the split with all necessary cable extensions across the splits. These cable extensions shall be confined within the panels with suitable internal cable ducts.

Unless stated otherwise, all cubicles and panels shall be provided with a ground bus with 40mm copper bar extending through out the length. Each end of this bus shall be drilled and provided with lugs for connecting ground cables ranging from 70 to 120mm².

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The standard phase arrangement when facing the front of the motor control centres and switchboard shall be RYB from left to right, from top to bottom and front to back. All instruments, devices, buses and other equipments involving 3 phase circuits shall be arranged and connected in accordance with the standard phase arrangement, where possible. Electrical clearances shall conform to applicable standards and shall not require cutting away of adjacent framework.

All instruments, control knobs and indicating lamps shall be flush mounted on the panels. Relays and other devices sensitive to vibration shall not be installed on doors or hinged panels, and no equipment shall be installed on rear access doors.

The instrument and control wiring, including all electrical interlocks and all interconnecting wiring between sections, shall be completely installed and connected to terminal blocks by the manufacturer.

The arrangement of control and protection devices on the panels and the exterior finish of the panels shall be subject to the approval of the Engineer. The interior of all cubicles and panels shall have a mat white finish unless specified otherwise.

Switched interior light and socket outlets shall be provided for all cubicles and control panels.

All cubicles and control panels shall be provided with lamacoid nameplates, identifying the purpose of the panel and all of its components.

6.5.8. Alarm contacts

Where applicable, all alarm contacts shall be of galvanically isolated type and provide inputs to the following devices.

- Local annunciator
- Station annunciator
- Supervisory control and sequence of events / fault recorder system.

All alarm contacts shall be changeover type. Where required, relays shall be provided as contact multiplier.

6.6. Cables

Refer to particular technical specifications Volume 3B

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6.7. Earthing System

The Contractor shall coordinate between the suppliers of Electro-Mechanical Equipment who shall design, supply and install the necessary earthing material and the sub contractor responsible for civil works during earth mat laying.

6.8. Labels and Plates

6.8.1. General

Labels and data plates shall be provided in accordance with applicable standards and as detailed hereunder.

The proposed material of the labels, size, exact label lettering and proposals for the arrangement of the labels shall be submitted to the Engineer for approval.

Where applicable, designations in the selected local language shall appear above or to the right of the designation in the Contract language. The translations into and writings in the local language shall be submitted for approval.

6.8.2. Equipment Labels and Instruction Plates

Labels written in the Contract language shall be provided for all instruments, relays, control switches, push buttons, indication lights, breakers, etc. In case of instruments, instrument switches and control switches, where the function is indicated on the device, no label is required. The label shall be fixed close to the devices in such a way that easy identification is possible. Fixing on the dial glass of instruments will not be accepted. The wording shall conform to the wording used in engineering documents.

Each separate construction unit (cubicle, panel, desk, box, etc.) shall be identified by its Works identification number. Cubicles and similar units shall also bear this identification number on the rear side if rear access is possible. The overall designation of each unit shall be given in the Contract language and - if required - also in a selected local language. These labels shall be made of anodised aluminium with black engraved inscriptions, arranged at the top section of the units. Manufacturer's trade labels shall - if desired - appear in the bottom section of the units.

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All Works inside cubicles, panels, boxes, etc., shall be properly labelled with their item number. This number shall be the same as indicated in the pertaining documents (wiring diagrams, Works list, etc.).

Instruction plates in the Contract and selected local language, the sequence diagrams or instructions for maintenance shall be fitted on the inside of the front door of the electrical switchboards.

6.8.3. Warning Labels

Warning labels shall be made of synthetic resin with letters engraved in the Contract and selected local language, where required in particular cases.

For indoor circuit breakers, starters, etc., transparent plastic material with suitably contrasting colours and engraved lettering would be acceptable.

Details are stated in the Particular Technical Specifications or will be fixed at a later date.

6.8.4. Labels for Conduits, etc.

The material shall be non-corrosive and the description be done with 4 mm high letters/figures.

6.8.5. Labels for Cables

Each cable when completely installed shall have permanently attached to each end and at intermediate positions as may be considered necessary by the Engineer, non-corrosive labels detailing identification number of the cable, voltage, and conductor size.

The cable identification numbers shall comply with those of the cable list.

All cables in cable pits and at the entry to buildings shall be labelled utilising the aforementioned type of label.

6.8.6. Rating Plates

Works (hoists, machines, transformers, etc.) rating plates and other technical data/informative plates shall either be of the enamelled type or be of stainless steel suitably protected after engraving with a transparent paint resistant to aggressive atmosphere and solar radiation.

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6.8.7. Single-Line Diagrams

Each switchgear room shall be furnished with a copy of the final as-built single-line diagram detailing all electrical data and denominations, separate for each individual switchgear / distribution board / MCC, placed under glass and frame/wall mounted at an approved location.

The same applies to the Station Single-Line Diagram one copy of which shall be arranged in the control room(s).

6.9. Key System for Electric Boards

Key interlocked switches shall be provided with Yale or other approved locks for locking in the neutral position. Similar locks shall be provided for selector switches for locking the switches in any of the positions.

The locks or padlocks shall be co-ordinated for the different applications and shall be supplied with three keys. A key cabinet at the end of each board (distribution board, MCC, control cubicles, etc.) shall be provided for storing the keys of that board. All keys shall have six master keys to open any lock or padlock supplied. Each key shall have one identification label fixed above the key-hanging hook inside the cabinet.

The cabinet door keys shall be similar and shall be six (6) in number.



7. INSTRUMENTATION AND CONTROL EQUIPMENT

7.1. General

All instrumentation and control equipment shall be of internationally reputed make having proven performance and acceptability in the field.

7.2. Design Criteria

7.2.1. General

Chapter 6, "Electrical Works", shall be considered for I & C equipment as far as applicable. Special reference is made to cabling, wiring and labeling.

All components shall be of an approved and reliable design. The highest extent of uniformity and interchangeability shall be reached. The design shall facilitate maintenance and repair of the components.

The Works shall be pre-assembled to the highest extent in the Contractor's or Sub-Contractor's workshop, e.g., shop welding of thermometer wells and other connections, wiring of boards, desks, etc., including internal wiring and installation of devices shall be carried out. Fragile instruments shall be removed for transportation to site.

All components shall be suitable for continuous operation under site conditions.

Materials for instrumentation and control equipment, including piping material, which is exposed to the measured media, shall be selected accordingly.

All components shall be compatible with other electrical, electronic and mechanical Works.

All instrumentation and control functions shall be shown on the piping and instrumentation diagrams. The symbols to be used shall be in accordance with ISO standard. The identification system (tag numbers) shall be in accordance with the Works identification system and is subject to approval by the Engineer. All measurements and alarms shall be listed in a measuring list of a standard form subject to Approval by the Engineer. For remote controls, a schedule of interlocks shall be provided. The features of automatic controls shall be shown in block diagrams.



Shielded cables shall be provided for the control and supervisory equipment where required.

7.2.2. Standards

If the Contractor intends to apply Standards and Regulations other than those specified, he shall provide the Engineer with two (2) sets of such documents, which shall be complete, unabridged and written in the Contract Language.

7.2.3. Sizes of Indicators, Recorders, Etc.

The meters, instruments and recorders shall be of standard size, to be selected to guarantee unique appearance of switchgears, control panels, control desks, etc. The front glasses shall be of the anti-glare type. The scales shall be 90 degrees type for local control panels but must be 240 degrees type for control room instrumentation.

The indicating instruments and recorders shall have the following or similar sizes:

- Indicators on local control panels, M.V. and L.V. switchgears 72x72mm or
144x72mm
- Recorders 144x144mm
(for line and 6-point recorders)
- Pressure gauges and other dial type
instruments (local) preferably 160 mm diameter

The control switches, adjusters, etc., on the panels and desks shall harmonise with the utilised indicator sizes.

7.3. Tests

The single components and pre-erected assemblies shall undergo functional and routine tests in the Contractor's or Sub-Contractor's workshop. The ready mounted control and supervisory system shall undergo functional tests on Site prior to commissioning of the power Works.

Calibration tests shall be made on all-important pressure gauges and other instruments as required by the Engineer.



7.4. Measuring Systems

Electric measuring signals of 4-20 mA shall be transmitted to the control room for essential or regulating circuits. In this case the absence of live zero signal shall lead to a warning signal. Measuring signals for indicating purposes will be 4-20 mA.

The components shall quickly respond to any changes of the measured magnitudes. Measuring ranges of indicators, transducers, etc. shall be selected in such a way that the rated value of the measured magnitude covers approx. 75% of the range.

All local instruments shall, as far as practicable, be mounted vibration free to allow good reading. Wherever required, damping elements shall be used.

Corresponding systems shall be grouped together in local panels.

All local indicating instruments and test connections shall be included in the respective Works as integrated parts. The scope of local indicating instruments and test connections shall enable the operator to properly survey the Works, and shall also allow to adequately carry out all acceptance and other tests.

The binary sensors shall be fused separately and supplied with 24 V D.C.

7.4.1. Flow Measurements

The primary elements of flow meters shall be standard Venturi tubes, pitot tubes, standard orifices, anubar inductive or ultrasonic type. Their design and performance shall be in accordance with applicable standards.

Beginning at a rate of flow of at least 5% of the measuring range all flow transmitters shall measure correctly. The error limit shall be $\pm 2\%$ for a rate of flow higher than 10%. The error of the primary elements is not included in this accuracy. The root extraction of flow measurement shall be effected electrically within the transmitter.

Arrangement:

The arrangement of the throttling devices, the straight lengths upstream and downstream from the throttling device shall be in accordance with the said standards. Bends shall be at a sufficient distance upstream from the throttling device, particularly when large orifice ratios are used.



7.4.2. Temperature Measurements

All wells for capillary type thermometers, resistance temperature sensors and thermocouples shall be of the weld-in type. Wells for thermometers and temperature sensors of the screw-in type shall be restricted to measuring points for lubrication oil, and to such measuring points where welding is not suitable, e.g., at cast-iron parts. Shop-welded thermometer wells shall be covered by screw caps for protection during transportation and erection.

Resistance thermometers and thermocouples shall be equipped with waterproof connection heads. Thermometer arrangements shall be such that the connection heads do not become warmer than 80 °C, and the measuring inserts are easily exchangeable.

The temperature sensors shall be selected in such a way to minimise the number of different spare inserts. Resistance thermometers shall be used as far as possible and shall generally be of type Pt 100. Double resistance thermometers (with two resistors in one insert) should be avoided.

The use of dial-type contact thermometers shall be restricted to bearing metal and oil temperature measuring. In all other cases, thermocouples or resistance thermometers and electric contact modules (monitors) shall be used. Glass thermometers or similar will not be accepted as contact thermometers.

7.4.3. Pressure Measurements

Pressure gauges shall be shock and vibration-proof (preferably by filling with glycerine) and shall be equipped with toothed wheels and toothed segments of the machined type. They shall completely be made of stainless steel.

Higher than rated pressure shall not deteriorate the pressure gauge or affect its calibration. The pressure gauges shall be equipped with a radial-connecting stud, to allow the mounting on a gauge holder.

The error for pressure transmitters shall be limited to $\pm 0.5\%$.

Pressure gauges and transmitters for inflammable liquids shall have filled systems and the filling liquid shall be separated from the inflammable liquid by means of adequate isolating membranes.

Each gauge, pressure switch and transmitter for absolute or differential pressure shall be equipped with a pressure gauge isolating valve including a test connection of the screwed type M20 x 1.5 mm so that

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such device can be removed without any disturbance of the plant operation.

Pressure gauges and transmitters for pressures of 10 bar and above shall not be directly mounted on the pressure tapping point. They shall be mounted apart from the tapping point on gauge holders or gauge boards. Whenever possible, pressure gauges and transmitters shall be groupwise combined on racks or consoles.

Pressure gauges for high pressures shall be equipped with a relieve valve for safety reasons in case of leaks (with a rubber reverse flow check).

In case of flowing substances, the measuring point shall be selected in locations of undisturbed flow.

If the pressure is pulsating, the devices concerned shall be connected via flexible tubes or other pulse-absorbing means.

In general, all pressure gauges, transmitters and pressure contacts shall easily be accessible for maintenance and supervision.

The scales shall have a diameter of 150 mm with black letters and figures on a white ground. The calibration shall be in "bar".

The adjustment of the pointer shall be possible by means of an adjustment device without removing the pointer from its axle.

The high and low-pressure connections of differential pressure gauges shall be marked accordingly.

All casings shall be dust and watertight and be made of stainless steel.

7.4.4. Level Measurements

The liquid level measurements in reservoirs and tanks with atmospheric pressure shall be made by means of pressure transmitter of mercuryless-type, by displacement-type transmitters or float-disc-transmitters. The errors shall not exceed $\pm 1.0\%$ of the total measuring range. Level switches shall be of the externally mounted float or displacement operated type. The switch shall be of packingless construction; there shall be a minimum of moving parts.

7.4.5. Electrical Measurements

All Electrical instruments shall be of flush mounted design, dust and moisture-proof. A.C. ammeters and voltmeters shall have digital type



system of not less than 1.5 accuracy class for connection to the secondary side of instrument transformers. D.C. measuring instruments shall have digital type systems of the same accuracy. Wattmeters/energy meters shall have electro-dynamic measuring mechanisms if fed by transmitters. Wattmeters shall be suitable for unbalanced systems and accuracy of energy meters should be of 0.2 % accuracy class.

All indicating instruments shall generally withstand without damage a continuous overload of 20% referred to the rated output value of the corresponding instrument transformers. Ammeters shall not be damaged by fault-currents within the rating and fault duration time of the associated switchgear via the primaries of their corresponding instrument transformers.

All instruments and apparatus shall be capable of carrying their full load currents without undue heating. All instruments and apparatus shall be rear connected, and the enclosures shall be earthed. Means shall be provided for zero adjustment of instruments without dismantling.

All voltage circuits to instruments shall be protected by MCB's in the unearthed phases of the circuit, installed as close as practicable to the instrument transformer terminals, or, where instruments are direct-connected, as close as practicable to the main connection. All power factor indicators shall have the star point of their current coils brought out to a separate terminal which shall be connected to the star point of the current transformer secondary windings.

When more than one measured value is indicated on the same instrument, a measuring point selector switch shall be provided next to the instrument and shall be engraved with a legend specifying each selected measuring point.

All instruments shall be of the flush mounting type and shall be fitted with non-reflecting glass and shall comply in every respect with the requirements of IEC Publication 51. Except for instruments employed for Works performance tests all instruments shall have an accuracy class of 1.5.

Scales shall be arranged in such a way that the normal working indication is between 50-75% of full-scale reading permitting an accurate reading. CT connected Ammeters provided for indication of motor currents shall be provided with suppressed overload scales of 2 times full scale. The dials of such ammeters shall include a red mark to indicate the full load current of the motor.

Instrument scales shall be submitted for approval by the Engineer. All instruments mounted on the same panel shall be of same style and appearance.



Transmitter connected ammeters (for example those in mosaic-type control desks) shall have 90 degrees or 240 degrees circular scales calibrated 0-120 %. The rated motor current shall correspond to 100% scale indication.

All metering circuits shall be terminated in marked terminal blocks for remote metering purposes.

7.4.6. Position Measurements

Position transmitters of the potentiometer type will not be accepted. Inductive or capacitive type shall be provided.

Position transmitters for continuous position indication and measuring transducers shall have an output current of 4-20 mA and aux. supply voltage (if required) 220 or 48 V D.C. The "potentiometer-type" position measuring principle is not permitted.

7.4.7. Limit Switches

Limit switches shall be provided for each electrically operated gate, valve or gantry to automatically stop the motor at both ends of travel. Additional switches shall be provided where necessary for control, interlocks and indication.

Limit switches shall be mounted suitable for easy adjustment and for rigidly locking in position after being adjusted. They shall be of heavy-duty rating and have two changeover contacts suitable for 220 V D.C. operations.

Switch fixings shall be positive and shall be unaffected by vibration. At the same time they should be capable of easy adjustment to suit changing parameters of the associated plant.

Particular attention shall be paid to potentially harmful environmental conditions, including water, oil, dust, dirt, temperature variations and differential expansions. Where switches operate through linkages, precautions shall be taken to eliminate variations of settings and incorrect operations resulting from wear or tolerances.

7.4.8. Contact Devices

Contacts of level switches, pressure switches, temperature switches, limit switches, and of all other devices shall be of the snapaction type (SPDT). Contact devices for interlocking systems shall be separate, i.e., contact



devices serving commonly for interlocking and other purposes will not be accepted.

7.5. Protection Systems

Electrical/Mechanical Protection and Interlocking Systems shall be provided for all works components and individual systems to ensure a safe and reliable operation and to limit harm and damage to personnel and works to an utmost extent.

The primary functions of these facilities shall be to disconnect selectively faulty sections of the systems prior to influence or damage to other works and to maintain operative systems as far as possible.

Moreover these devices shall facilitate the duty of the operation staff and prevent mal-operation.

7.6. Transmitter Racks and Piping

Wherever practicable, transmitters for flow, pressure, etc., shall be installed in readily accessible positions in the proximity of the measuring point, free from vibration and protected against damage, moisture, dust, corrosive air, and great temperature changes.

The transmitters shall be grouped and assembled as far as practicable on local transmitter racks or in cubicles with glass or plexi-front.

The connecting lines between the primary elements and the transmitters shall be installed to falls in order to ensure that no air pockets or water locks are created.

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8. TRANSPORT AND INSTALLATION

8.1. General

Shipping, loading, transportation, unloading, storage, erection and test running shall be performed by the Contractor.

From the time of manufacturing until commissioning all parts of the plant shall be protected and insured at the Contractor's expense against damage of any kind. Parts, which are damaged during transport, storage, erection or trial operation, shall be replaced at the Contractor's expense.

The Contractor shall provide the Engineer with complete packing lists of each performed shipment.

8.2. Packing

The Contractor shall prepare all plant, devices & materials for shipment to protect them from damage in transit, & shall be responsible for make good all damages due to improper preparations, loading or shipment.

After the workshop assembly & prior to dismantling for shipment to the site, all items shall be carefully marked to facilitate site erection. Wherever applicable, these markings shall be punched or painted so they are clearly visible.

Dismantling shall be done into convenient sections, so that the weights & sizes are suitable for transport to site & for handling on the site under the special conditions of the project.

All individual pieces shall be marked with the correct designation shown on the Contractor's detailed drawings and other documents (packing lists, spare part lists, in Operating and Maintenance Instructions, etc.).

Marking shall be done preferably by punching the marks into the metal before painting, galvanising, etc., and shall be clearly legible after painting, galvanising etc. In labeling, the Contractor shall endeavor to use as few designations as possible and each part of identical size and detail shall have the same designation, regardless of its final position in the plant.

All parts shall be suitably protected against corrosion, water, sand, heat, atmospheric conditions, shocks, impact, vibrations, etc.

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All electrical parts shall be carefully protected from damage by sand, moisture, heat or humid atmospheric conditions by packing them in high-pressure polyethylene foil. Where parts may be affected by vibration, they shall be carefully protected and packed to ensure that no damage will occur while they are being transported and handled.

The material used for shipment of material frame at manufacturer's works withstanding the above shall be preferably environment friendly. Biodegradable packing shall be used to the extent possible.

The Engineer reserves the right to inspect & approve the packing before the items are dispatched but the Contractor shall be entirely responsible for ensuring that the packing is suitable for transit & such inspection will not exonerate the Contractor from any loss or damage due to faulty packing.

All packing costs shall be included in the scope of Work.

8.3. Marking

The Contractor shall mark all containers with the implementing document number pertinent to the shipment. Each shipping container shall also be clearly marked on at least two sides as follows:

- Consignee : to be furnished at a later date
- Contract No. :
- Country of Origin :
- Port of entry :
- Item number (if applicable)
- Package number, in sequence
- and quantity per package :
- Description of Works :
- Net and gross weight, volume :

8.4. Transport and Storage

The Contractor shall inform himself fully as to all relevant transport facilities and requirements, loading gauges and other limitations and shall ensure that the equipment as prepared for transport shall conform to such limitations. The Contractor shall also be responsible for obtaining from the Indian railway or highway authorities any permit that may be required for the transport of loads exceeding the normal gauges.



The Contractor shall provide means for all unloading and reloading for all consignments of plant; both during transport to Site and on the Site. Consignments shall be unloaded immediately on arrival at Site. The Contractor is required to take the necessary steps in order to provide the carriage, special supporting structures for heavy loads, etc.

All parts of the plant shall be brought, as far as possible, to their final place of erection. The Contractor shall construct their own storage facilities at site.

The warehouses shall be weatherproof, with good ventilation and solid floors. The floors of the warehouses and storage areas shall be designed to carry the loads imposed on them by the stored parts. The following parts shall be stored inside enclosed warehouses:

Bolts, pins, packing, tools, insulation materials, electrical parts with electrical devices attached, electric motors and excitation equipment, instruments, welding material and equipment, all small parts and all parts of the plant which already have been finally painted.

If large parts are stored in the open air, they shall be provided with weather resistant and fire-resistant covers. Electrical parts, which are not packed in heavy-duty polyethylene foil and those so packed, but whose packing has been damaged shall be kept in suitable places from the moment of storage to the moment of installation.

All insulation materials which will be taken from the warehouse for installation and which are stored temporarily in the station shall be protected from weather or humidity.

All the equipment shall be stored as per standard storage and preservation instructions etc. of the suppliers.

8.5. Preparation and Installation

Prior to commencement of installation, the Contractor shall closely inspect the site and all the foundations and other structures on which parts of the plant supplied under this Contract will be installed; he shall check that the foundations conform to the installation drawings.

The result of this check shall be reported to the Engineer in due time to allow any errors to be corrected before the commencement of erection. All parts of the plant shall be cleaned carefully of all contamination such as dust, sand, rust, mill scale and other dirt prior to installation.

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8.6. Reference Points

The Contractor shall employ a competent surveyor for setting-out of all datum lines including the constant checking and maintenance of the setting-out until the completion of his works.

The Contractor shall provide all necessary pegs, profiled templates and centre lines and shall establish all such permanent markings and recovery marks as may be required by the Engineer for checking the Contractor's setting-out. The Contractor shall be responsible for rectifying, at his own cost, all work rejected by the Engineer due to errors in setting-out.

All bench marks, notch marks, pegs and signals on the surface, alignment pins and the like put in by the Engineer for the purpose of checking the Contractor's work or as permanent survey marks will be under the care of the Contractor during the period of the Contract. He shall, at his own expense, take all proper and reasonable care and precautions to preserve and maintain them in their true position where such marks are within or adjacent to his work area. In the event of their being disturbed or obliterated by any cause whatsoever, they may, if so determined by the Owner, be replaced by the Engineer at the Contractor's expense.

The Contractor shall be responsible for the true and proper staking-out of the works and levels of reference given by the Engineer in writing, for the correctness of the positions, levels, dimensions and alignment of all parts of the works and for the provision of all necessary instruments, appliances and labour in connection with this.

The checking of any staking-out or of any line or level by the Engineer or the Engineer's Representative shall not in any way relieve the Contractor of his responsibility for its correctness.

8.7. General Notes on Installation Work

All transportation and handling of the plant from the place of storage to the place of installation shall be carried out by the Contractor. He shall provide all hoisting equipment, staging and scaffolding, winches and wire ropes, slings, tackles and all other appliances and temporary materials. The erection staging and scaffolding shall be provided with coverings and barriers and shall guarantee safe working conditions.

The Contractor shall comply with all applicable and approved safety regulations while carrying out the works on Site and with all reasonable requirements of the Engineer. This stipulation shall in no way release the Contractor from any obligation concerning his liability for accidents and damages. He shall be responsible for adequate protection of persons,

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plant and materials against injuries and damages resulting from his operations.

The plant or parts to be installed shall not be overstressed during the process of installation.

The Contractor shall be responsible that the installation of all plant is properly executed to the correct lines and levels and in accordance with the manufacturer's instructions and the Contract requirements.

The alignment of the plant shall be done exactly; the tolerances indicated by the Manufacturers or in the drawings shall be kept.

Setting of parts to be aligned shall be performed by means of fine measuring instruments. All erection clearances and settings shall be recorded. Copies of these records shall be given to the Engineer. After alignment, the parts shall be held firmly in position by means of set pins, fitted bolts, etc.

All parts to be embedded in concrete shall be set accurately in position and shall be supported rigidly to prevent displacement during the placing of concrete. Adjusting screws and bolts shall be drawn tight and secured adequately. Steel wedges shall be secured by welding. Wooden wedges shall not be used.

The Contractor shall verify carefully the position of all parts to be embedded before concrete is poured. All important measurements and dimensions shall be recorded. Copies of these records shall be given to the Engineer for checking and approval before items are built-in to the Works.

After concreting, the control measurements shall be verified again, indicated in the above-mentioned records and submitted to the Engineer.

The Contractor shall provide all necessary anchors and braces to ensure the alignment and stability of the parts to be installed. All temporary anchors and bracings shall take care of all dead load, wind load, seismic and erection stresses, e.g., during concreting, and shall remain in place until they can be removed without endangering the stability of the plant.

Welding, torch-cutting and drilling work on the plant to be erected shall only be carried out with the approval of the Engineer only for modification if any.

If for installation purposes auxiliary structures have been attached to the plant, they shall be removed after completion of work and the surface restored to proper condition by grinding and repainting.



Special care shall be taken not to damage surfaces of galvanised or specially treated plant during erection. Care shall be taken to prevent or remove any rust streaks or foreign matters deposited on galvanised or otherwise finished surfaces during storage or transport or after installation.

Glass parts or other parts, which can easily be damaged, shall be provided with suitable protective sheaths or coverings during installation.

Machined or bare metal surfaces, which are to receive no coat of paint, shall be protected during transportation, storage and erection by a suitable anti-corrosion film.

All power tools preferably be operated pneumatically. They are to be handed over at the end of the installation work in good condition in accordance with the Engineer's instructions.

After erection, the works shall be finally painted, in accordance with the painting specification, and any damaged paintwork shall be restored.

The Contractor shall keep the site in clean condition during erection and commissioning time. On instruction of the Engineer he shall remove waste from the place of installation to the defined deposit site at his own cost.

8.8. Civil Site Work

The following works shall be carried out as part of the civil works contract and is not included within the scope of work covered by the equipment specifications.

- All concrete work, including reinforcement and form-work, and all grouting required for filling in, around and under the various parts of the works to be embedded in concrete.
- All necessary excavation and backfilling required for installing the plant in its final position, unless otherwise stated in the Particular Technical Specifications.
- Building in of all required parts into the first stage concrete. The readiness of such parts shall be communicated to the Engineer and they shall be delivered in due time by the Contractor unless otherwise specified or agreed in the Contract.
- Providing and grouting the blockouts for all anchoring and foundation bolts needed to support and fix the plant in its final position.

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- All protective measures, e.g., pumping, etc., to keep the various parts of the plant and the erection site free from water during the time of erection.
- Provision of cable and pipe ducts, trenches, block-outs, etc., in accordance with the drawings supplied by the Contractor and supervised by the Contractor.
- Adequate safety covers and protective measures against injury or damage to the Contractor's employees and equipment and to the works due to any operations in the civil works.
- If chequered plates or other covers provided under the civil contract require special care for fitting to plant and installations, such work (cutting, matching, welding of supports, etc.) shall be performed by the Contractor.

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KISHANGANGA H.E PROJECT

Volume 3A (GTS)

Volume 3A

ANNEX-1

PAINTING SYSTEM

ANNEX-1

1

May- 2006

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PAINTING SYSTEM

Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
A	Internal surfaces of steel linings, penstock, turbine spiral casing, valves and other wetted internal ferrous surfaces		<u>Intermediate Coat:</u> 2 x micaceous iron oxide paint, 2-component Base: epoxy resin	2 x 100	This paint system is for temperatures up to 120°C
			<u>Finish Coat :</u> 1 x topcoat, 2-component Base : epoxy resin	1 x 100	The colours of intermediate and finish coats shall be black - brown - black
			Total	300	



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PAINTING SYSTEM

Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
B	External surfaces of penstocks, Gantries, Cranes, Lifting Beams, Fixed Hoist supports and other Drive Supports	Sa 2 1/2 - 3	<u>Prime Coat:</u> 1 x zinc dust primer, 2-component Base: epoxy resin	1 x 50	The pure metallic zinc shall be at least 92% of the polymerized film
			<u>Intermediate Coat:</u> 2 x micaceous iron oxide paint, 2-component Base : epoxy resin	2 x 80	This paint system is for temperatures up to 60°C
			<u>Finish Coat :</u> 1 x micaceous iron oxide paint, coloured, 2-component Base : epoxy resin	1 x 80	
			Total	290	



A Maharatna company

भारत हेवी इलेक्ट्रिकल्स लिमिटेड (126)

Bharat Heavy Electricals Limited

(A Government of India Undertaking with Maharatna status)

पारेषण व्यापार समूह, नई दिल्ली / TBG, New Delhi

वाणिज्यिक प्रबंधन / Commercial Management, 5TH Floor, Advant Navis IT Business Park,

Plot no-7, Sector-142, Express way Noida, Distt. Gautambudh Nagar, UP-201301

फोन/Phone-+91-120-6748567; 9650094437 email: mojahid@bhel.in

To,

Ref: TBCM/2317/BWD/WHOLDREL

Date : 18.04.2016

DGM

Power Grid Corporation of India Ltd.

± 500 kV, 2500MW HVDC Bhiwadi Project

Distt.Alwar (Rajasthan)

LOA No: C-46002-S656-1/CA-II/2317 dt.12/3/2007

Sub: On Shore supply contract for ± 500 KV, 2500MW HVDC Ballia Bhiwadi Bipole Terminal Package associated with Ballia - Bhiwadi Transmission System - : Release of with hold amount of spares and other heads

Dear Sir,

This is reference to mentioned below with hold amount from our various supply bills.

RA No.	RA Date	AB No.	Withheld Amount	Reason for With Hold
29	27.06.09	1454	5,00,000	5% W/H for spares
38	27.11.09	1112	5,09,774	5% W/H for spares
43	30.12.09	1112	2,75,000	5% W/H for spares
47	30.03.10	1454	2,28,256	5% W/H for spares
53	25.11.10	1112	17,500	5% W/H for spares
64	12.12.12	1112	2,40,000	Oil Handling system
	Total		17,70,530	

The spares items included in the above mentioned bills have handed over to POWERGRID.

So, we request you to release the above mentioned with hold amount.

Thanking you.

Yours sincerely,

(Mojahid Hussain)
Sr. Engineer/TBCM



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PAINTING SYSTEM

Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
C	External surfaces of indoor ferrous parts such as valves, connection pipes, oil carrying tanks and pipes, supporting structures, gantries, etc.	Sa 2 1/2 - 3	<u>Prime coat :</u> 1 x zinc dust primer, 2-component Base: epoxy resin	1 x 50	The pure metallic zinc shall be at least 92% of the polymerized film
			<u>Intermediate Coat:</u> 2 x micaceous iron oxide paint, 2-component Base : epoxy resin	2 x 80	This paint system is for temperatures up to 120°C
			<u>Finish Coat :</u> 1 x topcoat, 2-component Base : epoxy resin	1 x 50	
			Total	260	



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PAINTING SYSTEM					
Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
D	Control cabinets, panels, cubicles, electric motors.	Sa 3 and de-grease before painting	<u>Prime Coat:</u> 2 x zinc chromate primer, 2-component Base: epoxy resin <u>Finish Coat</u> : 2 x topcoat, 2-component Base : epoxy resin Total	2 x 40 2 x 50 180	

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PAINTING SYSTEM					
Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in m	Remarks
E	Interior surfaces of oil tanks	Sa 2 1/2 - 3	2 x thixo trop consistent paint Base : epoxy resin	2 x 220	
			Total	440	



Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
F	Frames, cover plates, pipes and tubes, and miscellaneous steel parts not especially mentioned	Hot-dip-galvanised as specified in Section 4.12.8.3 and degrease before painting	<u>Intermediate Coat :</u> 1 x micaceous iron oxide paint, 2-components Base : epoxy resin <u>Finish Coat</u> 1 x topcoat, 2-component Base: epoxy resin Total, incl. zinc	1 x 80 1 x 50	All the parts inaccessible for painting shall be only hot-dip galvanised



16. CABLING SYSTEM

16.1. Scope of Work

Scope of work under this section covers the provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, site storage and preservation, installation, commissioning, performance testing, acceptance testing, training of Owner's personnel, handing over to NHPC and guarantee for two years of cabling system as per the specifications hereunder, complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation.

The scope of work shall be a comprehensive functional system covering all supply and services including but not be limited to following:

16.1.1. Cables and accessories

- i) 11 kV XLPE power cable (High voltage cable),
- ii) 600/1000 volt grade power cable (Low voltage cable),
- iii) Control cables,
- iv) Instrumentation cables,
- v) Cable terminals, termination kits, cable lugs, cable glands, button tape (strap and stud), and cable junction boxes and all other accessories.

16.1.2. Cable routing and support systems

- i) Cable trays, connectors, hardware etc.
- ii) Flexible/adjustable cable support system including pre-fabricated structures/fixtures, strut channels, embedment, hardware etc.
- iii) Cable ducts, conduits, channels, joints etc.

Any other item(s) not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard(s) / best international practices.

16.2. Specific Parameters and Layout Conditions

16.2.1. Layout and General Arrangement

The 11kV power cables shall be required to interconnect the following:

- ◆ One (1) nos. 33/11kV Power transformer to 11kV panels,
- ◆ Two (2) nos. 1.0 MVA DG sets to 11 kV panels,
- ◆ One (1) nos. 11kV incoming supply to 11kV panels,



- ◆ Two (2) nos. outgoing from 11 KV Panels to 1.5 MVA, 11/0.415kV SSTs,
- ◆ One (1) no. outgoing from 11 KV Panels to 250 KVA, 11/0.415kV Switchyard Auxiliary Transformer,
- ◆ One (1) no. outgoing from 11 KV Panels to 250 KVA, 11/0.415kV Transformer at Valve House

The 415V/ 240V AC and 220V/ 48V DC cables shall be required to connect / interconnect all the equipment as per the scope of complete E&M package in power house complex, transformer cavern, switchyard surge shaft gallery/ switchyard/ butterfly valve house and other area in the vicinity of power house such as fire tank etc which shall include:

- Different auxiliary/station service boards,
- Various distribution boards to local control cubicles/ equipment.

Control, instrumentation, coaxial and communication cables shall include all cables required for the installation of the complete instrumentation, control, protection and communication systems in the power house complex, surge shaft gallery and other area in the vicinity of power house such as fire tank etc.

16.2.2. Design considerations

The number of cores and sizes of the cables required for various circuits shall be worked out during detailed engineering.

However, minimum sizes for the following cables conductor shall be taken as:

- ◆ 2.5 mm² copper for control cable conductor,
- ◆ 1.5 mm² copper for annunciation and RTD cable conductor,
- ◆ 4 core x 6 mm² copper for connection between CT junction boxes and panels having red, yellow, blue and black colour cover,
- ◆ 4 core x 4 mm² copper for connection between PT junction boxes and panels having red, yellow, blue and black colour cover.

The cables covered by this specification shall be supplied in one length or in standard length as approved by the Owner.

Normally all LV cables will be un-armoured and will be laid in cable trays. However any cable laid directly (without cable tray/pipe etc.) either underground or overhead shall be of armoured type. The armouring shall always be earthed at one end to ensure that it can not become live if a fault develops within the cable.

16.3. Rating and Functional Characteristics

i) Power and control cables

The power and control cables shall have the following properties:



- ◆ Oxygen index Min. 29,
- ◆ Smoke density Min. 40% light transmittance,
- ◆ Acid gas Max. 20% by weight,
- ◆ Flame propagation shall meet IEC 60332-1, IEEE 383.

16.4. Performance Guarantee

The power and control cabling system along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. The Contractor shall guarantee the reliability and performance of the individual equipment as well as of the complete system.

16.5. Design and Construction

16.5.1. Standards

The system and equipment shall be designed, built, tested and installed to the latest revisions of the following applicable standards. In the event of other standards being applicable they will be compared for specific requirement and specifically approved during detailed engineering for the purpose:

Standards	Description
IEC 61537	Cable tray systems and cable ladder systems for cable management
IEC 60331	Tests for electric cables under fire conditions
IEC 60332	Test on electric and optical fibre cables under fire conditions
IS 1554	Specification for PVC insulated (heavy duty) Electric cables
IS 7098	Specification for cross linked polyethylene insulated PVC sheathed cables
IS 1255	Code of practice for installation and maintenance of power cables up to and including 33kV rating

16.5.2. Cables

16.5.2.1. Power cables –11kV system

11kV power cable shall be of heavy duty, stranded circular copper conductor, cross linked polyethylene (XLPE) insulated provided with conductor screening and insulation screening, laid up, extruded PVC inter sheathed and armoured The insulation and screening shall be extruded, semi-conducting and with copper tape screening (at least 0.075 mm thickness) .

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16.5.2.2. Power cables - 600/1000 volt grade

i) Single core cables

These cables shall be at least 600/1000 volt grade, heavy duty, single core, stranded Aluminium / Copper conductor, HR-PVC insulated and PVC sheathed. The outer sheath shall be of specially formulated PVC compound.

ii) Multi core cables:

The cable shall be at least 600/1000 volt grade, heavy duty multi core, stranded Aluminium conductor, HR-PVC insulated, colour coded, laid up, inner sheathed with extruded PVC, 2/3.5 cores.

16.5.2.3. Control and instrumentation cables

The control and instrumentation cables shall be multi core, colour coded, annealed stranded high conductivity Copper, single conductor, insulated with HR-PVC insulation, PVC sheathed. The outer sheath shall be of specially formulated PVC compound.

16.5.3. Colour scheme and Identification

To facilitate easy identification of phases a colour scheme of red, yellow and blue for phases and black for neutral shall be adopted for power cables. Multi-core control cables shall be colour coded for identification of cores as per IS: 1554 1988 / IEC.

All the cables shall carry manufacturer data in a permanent, legible manner at an interval of at least three (3) meter run. The manufacturer's data shall include the name, cable size, and voltage rating together with any other information. Permanent sequential marking to indicate length of the cable shall be embossed at every meter along with Owner's name (NHPC).

16.5.4. Accessories

16.5.4.1. Termination kit

The termination kits required for 11kV XLPE cables terminations shall be heat shrinkable type. Any other latest type having proven performance in the field can also be accepted subject to approval of Owner.

The Contractor shall supply all hardware consumables such as plumbing metal, sealing compound, tapes and other materials required for the making of these terminal connections of various sizes of cables and should leave at least 5% of these items for future use by the Owner.

16.5.4.2. Cable lugs

The Contractor shall ensure that no bimetallic action takes place, between the conductor of the cable and the cable-connecting lug by filling the lugs



with suitable compound. The lugs shall be of standard quality conforming IEC / IS and of make approved by the Owner.

16.5.4.3. Cable glands

The cable glands shall be made of brass duly electro tinned in order to avoid corrosion and oxidation of the surface. Glands shall provide neat, tight, dust and vermin proof termination. Gland shall be provided with rubber ring to hold the cables firmly when check-nut is slightly tightened. Gland shall be complete with suitable washers etc.

16.5.4.4. Compression type terminals for control wiring

These terminals are required for copper conductor of control wiring. They shall be crimped to the conductor while other end will provide flat surface for better connections. The connectors shall be made of Copper electro tinned.

16.5.4.5. Button tape (strap and stud)

This consists of perforated cable strapping with holes conveniently spaced for assembly and moulded studs. The strapping shall be made of NYLON Grade 220 or other elastic material to give proper performance. The studs shall be made of 'NYLON'.

16.5.4.6. Self adhesive marker

Self-adhesive marker in the form of strips of any one character, which can be easily peeled from the backing cards and can be applied on the cable, shall be supplied. The strips shall be water- proof duly marked with special formulated ink with specific thermo-setting adhesive to withstand high temperature.

Suitable plastic ring type ferrules marked with engraved indelible ink for control cables and sticker type ferrules for power cables shall be supplied. These shall be marked as per cable schedule such that each core of each cable can be identified easily.

16.5.4.7. Aluminium strip

Aluminium strip of adequate size for making tags for labels shall be supplied.

16.5.5. Cable trays and support structure

The cable trays including accessories like bends, elbows, tees, cross etc. shall be of perforated (long slots) type, for proper ventilation of the cables, made out of 14-gauge mild steel sheet. The trays shall have minimum 50 mm edge height.

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The cable trays shall be fully galvanized and the Owner reserves the right to test galvanizing as per approved standard in presence of its representative.

Stainless steel cable trays shall be provided for humid premises and the area prone to water dripping and spray.

Supports and screws and bolts for cable trays shall be made of the same materials as the cable trays they support.

Tray support system shall be flexible/adjustable type having pre-fabricated sections and supports that can be assembled and bolted for quick and easy installation.

Trays provided in tiers shall have minimum 300 mm spacing between tiers.

Ladder type tray with double bends may be used wherever required.

16.5.6. Fire proofing

Cables passing through different fire zones shall be provided with fireproof barriers with the same fire rating as the penetrated walls or partitions.

16.5.7. Cable junction boxes

Junction box shall be constructed of sheet steel of thickness not less than two (2) mm. Ample wiring space shall be provided at the sides, and back of the enclosure for incoming and outgoing circuits.

Removable plates with gaskets shall be fitted at the top and bottom of the box to provide the entry for conduit or cable. The door shall be provided with suitable gasket and fitted with a lock type handle. The door shall be hung on hinges having brass bodies and stainless steel pins.

Each cable junction box shall be provided with terminals of adequate rating on the terminal strip of suitable thickness.

16.5.8. Terminal blocks

Terminal blocks shall be in accordance to clause 1.5.2.5 "Electrical equipment" of "Section 1- General Technical Requirements".

16.6. Drawings, Documents and Design Calculations

16.6.1. Design memorandum

The Contractor shall submit to Owner a design memorandum prepared in accordance to clause 1.6 "Record and Documentation" of "Section 1- General Technical Requirements."

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16.6.2. Drawings and documents

The Contractor shall submit all the drawings and documents in accordance with requirements stipulated in "Section 2 - Technical Documents" of "General Technical Specification (GTS)".

16.6.3. Design calculation

The Contractor shall submit the design calculation in accordance to Clause 2.6 of "General Technical Specification (GTS)" covering at least the following, for review / acceptance.

- ◆ Calculation for fault level and short circuit calculation for selecting the cable size,
- ◆ Cable schedule.

16.7. Delivery, Installation and Commissioning

The Contractor shall follow the requirements of Delivery, Installation and commissioning elaborated in clause 1.7 "Delivery, Installation and commissioning" of "Section 1 - General Technical Requirements."

16.7.1. Construction methodology

16.7.1.1. Fixing of supports

The fixing arrangement shall be approved by the Owner. Strut channels shall be embedded for fixing of the supports and shall be provided, installed and supervised during concreting for correctness of positioning and alignment by the Contractor. Anchor fasteners shall be used wherever required to fix the anchors / supports. Field welding for support system shall not be allowed except fixing of strut channels / supports to embedment. All such welds shall be treated with galvanized compound. Welding to cable trays in any case shall not be allowed.

16.7.1.2. Cable routing

For the main cableways, a system of cable racks and trays as well as cable ducts and trenches shall be provided.

The cables for emergency lighting, fire alarm systems, etc., shall be run on separate trays.

The 11kV XLPE cables, power and control cables shall be run separately on racks/trays, in cable trenches/cable tunnels and on columns, walls, ceiling and pulled through pipes. The Contractor shall be responsible for carrying out proper dressing of the cables and supply non-magnetic/moulded fiber-glass cable fixing cleats, fasteners and clamps wherever necessary to hold the cables firmly to the trays.

Contractor shall take proper care in the handling of cables against external damage of any kind. Necessary rollers etc. shall be used while



pulling and laying of the cables. Owner shall have the right to stop the work in case of improper handling of the cables.

Cables shall be properly clamped at regular intervals with the help of non-magnetic/moulded fibreglass strip clamps/PVC sleeved clamps, of suitable size. Contractor shall submit typical drawings along with tender giving proposed clamping arrangement and give distance of clamping at bends and in regular run of cables.

16.7.1.3. Cable markers and cable binding

Suitable cable markers of Aluminium with punch marks shall be provided and suitably tagged to the cable permanently so that cable could be easily identified.

16.7.1.4. Cable binding/strapping

All control cables after glanding shall be neatly routed and bonded with the help of cable straps and studs inside the panel. Complete routing in panel shall be such that it gives a neat appearance good workmanship.

For L.T. Power cables, suitable holding clamps will be provided in the panel if required.

The Contractor shall do the cable glanding suitable for each cable size at both ends of termination of each cable.

16.8. Spare Parts

Recommended spare parts shall be supplied in accordance to clause 1.8 "Spare Parts" of "Section 1 - General Technical Requirements". Specified spare parts to be supplied under this section are as follows:

S. No.	Description	Quantity
1	Cable 11kV	10 % of installed quantity
2	LV power cable of each type	10 % of installed quantity
3	Control cable of each type	10 % of installed quantity
4	Communication cable of each type	10 % of installed quantity
5	Termination kits -11kV Outdoor type Indoor type	10 % of installed quantity 10 % of installed quantity
6	Lugs of each size	10 % of installed quantity
7	Coaxial cables	10 % of installed quantity
8	Cable glands of each size	20 % of installed quantity
9	Junction boxes of each size	20 % of installed quantity



10	Cable tray of each size	10 % of installed quantity
11	Cable supports, hardware etc.	20 % of installed quantity

16.9. Tools and Instruments

The Contractor shall supply all necessary tools and instruments etc. for installation, repair and maintenance in accordance to clause 1.9 "Tools and Instruments" of "Section 1 - General Technical Requirements".

16.9.1. Special tools

The Contractor shall propose the list of special tools including their make and detailed specification as recommended by manufacturer(s), to be accepted by the Owner.

The proposed list of special tools must include the following in addition to tools recommended by manufacturer(s)

- ◆ Two (2) sets of hydraulically operated crimping tools,
- ◆ Two (2) sets of control cable crimping tools,
- ◆ Two (2) sets of wire cutters for all sizes of cables,
- ◆ Two (2) sets of wire strippers for all sizes of cables.

16.10. Quality Assurance and Testing

The Contractor shall follow the quality assurance and testing requirements specified separately in "Quality assurance and Testing Specifications (QTS)".



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13. DC SYSTEM**13.1. Scope of Work**

Scope of work under this section covers the provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, site storage and preservation, installation, commissioning, performance testing, acceptance testing, training of Owner's personnel, handing over to NHPC and guarantee for two years of DC system as per the specifications hereunder, complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation.

The scope of work shall be a comprehensive functional system covering all supply and services including but not be limited to following:

13.1.1. 220V DC system

- i) Two (2) sets of Lead acid Plante type 1400 Ah or of higher capacity battery banks complete with terminal connections, hardware, connecting cables and associated accessories,
or
Two (2) sets of Nickel-Cadmium 1150 Ah or of higher capacity battery banks complete with terminal connections, hardware, connecting cables and associated accessories
- ii) Two (2) sets of chargers,
- iii) One (1) set of DC distribution board.

13.1.2. 48V DC system

- i) One (1) set of Lead Acid Plante type 250 Ah or of higher capacity battery banks complete with terminal connections, hardware, connecting cables, and associated accessories,
Or
One (1) set of Nickel-Cadmium 200 Ah or of higher capacity battery banks complete with terminal connections, hardware, connecting cables and associated accessories
- ii) Two (2) sets of chargers,
- iii) One (1) sets of DC distribution board.

13.1.3. Miscellaneous items

- i) Two (2) sets of 10 kVA or higher inverter along with its distribution boards,
- ii) Seismic-proof racks, hardware, interconnecting cables and other



accessories etc for each bank of batteries,

- iii) Apron, safety gloves, goggles and other safety items for handling of batteries,
- iv) One (1) set of eye wash station,
- v) Coordination and Provision of necessary contacts and/or ports for integration with plant SCADA system.
- vi) Spare parts as per clause no. 13.8
- vii) Tools & instruments as per clause no. 13.9

13.2. Specific Parameters and Layout Conditions

13.2.1. Layout and General Arrangement

The 220V DC system in the power house shall have provision for boost and float charging and distribution boards as per the single line diagram for the 220V DC system.

The control and protection circuits, emergency lighting and inverters in the power house shall be supplied from the 220V DC system.

The 48V DC system shall have provision for boost and float charging and distribution boards as per the single line diagram for the 48V DC system.

The 48V DC system will serve the consumers particularly in the communication and control system.

The static inverter will be connected to the 220V DC system and a distribution board. The inverter will serve essential consumers of the control system, power outlets circuits of control room, office areas and individual sockets intended for electronic appliances and computers, monitors, printers and uninterrupted lighting in critical areas.

Each set of battery bank of 220V DC and 48V DC shall be capable of supplying successfully total station loads of 220V and 48V DC systems respectively for at least ten (10) hours without any assistance from the charger and without its terminal voltage falling below 193 V in case of 220V battery and 42V in case of 48V battery.

13.2.2. Design considerations

The basic description of scheme for 220V DC system shall be as per drawing no. NH/DEM/KSG/DC/01.

In case of 220V DC system, two identical chargers each complete with float charging and boost charging functions etc. are required. Normally, each of the two float chargers shall supply one half of the total DC load and also be supplying the trickle charging current for one battery bank. In case of failure of any of the float chargers, the other should be able to supply the complete DC load and trickle charging current to all the battery banks.

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**13.3.1.1. Battery Chargers**

AC Power supply	415 $\pm$ 10 %V, 3-phase, 4 wire for 220V DC 240 $\pm$ 10 %V for 48V DC
Frequency	50 $\pm$ 5% Hz
Nominal DC output voltage	220V adjustable / 48V adjustable
Voltage Regulation (From no load to full load)	$\pm$ 1 %
Ripple of output voltage (peak to peak)	
With battery connected	< 1 % RMS
Without battery connected	< 2 % RMS

13.3.1.2. Batteries

220 V Battery bank	Lead Acid Plante type	Ni-Cd Type
No. of battery bank	2	2
No. of cells in each battery bank	110	184
Nominal cell voltage	2V	1.2
Cell voltage at equalizing charge	2.33 V	1.42
Nominal end cell voltage	1.85V at 10 hour rate	1.05 at 5 hr.rate
Minimum Ampere-Hour capacity of each battery bank	1400 Ah (10 hour discharge rate to 1.85V /cell at 25°C)	1150 Ah
48 V Battery bank	Lead Acid Plante type	Ni-Cd Type
No. of battery bank	1	1
No. of cells in each battery bank	24	36
Nominal cell voltage	2.0V	1.2
Cell voltage at equalizing charge	2.33 V	1.42

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Minimum Ampere-Hour capacity of battery bank	250 Ah (10 hour discharge rate to 1.85V / cell at 25°C)	200Ah
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13.3.1.3. Inverters

Rated capacity	10kVA (minimum) at $\cos \phi = 0.8$ lag.
Rated input voltage (dc)	220 plus (+) 10%/ minus (-) 10% V DC
Rated output voltage (ac)	3 phase 415V, Neutral Fully loadable
Rated frequency of output	50Hz
Voltage regulation	$\pm 2\%$
Frequency	$50 \pm 0.5\%$ Hz
Wave form	Sine, with max. 5 % THD at linear load Sine, with max. 7 % THD at 100% non-linear load
Overload capacity for 1 sec	2 times rated current
Overload capacity for 1 min	1.5 times rated current

13.4. Performance Guarantee

The DC system along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. The Contractor shall guarantee the reliability and performance of the individual equipment as well as of the complete system.

13.5. Design and Construction

13.5.1. Standards

The system and equipment shall be designed, built, tested and installed to the latest revisions of the following applicable standards. In the event of other standards being applicable they will be compared for specific requirement and specifically approved during detailed engineering for the purpose:

Standards	Description
IEEE Std 485	IEEE recommended practice for sizing Lead Acid

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Standards	Description
	batteries for stationary applications.
IS 1652	Stationary cells and batteries, lead-acid type with Plante positive plates-specification
IEC 60146	Semiconductor converters.
IEC 60439	Low-voltage switchgear and control assemblies.

13.5.2. Cubicles

The cubicle assemblies shall be of metal enclosed, free floor standing type, of manufacturer's standard production of protection class IP 52.

13.5.3. Battery chargers

Dry type transformers and static type rectifiers shall be used throughout.

The chargers will be protected against harmful overload by a drooping characteristic, which transfers all loads in excess of the capacity of the chargers to the battery. The battery chargers shall be connected in parallel with the corresponding battery through the main distribution bus bar.

The chargers shall be completely equipped for a fully automatic and controlled charging and floating charge of the batteries, and shall be of the constant voltage type with current limiting devices.

Complete control and supervision equipments such as circuit breakers, ammeters and voltmeters and alarm indicating devices shall be incorporated with each charger.

All alarm devices shall be provided with auxiliary contacts for remote indication. Adjustable alarm devices shall be provided with potential free contacts wired to terminals for over voltage, under voltage, ground fault and availability.

The equipment shall have provisions for testing the ground resistance alarm device on both poles (plus and minus).

13.5.4. Batteries and battery racks

The individual Flooded Lead Acid Plante Battery cells shall have removable top cover and a float to showing the electrolyte level in the battery. The polarity of the batteries shall be engraved and shall be easily legible.

Each battery assembly shall be complete with racks, flexible connections between the cells and a cable terminal box containing the battery dc MCCB (2 poles). Inter cell connectors shall be insulated type. Adequate alarm devices (with auxiliary contacts for remote indication) shall be provided with the battery DC MCCB in order to indicate the tripping of this MCCB.

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The battery racks shall be designed to withstand earthquake forces as laid down in "Section 1 - General Technical Requirements" without damage to the batteries. The batteries shall preferably be arranged in not more than two levels. The connecting points of the cells shall be easily accessible for the periodic checks of the cell voltage.

13.5.5. Inverters

Static inverters of on-line type shall be installed nearby to the 220V DC main distribution board and be suitable to feed continuously the essential loads.

The inverter panel shall include:

- ◆ Electronic switches and all accessories for uninterrupted power supply
- ◆ Instruments for Input/output voltage, current and frequency
- ◆ Alarms on the panel front

13.5.6. DC distribution boards

i) 220V DC

The distribution board shall consist of sectionalised bus with tie breaker and each section of bus shall have one incoming disconnecting MCCB, minimum thirty (30) nos. of outgoing MCCBs of suitable capacity, automatically controlled heating element and all necessary control, protection and supervision instruments.

ii) 48V DC

The distribution board shall have one incoming disconnecting MCCB, minimum six (6) nos. of outgoing miniature circuit breakers (two poles), automatically controlled heating element and all necessary control, protection and supervision instruments.

13.6. Drawings, Documents and Design Calculations

13.6.1. Design memorandum

The Contractor shall submit to Owner a design memorandum prepared in accordance to clause 1.6 "Record and Documentation" of "Section 1- General Technical Requirements."

13.6.2. Drawings and documents

The Contractor shall submit all the drawings and documents in accordance with requirements stipulated in "Section 2 - Technical Documents" of "General Technical Specification (GTS)".



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13.6.3. Design calculation

The Contractor shall submit the design calculation in accordance to Clause 2.6 of "General Technical Specification (GTS)" covering at least the following, for review / acceptance.

- ◆ Calculations of the DC power consumption during standstill of the generator units, during start, operation and shut-down of one generator unit, taking into consideration that the floating charge voltage of cell is maintained,
- ◆ Calculations for capacity of the batteries,
- ◆ Calculations for ratings/ capacities of the battery chargers.

13.7. Delivery, Installation and Commissioning

The Contractor shall follow the requirements of Delivery, Installation and commissioning elaborated in clause 1.7 "Delivery, Installation and commissioning" of "Section 1 - General Technical Requirements."

13.8. Spare Parts

Recommended spare parts shall be supplied in accordance to clause 1.8 "Spare Parts" of "Section 1 - General Technical Requirements". Specified spare parts to be supplied under this section are as follows:

S. No.	Description	Quantity
	Battery	
1	Battery cells	5% of the installed capacity for 220V 5% of the installed capacity for 48V
2	Vent plugs/ caps/ connectors/ hardware of each type	10 % of installed quantity
3	Inter cell connectors	20 nos. for 220V 10 nos. for 48V
3	Connector bolts (if applicable)	20% of installed quantity.
4	Electrolyte	10 % of used quantity
	Distribution boards	
1	Inter cell connectors	5 nos. of each used type
2	Indicating lamps	20% of installed quantity
5	Control switch and supervision relay	4 nos.
6	Voltmeter	2 nos.



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	Battery charger	
1	Ammeter and Voltmeter	2 nos. of each used type
2	Shunt resistor	2 nos. of each used type
3	Diode / thyristor module	6 sets of each used type
4	Printed circuit cards	6 sets of each used type
5	Semi conducting type Fast fuse	20% of installed quantity
6	Auxiliary fuse	20% of installed quantity
7	Auto transformer	2 nos.
	Inverter	
1	MCCB	10 nos. of each used type
2	Thyristor Bridge	4 sets of each used type
3	Printed circuit cards	4 sets of each used type
4	Circuit breaker and auxiliary contact	4 nos. of each used type
5	Cooling fan	4 nos.

13.9. Tools and Instruments

The Contractor shall supply all necessary tools and instruments etc. for installation, repair and maintenance in accordance to clause 1.9 "Tools and Instruments" of "Section 1 - General Technical Requirements".

13.9.1. Special tools

The Contractor shall propose the list of special tools including their make and detailed specification as recommended by manufacturer(s), to be accepted by the Owner.

The proposed list of special tools must include the following in addition to tools recommended by manufacturer(s)

- ◆ Two (2) nos. of lifting device for battery cells of each type,
- ◆ Six (6) nos. hydrometer/ KOH analyser,
- ◆ Two (2) cell testing voltmeter,

13.10. Quality Assurance and Testing

The Contractor shall follow the quality assurance and testing requirements specified separately in "Quality assurance and Testing Specifications (QTS)".



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1. GENERAL TECHNICAL REQUIREMENTS

1.1. Introduction

Particular Technical Specifications (PTS) elaborated in various sections specify the detailed technical requirements for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, site storage and preservation, installation, commissioning, performance testing, acceptance testing, training of Owner's personnel, handing over to NHPC and guarantee for two years of the Electrical & Mechanical works covered under this contract. The quality assurance and testing requirements for each section are specified separately in "Quality assurance and Testing Specifications (QTS)".

This section provides the general technical requirements applicable to all sections hereafter specifying the detailed technical specifications for respective equipment/ system forming E&M installation of the project.

1.1.1. Completeness of system/equipment/item

The work to be carried out as per the scope defined in respective sections shall be all in accordance with the requirements, conditions, appendices etc. given in Technical Specifications (GTS, PTS, TDS, QTS and Contract Drawings) together with those stated in General Conditions of Contract (GCC) and Special Condition of Contract (SCC).

It is not the intent to specify herein all aspects of design and construction; nevertheless, the equipment and installation/works shall conform in all aspects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Owner, who will interpret the meaning of the specification and drawings and shall have a right to reject or accept any work or material which in his assessment is not complete to meet the requirements of this specification and/or applicable Indian / International standards mentioned elsewhere in this specification.

Any such system/equipment/items, which are not explicitly mentioned in specification but are functionally necessary/advisable as per best national/international practices for smooth operation of powerhouse, shall be deemed to be included in the scope of work and the Contractor shall provide the same without any extra cost to NHPC.

1.1.2. Priority of documents

The documents forming the Technical Specifications are to be taken as mutually explanatory of one another. If there is an ambiguity or discrepancy in the documents, the Owner shall issue necessary clarification or instruction to the Contractor and the priority of the documents shall be as follows:

- Particular Technical Specification,



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- Guaranteed Technical Particulars in Technical Data Sheets,
- General Technical Specification,

In case of dispute in interpretation, Owner's interpretation shall be final and binding.

1.1.2.1. Interfacing with sub-contractors/manufacturers/vendors

The Contractor shall ensure the functional and physical compatibility of supply at each physical interface among various sub-contractors/manufacturers/vendors in order to ensure efficient, reliable and safe operation of the whole system/scheme.

The limits of the supply and the definition of interface indicated by any sub-contractor shall in no way release the Contractor from his obligation to fulfil the scope defined in specifications.

The Contractor shall ensure co-ordination among various sub-contractors, to verify the continuity and the coherence between their scopes and shall be accountable to the Owner for fulfilment of the scope defined in the specifications. The Contractor shall also resolve all interfacing requirements among various sub-contractors for execution of the work as per scope of contract.

1.2. Project Arrangement/Layout

1.2.1. Brief description of the project

Kishanganga H.E. Project envisages diversion of water from Kishanganga River, into Bonar nallah near Bandipora (J&K).

Powerhouse of Kishanganga H.E. Project (3 x 110 MW) is located near village Kralpora, tehsil Bandipora (J&K). The dams site is at Gurez valley—100m upstream of Malik Kadal Bridge.

It is envisaged as peaking station having three (3) generating units of 110 MW each. The annual energy generation is 1350.03 MU in 90% dependable year with 95% machine availability.

1.2.2. Main project features

The project is proposed with following major components:

- ◆ A concrete faced rockfill dam.
- ◆ One Head Race Tunnel with design discharge 458.45 cumecs and pressure shaft trifurcating into three nos. horizontal branches at bottom.
- ◆ A 220 kV outdoor switchyard, connected to Transformer cavern through XLPE cable, for evacuation of generated power through 220kV transmission lines.

The generating units and the associated generator transformers shall be capable of:



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- ◆ Delivering each simultaneously a power of 135MVA (at the generator's terminal), continuously and reliably, under any combination of the specified grid parameters, hydraulic conditions and site data,
- ◆ Operating in black start/line charging mode for purpose of reconstruction of a part of the whole Indian network after any major grid collapse.

1.2.3. Salient features

Some of the features of the project are described below:

Full Reservoir level (FRL)	EL 2390.00 m
Minimum Draw Down Level	EL 2384.50 m
Centre Line of the Turbine	EL 1723.50 m
Gross storage at FRL	18.35 MCM
Turbine Type	Pelton
Installed Capacity	330 MW
No. and size of Units	3 units of 110 MW each
Generation voltage	13.8 kV
Transmission voltage	220 kV
Type of Power House	Underground
Type of Switchyard	Open Switchyard
GSU Transformer	45 MVA, Single Phase, 50 Hz, 13.8kV/220kV OFWF type
Method of connection between Transformer and Switchyard	220 kV XLPE cables

1.3. Operating Requirement / Specification

The equipment/system to be supplied under this contract shall be suitable for continuous operation under varying grid parameters as allowed in "Indian Electricity Grid Code" and "Indian Electricity Rule –1956 with its latest amendments".

The equipment/system shall be designed to operate continuously without any problem under $\pm 10\%$ voltage variation and $\pm 5\%$ frequency variation. Temperature rise/ variation limit for equipment shall be determined considering the above variation. Further, the power plant is required to be operated as peaking station. Start/ stop requirement of all equipment for daily peaking shall be taken into consideration while designing.

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1.3.1. Auxillary voltages

The electrical equipment like switchboards, MCCB, motors, contactors, relays, luminaries, heaters, switches, sockets, power outlets etc. should be rated for the following voltages:

i) AC power

Three-phase system with grounded neutral for feeding three-phase and single-phase equipment (connected between phase and neutral), type TN-C 415/240V $\pm 10\%$ and 50Hz $\pm 5\%$. All motors and other electrical apparatus should be designed to work continuously under $\pm 5\%$ frequency variation and $\pm 10\%$ voltage variation.

ii) DC power

DC Systems, ungrounded, with earth fault detection

- ◆ 220V $\pm$ (Plus / minus) 10%

for the supply of main control circuits for high and medium voltage switchgear, protection circuits and to other larger essentials loads.

- ◆ 48V $\pm$ (Plus / minus) 10%

for the supply to PLCC and EPBAX etc.

Other voltage systems eventually needed, shall be generated from the above systems by means of dc/dc converters, inverters etc.

1.4. Performance Guarantee

The Contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment/ systems covered in these specifications.

The Contractor shall demonstrate all the guarantees covered herein during functional guarantee / acceptance tests. The Contractor shall conduct the guarantee tests at site in presence of Owner on any one unit selected by the Owner for such tests.

1.5. Design and Construction

1.5.1. Design Criteria

The following design criteria shall be considered mutually complementary of one another and shall be applied by the Contractor to all aspects of the equipment and services supplied under this Contract.

1.5.1.1. Safety

i) Safety of personnel

Where specific standards are not mentioned by the Owner, all equipment and services provided under this contract shall abide by international standards commonly accepted in the hydroelectric utility industry for



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safety of personnel whether involved with operation or maintenance. All operations and routine maintenance interventions shall be completely safe and designed to be carried out under normal conditions of access and while the equipment is operating.

ii) Safety of operation

All equipment and services provided under this contract shall abide by commonly accepted standards for safety of operation.

The overall design shall comprise a substantial degree of conservatism, especially with respect to the selection of the design parameters and of the components critical to the safety and reliability of the operation.

iii) Handling provision

Lifting lugs, brackets, eyes, and other items required for attaching lifting devices shall be provided on all the major components of the equipment weighing more than 24 kg for safe handling. All slings and lifting devices required for attachment to the components and assemblies and to a crane hook for safe handling during erection and later disassembly shall be furnished.

1.5.1.2. Availability and reliability

The Contractor shall design each equipment, system or subsystem to provide a high level of availability and reliability.

The "Electrical & Mechanical Works" shall be designed, constructed and integrated using components and systems which have been proven in other plants of similar application and have shown low failure rates in such applications.

1.5.1.3. Maintainability

All verifications and inspections recommended by the Contractor for the correct functioning of the equipment such as thermometer readings, equipment lubrication, greasing and oil level readings etc. shall be possible under normal conditions of accessibility.

i) Frequency of maintenance interventions

The Contractor shall optimise the various systems and subsystems to provide the desired availability and reliability while minimizing their maintenance requirements.

Routine calibrations shall not be required more frequently than once a year.

ii) Interchangeability and consistency of parts

The Contractor shall optimise the various systems and subsystems to minimize the number of different components and associated spare parts. Equipment fulfilling the same or similar functions at various locations shall whenever possible use the same material.

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Homologous parts shall be interchangeable without needing any adjustment.

All equipment, parts and elements of mass production shall be standardized. These pieces of equipment, parts and elements shall include but not be limited to the following: motors, pumps, flanges, bolts, nuts and threads, valves, gauges and detectors, electrical instruments and measuring devices, flow meters, terminal and terminal boxes, primary, secondary and auxiliary relays, contactors, fuses and switches, lamps, bulbs sockets push buttons, lubricants, control modules, I/O modules, etc.

Where the equipment supplied under this Contract comprises identical pieces of equipment each of their corresponding removable parts shall be fully compatible and interchangeable for use in the other, without adjustment to the remaining parts.

The Contractor shall coordinate the supply of his sub-contractors to achieve a great degree of standardization throughout the "Electrical & Mechanical Works" and the stock of spare parts.

1.5.1.4. Maximum allowable stresses

i) General

Adequate factors of safety shall be used throughout the design, especially in the design of parts subject to alternating stresses, vibration, impact, or shock. The design of the equipment shall include seismic loads as specified in the clause 1.6.9 "seismic design". Under the most severe conditions of loading expected in normal operation, stresses in the materials shall not exceed the values listed below except that appropriately lower values shall be used where loading characteristics could cause fatigue failure or excessive deflections. The design stresses for materials not listed herein shall be selected by the Contractor, but the maximum stresses in tension or compression shall not exceed one-third of the yield strength or one-fifth of the ultimate strength.

ii) Direct or combined steady stresses

- ◆ For materials used in the construction of the equipment, unless otherwise specified, the maximum stress due to maximum normal rated load operating conditions shall not exceed one-third of the minimum yield point or one-fifth of the minimum ultimate strength of the material, whichever is lower.
- ◆ Maximum unit stresses in rotating parts of the turbine due to maximum runaway speed or in parts under hydrostatic test conditions shall not exceed two-thirds of the minimum yield point.
- ◆ Maximum unit stresses in rotating parts of the generator due to maximum runaway speed shall not exceed three-quarters of the minimum yield point.



- ◆ Maximum unit stresses in parts of that equipment which is subject to the maximum normal operating conditions, shall not exceed the values in the following table:

Material	Maximum allowable stresses	
	In Tension	In Compression
Gray cast iron	1/10 U.T.S	70 Mpa
Carbon cast steel and alloy cast steel	The lesser of 1/5 U.T.S. or 1/3 Y.S.	The lesser of 1/5 U.T.S. or 1/3 Y.S.
Carbon or alloy steel forgings	1/3 Y.S.	1/3 Y.S.
Carbon or alloy steel plates for principal parts	1/3 Y.S.	1/3 Y.S.

U.T.S. = Ultimate Tensile Strength

Y.S. = Yield Strength

- ◆ Maximum stresses in shear shall not exceed 21 MPa in cast iron, nor 60% of the allowable stresses for other materials, except that the maximum shear stresses in the turbine / generator main shafts and shut-off valve stems shall not exceed 50 % of the allowable stress in tension.
- ◆ Thermally or hydraulically pre-stressed bolts such as coupling bolts, bolts for connecting of Butterfly valve body halves, bolts for pre-tensioning of Generator-stator metal sheets etc. are exempted from the limitations imposed and stresses up to 80 % of Y.S. are allowed in such cases.
- ◆ Parts subject to water pressure shall be designed to the applicable provisions of ASME Code and welding shall be as specified herein and in accordance with ASME Boiler and Pressure Vessel code Section 8, Division 2. These parts are the following:
 - Shut-off valve upstream and downstream connection pipes,
 - Shut-off valve housing and servomotor,
 - Distributor,
 - Nozzles,
 - Pressure vessels.

iii) Stresses in standard products

Standard products are not subject to the above conditions i.e. will not be custom designed. Such products are for example:

- Drainage water pumps,
- Cooling water pumps,

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- Air compressors,
- Fans, AHUs, Chillers,
- Other similar products.

1.5.1.5. Water characteristics

The characteristics of the water of Kishanganga River at Dam site of Project shall be ascertained by the contractor after award of the contract. The sampling of the river water shall be done during the season when silt load is very high.

1.5.1.6. Silt erosion consideration

The project is situated in Himalayan region where the silt content during high flow period is excessive and peaks abnormally during high flood. Sediments of Himalayan Rivers contain high quartz content. The turbine design shall be optimised in this regard.

1.5.1.7. Atmospheric condition

The temperature and humidity in the area of the project are as follows:

◆ Maximum temperature	38°C
◆ Minimum temperature	-12°C
◆ Maximum relative humidity	94%
◆ Minimum relative humidity	62%

1.5.1.8. Seismic design

The project is situated in a hilly seismic area and falls within Zone V of the seismic zoning Map of India. Value of peak ground acceleration for Maximum Credible Earthquake (MCE) and for Design basis Earthquake (DBE) shall be submitted for approval.

The forces being caused by earthquake including hydraulic loads, which may occur additionally, shall be taken into account for the computations. Stresses resulting after including these loads shall not exceed permissible stresses.

The Contractor shall design all equipment supplied under this contract to satisfy the seismic criteria. The Contractor shall submit to the Owner the method of calculation and relevant codes he intends to use for this purpose.

In addition to the above, the IS 1893 shall be adopted for seismic design. Hydrodynamic forces due to seismic conditions shall be considered on HM or EM equipment in addition to hydro static loads.



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1.5.1.9. Transportation Limitations

For shipments, the Manufacturer shall pack the items to meet size and weight restrictions of the Indian railways and road systems.

Shipments from Manufacturer's work (in case offshore consignments) shall travel to Port of entry – India, from where these will be transported, after necessary port clearances etc., by the Contractor to nearest rail head for the Project, and further transported to site. However, in certain cases the Contractor may be required to transport the materials from Port of entry to Project site directly by road transport. For onshore consignments, the Contractor shall be responsible in all respects for transportation of all material and equipment up to the project site.

The Contractor shall consult with the concerned authorities in railways and highways to ensure that his packaging will be such as to permit him to transport the plant and equipment within such imposed limits. The Contractor shall arrange to deliver the maximum sized sub-assemblies consistent- with safe and convenient transport.

All materials and equipment etc. arrived at nearest railhead for the Project will be unloaded from rail wagons and reloaded on to road transport for shipment to project site by the Contractor.

All components shall be so designed and constructed as would enable easy assembly of components at works and at the same time permit easy transportation. The weights and sizes of the components/packages shall be within the permissible transport limits for the project site.

1.5.1.10. Equipment and facilities layout

The Contractor shall submit to the Owner, arrangement and layout, optimised for the equipment supplied under this contract. The contractor shall give the details of equipment in the technical data sheets. The guaranteed values shall not be changed.

1.5.1.11. High Altitude Requirement

As the power house is located at an altitude of more than 1700m the requirement of clearances of electrical items and derating factor for equipment ratings needs to be taken into account for the altitude.

1.5.1.12. Control and monitoring

The system shall be controlled and monitored by the SCADA system. The details of control and monitoring requirement are defined in "Section – Computerized Control and Monitoring System" and "Section – Protection System".

The control by the SCADA system shall be through Unit Control Boards/Local Control Boards. All information that is necessary for comprehensive, convenient and selective control and monitoring of the

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system by the SCADA system shall be transmitted through Unit Control Boards/Local Control Boards.

It shall be the responsibility of the Contractor to make all necessary provisions required to achieve seamless and compatible interfacing of control and monitoring systems of generating units and other equipment with plant SCADA system.

Provisions of all transducers/ sensors, instruments, gauges for mechanical parameters (temperature, pressure, flow, vibration, etc.) and electrical parameters (current, voltage, frequency, power, MVAR, etc.) and spare contacts of relays, breakers, isolators push buttons, control/selector switches etc. from various equipment for monitoring, alarm, annunciation, control function etc. through plant SCADA system are in the scope of this contract.

Interconnection from various equipment to Local Control Cubicles and Unit Control Boards/Local Control Boards and all necessary interfaces, like I/O modules, PLCs, CPUs etc., required for communication between local panels/Local Control Cubicles of various auxiliaries/ equipment and respective Local Control Boards shall be covered under scope of this contract.

It shall also be possible to control locally the main elements of the system from local control cubicles. Local control shall be performed in a standalone manner independent of SCADA system, and all information (faults, alarms, measurements, status) necessary for such control shall be displayed locally. Provision of control selector switch for selection of control through Local Control Cubicle, Unit Control Board / Local Control Board and plant SCADA system shall be made in Local Control Cubicles and Unit Control Boards / Local Control Boards.

If the system consists of redundant subsystems, the priority of operation of such subsystems shall be selectable, either from SCADA system or locally.

1.5.1.13. Power supply for control and monitoring

A reliable power supply shall be provided for powering the electronic circuits of the equipment/component. The power supply shall be from two independent DC station battery source, one as primary and other as secondary. Switchover from primary to secondary will follow automatically on failure of primary and return to the primary source automatically following restoration of primary supply.

The power supply shall include redundant converter (dc-dc) connected to station battery source such that failure of any regulated output voltage shall cause instantaneous transfer to a redundant converter without affecting normal operation of the equipment/component in any way. Contacts shall be provided to alarm on power supply failure and local indication shall be provided to identify the failed functional block. The Contractor shall provide full details of the proposed power supply system for approval by the Owner.



In case AC supply is required for any control function, same shall be sourced from two on line UPS, with one main and other standby and with automatic change over facility.

1.5.2. Constructional Specifications

In addition to requirements specified in "General Technical Specifications (GTS)", the Contractor shall ensure strict observance of following constructional specifications.

1.5.2.1. Materials

Materials shall be new and of high-grade quality, suitable for the purpose, free from defects and imperfections, and of the classifications and grade meeting specification requirement and shall be subjected to acceptance by the Owner. Material specifications, including grade or class shall be shown on the appropriate Contractor's detail drawings submitted for review.

All materials or parts used in the equipment shall be tested in conformity with the standards accepted by the Owner.

Certified Material Test Report for the materials of major/important components and/or materials for special application shall be furnished to the Owner as soon as possible after the tests are performed. Each test certificate shall identify the components for which the materials are used and shall contain all information necessary to verify compliance with the contract.

1.5.2.2. Corrosion resistant bolts and nuts

Corrosion resistant steel or bronze shall be used for bolts and nuts when either or both are subjected to frequent adjustment or frequent removal, such as adjusting bolts for packing glands on removable screens or strainers, on adjustable bearings, rubber seal holders, etc. Bolts on manholes shall be of high-strength stainless steel. Protective measures against electrolyte corrosion shall be foreseen where necessary.

1.5.2.3. Painting and colour schedule

All the equipment furnished and installed by the Contractor shall be completely painted for final use, with the exception of those parts or surfaces that are expressly designated as unpainted. Surfaces to be painted shall receive the preparatory treatment and number of coats prescribed in the "Annex 1 - Painting schedule" of "General Technical Specifications (GTS)". The Contractor shall perform all painting work in the shop, before shipment, followed by a field touch-up during or after installation. If accepted by the Owner, the Contractor may apply the last coat of paint at the site instead of applying it in the shop.

Colour standard references to major equipment/system shall be as mentioned in below table:



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Raw water pumps	Mint green	RAL 6029
Raw water strainers	Mint green	RAL 6029
Heat exchangers	Mint green	RAL 6029
Turbines	Silicon grey	RAL 7032
Turbine shut-off valve	Mint green	RAL 6029
Governors	Silicon gray	RAL 7032
Oil pressure piping	Yellow orange	RAL 2000
Oil purification system	Yellow orange	RAL 2000
Lubrication oil piping	Yellow orange	RAL 2000
Air compressors	Sky blue	RAL 5015
Air piping	Light blue	RAL 5012
Tops of generators	to be decided later	
Transformers	- do -	
GIS	- do -	
Enclosures for electrical power equipment	Melon yellow	RAL 1028
Enclosures for electrical control and protection equipment	Pearl white	RAL 1013
Outdoor pot yard structure	Galvanised	

1.5.2.4. Electrical equipment enclosures

Unless otherwise specifically called for or described in these Contract documents all electrical appliances shall conform to the applicable IEC Publications.

The cubicles and enclosures shall be of protection class IP 40 or higher according to their location. For outside installation and area which are humid, corrosive, and prone to dripping and/ or spray of water, the protection class of cubicles shall be IP 65. Cubicles housing electronic cards/modules such as of unit control boards/local control boards, digital governors, static excitation equipment shall be of protection class of IP 5X.

Cables shall have at least 1000 V PVC insulation except for 220V DC and tele-metering or communication system equipment for which 650V and 300 V ratings respectively are acceptable.

For current and potential transformer secondary circuits the minimum cross section of the conductors shall not be less than 4.0 mm².

Wiring shall terminate at terminal blocks at one side only. Where tap connections are required, they shall be made on terminal blocks. Wiring



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shall be neatly arranged and laid in wire ways accessible from the front door. The wire ways shall not be filled more than 70 %.

Each cubical shall be provided with an earthing bar (PE) of sufficient cross section carrying any possible fault current without undue heating. All metallic parts of the cubicle not forming part of the live circuits, all instrument transformer terminals to be earthed and other earthing terminals as well as all cable screens and PE-wires shall be connected to the earthing bar.

All internal equipment and wiring shall be neatly and clearly marked as indicated on the schematic and wiring diagrams. Internal wiring and cables shall be marked with sleeve type engraved marking. Marking system and marking material shall be subject to approval by Owner. Identification of the respective conductors shall be in accordance with the requirements of IEC publication 60204. In cable, having five conductors or more the individual conductors shall be numbered throughout the entire length. In cables having less than five conductors colour coding in accordance with IEC Recommendations 60204 shall be used.

1.5.2.5. Terminal Blocks

Control circuits and power circuits shall be completely separated by use of divided or separate terminal blocks

Terminal blocks shall be 1100V grade and have continuous rating to carry the maximum expected current on the terminals. The terminal blocks shall be cage clamp type (Wago or equivalent) or non-disconnecting stud type (Elmex type CAT-M4 or equivalent). The insulating material of terminal block shall be nylon 6.6 which shall be free of halogens, fluorocarbons etc.

Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

The terminal blocks shall be of expandable design.

The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

All circuits except CT /PT circuits	Minimum of two of 2.5 sq. mm copper flexible
All CT/ PT circuits	Minimum of 2 nos. of 6 sq. mm



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copper flexible

The arrangements shall be made in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

At least 20% spare terminals shall be provided on each panel/ cubicle/ box and these spare terminals shall be uniformly distributed on all terminals rows.

There shall be minimum clearance of 250 mm between the first/ bottom row of terminal block and the associated cable gland plate. Also, the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

1.5.2.6. Control switches, Indicating lamps and Instruments

i) Measuring converters

The converters shall be suitable for direct connection to the secondary circuits of the potential and current transformers used, or other sensors, each as they apply. The converters shall be static type, having all accessories to provide an output signal of 4-20 mA, filtered DC.

For the measuring converters the following minimum requirements shall be fulfilled:

Current transducers shall be single-phase, of accuracy class 0.5 or better.

Voltage transducers shall be single-phase of accuracy class 0.5 or better.

W and VAr transducers shall be two elements, three-phase. Accuracy class of the transducers shall be 0.5 or better.

ii) Measuring transformers

Potential transformer secondary windings shall be rated $110/\sqrt{3}$ V

Current transformer secondary windings shall have a rated current of 1A/2.5A /5A.

1.5.2.7. Cautionary signs

Caution and warning signs must be displayed in English, Hindi and local language.

Identification plates and instruction plates shall preferably be bilingual i.e. English and Hindi/ local language.

1.6. Record and Documentation

1.6.1. Documentation / record of the work/activities

The documentation/ records of the work under this contract for future reference shall be included in the scope of work.



The Contractor shall document all the major activities, milestones related to installation of powerhouse from commencement of work under this contract and shall maintain the documentation/record in chronological order till the completion of the job specified under the contract.

The Contractor shall submit ten copies of above documentation/records to the Owner after completion of work under this Contract. The Contract shall be deemed as completed only after the Contractor submits the same.

1.6.2. Design memorandum

The Contractor shall prepare and submit to the Owner a "Design Memorandum" of the proposed equipment/system fulfilling the contract specification/requirement given in respective section for approval prior to submission of any drawings and documents. The memorandum shall include the design philosophy, methodology, system description, input parameters for design, standard and codes, design and selection criteria, equipment data, material specification, major technical features, basic arrangement/ layout etc.

Design memorandum of all the equipment / system shall be prepared and first draft shall be submitted within six (6) months from date of award of the contract.

1.6.3. Technical documentation

All the technical documents and drawings required to be furnished under this contract as per clause 2 "General Technical Specifications" shall be prepared in internationally accepted software of latest version used for preparation of documents and drawings. Layout shall be prepared in 2-D / 3-D form and the Contractor shall furnish latest network version of software with minimum 10 (ten) users' licenses to Owner's design office to study/review/approve the drawings during detailed engineering stage. The software shall be compatible with the Windows XP/latest version and MS Office programs.

The Contractor shall submit six (6) copies (or as required) of drawings along with copy in electronic form media for approval / review as per clause 20.3 of "General Conditions of Contract". At the time of completion of contract, the Contractor shall submit ten copies along with two reproducible and five copies in electronic form in CD media, of approved and as built drawings together with operation and maintenance manual as specified in clause 8 of "Special Conditions of Contract".

All the drawings and documents shall be submitted in presentable folders properly bound and catalogued for easy retrieval / reference. Drawings shall be submitted in A0 / A2 / A3 and all documentation in A4 size. All drawings shall be digitally printed/ plotted. Ammonia print/ blue print shall not be accepted.

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1.6.4. Unit model

A scaled model of section through a unit depicting the details of turbine generator set as closely as possible shall be supplied by the Contractor. The model should have high quality of craftsmanship to ensure the inclusion of all major details of the unit set. The details of model may be discussed during detailed engineering and should be approved by the Owner before acceptance of the same.

1.7. Delivery, Installation and Commissioning

1.7.1. Packaging, handling and site storage

The Contractor shall follow the general requirement of Packaging, Handling and Storage elaborated in "Section 8 - Transport and Installation" of "General Technical Specification (GTS)".

The Contractor shall pack all the consignment in sea worthy packaging, wherever required, strong enough to withstand rough handling during transit. Machine surface shall be suitably protected against scratches, corrosion, shocks, impact etc. Packages shall be suitably and distinctly identified for type of handling and kind of storage.

The packaging and storage of electronic equipment shall be strictly in accordance with internationally accepted standards. Electronic equipment shall be packaged, shipped and stored in anti-static packing. All packages shall be stored indoor. Packages containing electronic equipment shall be stored in humidity controlled environment.

1.7.2. Installation

The Contractor shall follow the requirements of installation elaborated in "Section 8 - Transport and Installation" of "General Technical Specification (GTS)".

The Contractor has to do all the work related to assembly, erection, testing and commissioning complete in all respects. All necessary tools, plants, labour, materials including consumables for performing installation, testing and pre-commissioning shall be provided by the Contractor.

The Contractor shall submit the necessary data/information, layout and foundation/support drawings well in advance.

The Contractor shall provide and install the concrete inserts/embedment, support steels and/or components for foundation/supports purpose as per approved erection drawings and coordinate the activities with civil contractors to keep his activities in synchronism with civil work. All installation for foundation shall be verified and accepted by the Owner.

The Contractor shall use anchor fasteners for installation of piping, fixtures, mountings, conduits, cabling, panels etc. Chipping of concrete and/or taking support from reinforcement bars shall not be allowed.



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The design, location and approval tests of anchoring rings for the fixing of lifting apparatus necessary for assembly and dismantling of equipment and plant accessories shall be the responsibility of the Contractor.

The Contractor shall supply sufficient number of erection and commissioning spares based on their experience so that erection, testing and commissioning work progresses smoothly and is not hampered for want of such spares. These spares shall be in addition to the spare parts described under clause "Spare Parts".

1.7.2.1. Installation procedure

The Contractor shall submit six copies of all detailed programs and the procedures to be adopted for erection / installation, testing and commissioning well in advance, before start of erection activities/ installation, for approval of the Owner.

The installation procedure shall also have a section "site quality assurance plan" containing erection data sheets for various components. These sheets should specify site measurements/ inspections required to be made for ensuring proper installation.

1.7.2.2. Field welding

The Contractor shall select the proper filler material with respect to parent material for all field welded connections and shall specify it on the applicable drawing, together with the detail design of the field weld joint.

All cutting, chamfering, and other shaping of metals necessary for the field connection shall be done as far as possible in the shop. Adequate temporary bolted field connections shall be provided to hold the assemblies rigidly and in proper alignment during shop and field assembly.

1.7.2.3. Cable laying

Wiring between equipment enclosures shall be made with cables, laid in trenches and/or cable trays and in cable conduits. The Contractor shall submit for review to the Owner a cable route layout-showing location of trenches, conduits and trays. All material for cable laying such as cable trays supports and fastening material shall be furnished and placed by the Contractor. Cables shall be properly fastened and marked where they enter enclosures by either cable clamps or nipples.

Cables in horizontal cable trays shall be fastened properly with clamps or plastic strips. Power and control cables shall be placed in separate trays or conduits. Cables shall be clearly marked at each terminal point.

1.7.2.4. Embedded parts and anchor bolts

All embedded anchor bolts, rods, welding plates and support plates shall be provided. Anchor bolts shall consist of a threaded steel rod installed inside a pipe sleeve to provide lateral adjustment after the sleeve is



embedded. The embedded end of the rod shall be provided with a steel plate, which shall be welded to the rod and sleeve to provide anchorage and to prevent entry of concrete into the sleeve during installation.

The threaded end of the rod shall be provided with two steel nuts and two steel washers to permit levelling and anchoring the equipment prior to grouting.

Approved types of expansion or chemical anchors shall be used where practicable for small equipment.

1.7.2.5. Installation records

The Contractor shall maintain the installation records including installation quality control (QC) records of each activity to ensure quality of installation as per specification/requirement. The QC record shall clearly show the achieved erection tolerances vis-à-vis the allowable limits. The installation records shall be submitted to Owner for approval/ acceptance to establish completion of installation milestones as per program of performance. All installation records shall be compiled and submitted to the Owner before taking over the respective unit. Completion Certificate for any work shall be issued only after approval / acceptance of complete installation records.

1.7.2.6. Field inspection

The Contractor shall permit Owner to perform inspections of the assembly which will include a complete verification of the assembly of all parts as to their levels, clearances, pertinent fits, alignments and quality of workmanship. The field supervisor of the Contractor shall provide Owner with three (3) copies of all the clearances, tolerances and data of all pertinent fits, alignments and levels, so that the latter may repeat the Contractor's measurement, if desired.

Unless otherwise specified, any rejection based on the inspection will be reported to Contractor within fifteen (15) days and injurious defects subsequent to assembly and acceptance will be rejected.

1.8. Spare Parts

The Contractor shall supply the specified spare parts as defined in "Section 3 – Spare Parts and Tools" of "General Technical Specifications (GTS)".

The Contractor shall be recommended a list of spare parts which would be required for smooth operation and maintenance of plant for a period of five (5) years. Such list shall be finalised during detailed engineering. The cost of such spare parts shall be deemed to be included in the quoted price of the contract.

In addition, the Contractor shall supply sufficient number of erection and commissioning spares based on their experience so that erection, testing

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and commissioning work progresses smoothly and is not hampered for want of such spares.

The spare parts provided by the Contractor shall be of the same quality and have the same mechanical and/or electrical properties as the original parts and be fully interchangeable with them. If modifications are made to equipment during erection, the Contractor shall ensure that these modifications are also made to all spare parts.

Conditions for tests, surface treatment, painting, etc., stipulated in the Owner's Requirements, shall also apply for the spare parts.

Spare parts shall be conditioned, packaged, shipped and stored to ensure long term storage without degradation.

The complete set of the spare parts for the works or a section shall be delivered prior to taking over.

1.9. Tools and Instruments

1.9.1. Special tools

Special Tools shall be supplied by the Contractor as necessary for erection, installation, operation and maintenance, etc. of each item of equipment supplied under this Contract.

Special tools shall include tools specified by the Owner and those others recommended as necessary and accepted at the time of award of the contract.

All special tools shall be clearly marked to identify their use and shall be made available for the erection to be undertaken by the Contractor. Special tools shall be shipped with the first consignment of equipment to be erected.

The tools shall be delivered to the Owner prior to taking over, in perfect condition or be replaced, if necessary, with new tools of equal or better quality than the original ones.

1.9.2. Tools for erection and Installation

The Contractor shall bring his own tools, devices, testing instruments/ equipment to site in order to erect and install the complete equipment delivered under this section.

These shall remain the property of the Contractor unless otherwise agreed to be taken over by the Owner any / all of these at mutually agreed conditions.

For on-site assembly, the Contractor shall use the same assembly tooling and procedures as those used in the shop.

A list of minimum number and times of tools & plants to be deployed by the Contractor to site is enclosed at the end of this section as Enclosure 2.

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1.10. Training

The Contractor shall arrange training to familiarize the Owner's personnel about constructional and O&M aspects of equipment wherever need of specialized training is felt during detail engineering. Cost of such training shall be borne by the Contractor. Travelling and living expenses, of the personnel deputed on such training, however, shall be borne by the Owner.

Besides above, the Contractor shall hold training sessions to familiarize the Owner's personnel with all aspects of operation and maintenance of the plant and sub-systems before the beginning of the dry tests on site. The technical documentation used in the training sessions shall include the Contractor's draft operation and maintenance manuals and test procedure descriptions approved by the Owner.

The Contractor shall provide training for each phase of work as per details agreed at the time of award.

1.10.1. General requirements of training

The Contractor shall provide suitable instructors, training material and facilities (instruments, apparatus, simulators, documents, drawings, protective clothing, rooms, office supplies, etc.) for the personnel made available by the Owner for training.

One month before the training start, the Owner will send the list of the trainees and any comments on the training program proposed by the Contractor. This program shall be adapted to the design and nature of the Works, and the needs of trainees. Trainees shall be suitably trained in the various aspects of design, manufacture, installation/erection, operation and maintenance, relevant to the training, of works similar to the Works

The Contractor shall supervise and provide direction to, and be liable for the acts or omissions, other than negligent or wilful misconduct of such personnel, of the Owner's trainees.

The Contractor shall provide the training described hereafter in accordance with any further specific requirements stated in the Owner's Requirements.

The Contractor shall assist the Owner in obtaining any visas and other formalities for entering or leaving the territory on which the training is being provided.

The Contractor shall bear responsibility for ensuring the safety of the trainees during their stay in the country of the training. On their part, the trainees shall comply with the laws, regulations and customs of the country in which training is being provided.

In the event of illness or accident, the Contractor shall take all steps to provide the trainees with the appropriate medical care.

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1.10.2. Training of Owner's personnel

The scope of service under training of Owner's engineers shall include a training module covering the following:

1.10.2.1. Training during engineering/ manufacturing phase

This shall cover all disciplines viz, Mechanical, Electrical, C&I & QA etc. and shall include all the related areas like design familiarisation, training on product design features and product design software of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer's works, exposure to various kinds of problems which may be encountered in fabrication, manufacturing, erection, welding etc. The training in areas of Operation and Maintenance shall take place preferably during end of manufacture/ tests.

The proposed training for various equipment and systems shall be minimum 30 man-months.

1.10.2.2. Training during the erection / installation / site work

Independently from the supervision and inspection functions of the Owner's Representative, the Contractor shall authorise the Owner's Personnel to follow the erection / installation / site work at his site.

The Owner's Start-up Personnel shall take no part in the equipment erection and/or installation operations, which shall be exclusively carried out by the Contractor and under his entire responsibility.

This on site training shall cover each phase of erection / installation / site work and shall be of sufficient duration.

The Contractor shall supply the information or measurements concerning the erection requested by the Owner's Representative or/and by the Owner's personnel.

1.10.2.3. Training during the tests on completion phase

The Contractor shall provide on the-job training in the operation and maintenance of the Works to the Owner's Operating Personnel. Such training shall start at least 30 days prior to commencement of Tests on Completion and continue until taking over of units. Its scope and quality shall be such as to provide the trainees with comprehensive understanding of all operational and maintenance aspects of the work. Such training shall also include safety and environmental protection aspects applicable to the work.

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20.1.3. Power supply network

Maintenance power supply network shall comprise of:

- ♦ The power outlets circuits and individual sockets of single phase 5A/15A (normal and UPS),
- ♦ Fixed wall mounted sockets of single-phase 16/32A,
- ♦ Fixed wall mounted sockets of three-phase 63A,
- ♦ Fixed wall mounted sockets of single-phase 24V, 32A for inspection lamps for leakage prone areas,
- ♦ 24V AC supply panels having 415V/24V, 3-phase, 5.0 kVA transformer and required nos. of MCCBs.
- ♦ Six (6), portable socket cubicles supplied from a network of sockets distributed throughout the various areas,
- ♦ All cabling and wiring including conduits, racks, ducts, channels or any other media of cable runs and associated accessories / fixtures/ fasteners for power supply network.

20.1.4. Miscellaneous Items

- i) Illumination panels as per requirement complete with cubicles, bus-bar system, circuit breakers, instrument transformers, instruments cabling and wiring and complete with all other accessories.
- ii) One (1) no. wheel mounted platforms with ladder for maintenance of overhead lighting system.
- iii) Inspection lamps as per the requirements specified.
- iv) Coordination and provision of necessary contacts and/or ports for integration with plant SCADA system.
- v) Spare parts as per clause no. 20.8
- vi) Tools & instruments as per clause no. 20.9

20.2. Specific Parameters and Layout Conditions**20.2.1. Layout and General Arrangement**

The illumination system for powerhouse complex shall be supplied from the powerhouse illumination boards, which shall be connected to station service board (SSB) as shown in single line diagram NH/DEM/KSG/LT/01 (Sheet 1 to 3).

Lighting and service power supply network shall cover all areas of power house. Major areas are listed below:

- ♦ Indoor lighting
 - Power House Block Area complete

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- Complete floors of Control Block Area
- Switchyard Control room, DG Hall/Oil handling area/Pump room and other adjoining area
- Transformer cum Tail Race Gate Cavern.
- Bus duct tunnel.
- Drainage gallery Staircases, lift well, toilets, kitchens and other utility areas
- Cable and Ventilation Tunnel
- Main access tunnel.
- Adit to surge shaft.
- Penstock Butterfly valve cavern
- Any other gallery/cavern
- ♦ Outdoor lighting
 - Walkways and at the entrance of access tunnels to the Power House Cavern
 - Surge shaft area/valve house and its approach road (Up to 500m)
 - Outdoor pothead yard area and its approach road (Up to take off point from main road)
 - Outlet area of Tail race tunnel including approach road (Up to 500m)

The entire lighting network of the power house shall be supplied from two different boards, each board supplying the half power house lighting.

20.2.2. Design considerations

20.2.2.1. Normal lighting

Normal lighting in each functional area shall be divided in four circuits, each circuit providing one fourth of specified lux level. Control points shall be arranged to provide lighting of varying intensity.

Smart switches / sensors shall be installed in office/facility areas to turn off or on the lights depending upon occupancy for the purpose of power saving.

Provisions shall be made to get glare free uniform intensity of light in the area.

Supply to control room and critical areas shall be through UPS for interruption free lighting.

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20.2.2.2. Emergency lighting

A separate emergency lighting system shall be supplied through emergency lighting boards. Emergency lighting boards shall be fed from 220V DC distribution boards. Emergency lighting shall automatically replace normal lighting, if the power supply source fails. It shall be off when normal lighting is operational.

The cables for illumination system and for convenient power outlets of switchyard/pothed yard shall be partly in the conduits and cable trays.

The design and construction of illumination system and that of 220 V DC system shall be adequately coordinated.

20.2.2.3. Power supply

Power supply shall be taken from station service boards.

Power outlet circuits for control room, office areas and individual sockets incorporated in cubicles and cabinets intended for electronic apparatus and computer sockets shall be supplied through UPS.

Single phase and three phase power outlets covering all areas shall be provided for maintenance power supply.

20.3. Rating and Functional Characteristics**20.3.1. Service voltages**

Normal lighting system	Three-phase, five wire, 415/240V, 50Hz
Emergency lighting system	Two wire, 220 V DC
AC socket outlets single-phase	Single-phase, three pins, 240V, 50Hz
Power socket outlets three-phase	Three-phase, five pins, 415/240V, 50Hz

20.3.2. Lux levels and quality of direct glare limitation

The nominal illumination level for lighting, measured at the height of a worktable (0.9 m) shall have an average the following values:

Nature of area or activity	Lux levels	Quality class of direct glare limitation
General areas:		
Store	300 Lux	2
Changing rooms, washrooms and toilets	200 Lux	2

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Nature of area or activity	Lux levels	Quality class of direct glare limitation
Staircases	200 Lux	2
Office areas:		
Offices	500 Lux	1
Conference room	500 Lux	1
Data processing areas	750 Lux	1
Other office areas	200 Lux	1
Reception lobby, model room	200 Lux	1
Equipment areas:		
Power house machine hall, turbine pit, service bay area, transformer cum tail race gate cavern, electrical workshop, mechanical workshop, DG set room	300 Lux	2
Generator barrel, high and low voltage switching installations in building, other floors & Areas of power house	200 Lux	2
Mechanical equipment areas	200 Lux	2
Control room	500 Lux	1
Relay and telecommunication room	300 Lux	2
Emergency lighting, all areas	50 Lux	3
Out door areas:		
Switchyard	200 Lux	-
Entrance, exit and other areas	100 Lux	-
Road and traffic areas	20 Lux	-

20.4. Performance Guarantee

The illumination system along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. The Contractor shall guarantee the reliability and performance of the individual equipment as well as of the complete system.

The Contractor shall guarantee the lux levels in various areas as specified above.

ILLUMINATION SYSTEM



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20.5. Design and Construction**20.5.1. Standards**

The system and equipment shall be designed, built, tested and installed to the latest revisions of the following applicable standards. In the event of other standards being applicable they will be compared for specific requirement and specifically approved during detailed engineering for the purpose:

Standards	Description
IEC 60598	Luminaries
IEC 60309	Plugs, socket outlets and couplers for industrial requirements
IS 6665	Code of practice for industrial lighting
IS 10322	Specification for Luminaries
IS 3646	Code of practice for interior illumination

20.5.2. Scheme of luminaries and fittings

Following types of luminaries and fittings are proposed to be installed at various indoor and outdoor locations. However, these shall be finalized during detailed engineering and the Contractor shall supply the fittings and luminaries as per the approved drawings.

Service bay and machine hall	HPMV high bay lamp fittings
Cable spreading area	Fluorescent type tube fittings
Control room	Fluorescent type decorative fittings in false ceiling, Low wattage lamp (CFL)
Turbine floor, generator floor, MIV area, compressor room and other elevation areas	Fluorescent type tube fittings
AC room, test lab, DC distribution/LT room/battery charger	Fluorescent type tube fittings
Generator barrel (inside) and turbine pit	A mixture of fluorescent tubes and bulbs
Transformer Cum Tail Race Gate Cavern	HPMV lamp fittings
DG set rooms and other areas	Fluorescent twin tube fittings



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Battery rooms	Acid fume proof fittings
Switchyard	HPSV / HPMV fittings
Other outdoor fittings on the approach roads etc.	HPSV lamp fittings
Emergency lighting at all elevations of power house except control room	All lamp fittings
Emergency lighting in control room	Fitting suitable for false ceiling.
Machine hall, service bay, transformer cum tail race gate cavern	Additional GLS lamp fittings (minimum 6 nos. or more of 500/1000W at each location suitably spaced)
Surge Shaft Area	HPSV / HPMV fittings
Access Tunnels, Cable Cum Ventilation Tunnel, Drainage Gallery, Bus Duct Tunnel	HPMV fittings

Turbine pits, runner removal galleries and generator housings shall have water proof light fittings while DG set room and battery room shall have explosion proof light fittings.

20.5.3. Power supply network

Control rooms, offices, facilities, utilities and all cabinets and cubicles shall be equipped with power outlet circuits. These circuits shall comprise of:

- Sockets for normal power supply.
- Sockets for normal (UPS) power supply.

Each office rooms shall have at least two power sockets and all other areas shall have at least one socket for every five meter.

All rooms containing equipment requiring maintenance as well as all repair workshops shall be equipped with a maintenance power supply network to supply tools. This network shall comprise of:

- Fixed wall mounted sockets of single phase 16/32A,
- Fixed wall mounted sockets of three phase 63A,
- Portable socket cubicles supplied from a network of sockets distributed throughout the various areas.

All turbine and generator pit, machine hall and below floors, other leakage prone areas, drainage gallery shall be provided with fixed wall mounted



sockets of single-phase 24V, 32A for inspection lamps. 24V AC supply panels as required having 415V/24V, 3-phase, 5.0 kVA transformer and required nos. of MCCBs shall be provided to feed the 24V power supply network.

20.5.3.1. Portable socket cubicles

Portable socket cubicles mounted on wheel trolleys with 10 m long cable connected to the cubicle, and equipped with a male connector at the other end shall be provided to extend the maintenance power supply at required location by connecting these cubicles to fixed sockets. Cubicle shall include:

- ♦ A protection circuit breaker,
- ♦ An indicator light to show "On" and "Off" status,
- ♦ The following sockets:
 - Two (2) nos. 63 A, 415 V five (5) pin socket,
 - Three (3) nos. 32 A, 240 V three (3) pin socket,
 - Three (3) nos. 32 A, 24 V two (2) pin socket.

20.5.4. Terminal equipment design

The control equipment, the power sockets shall comply with the standards that are currently used in country and shall bear a Conformity Mark.

The standard selected for the project shall be submitted to the Owner for review.

In the offices and facilities, the equipment shall either be embedded, or mounted directly on the wire way.

20.5.5. Outdoor lighting

Areas for traffic and storage of handling gantries shall be lighted and marked, in addition to the floodlights on the gantries. Traffic areas shall receive lighting of at least 20 lux. Lighting mast shall be provided at strategic locations for outdoor illumination covering area. Street lights having underground cabling shall be provided for illumination of access and connecting roads. Luminaries for outdoor lighting shall be of IP65 Class.

20.5.6. Distribution boards

The boards shall be of wall-mounted/panel type and shall be suitably located. The boards shall be made of sheet steel not less than 3 mm thick and provided with front hinged cover for further enabling the board to be unscrewed for inspection of wiring in the board.

Boards shall be waterproof and shall be provided with glands or adapters to receive a screwed conduit.

20.5.7. Switchboards

The switchboards shall be of heavy duty and modular type and shall be located 1.5 meters above the floors. All the switches shall be of piano type and shall have silver cadmium contacts. Multiple plug power sockets shall be capable of taking at least one 3-pin plug and one 2-pin plug simultaneously. Each type of power socket shall have elliptical spring loaded contacts.

20.5.8. Cables

The cables shall be of at least 1000V grade, PVC insulated. All single core cables shall be of copper flexible conductor. Cables from distribution boards to switch boards and to light fixtures, single phase AC sockets shall be of copper flexible conductor. Minimum size of copper conductor for single core cable shall be 2.5 mm².

20.5.9. Wiring

It is proposed to carry out surface wiring for illumination circuits in equipment areas/floors. Concealed/recessed wiring shall be done in control room, offices, reception and any other area requiring aesthetic appeal.

Conduits and/or wire ways shall be used for wiring between fixtures and control points. Separate conduits/wire ways shall be used for light, power and communication points.

20.5.10. Lighting accessories

Each socket outlet for lighting and power shall be controlled by a switch, which shall be on the live side on the line. The socket outlets shall be of 3 pin type to provide earth connection to each outlet.

The power socket outlets shall be 16A / 32A single-phase and 63A three-phase as per requirement to be approved by the Owner.

Multi plugs of 16A, 32A and 63A shall be of metal clad type.

20.5.11. Conduiting

Conduits shall be of heavy duty type, hot dip galvanised steel conforming to IS 9537 or fiber glass reinforced epoxy conduits which have compressive and impact strength that of galvanised conduits. In corrosive areas galvanised conduits shall have additional suitable epoxy coating.

Anchor fasteners shall be used for fixing of conduits, light fixtures etc. wherever required. Suitable inspection boxes shall be provided to permit inspection and to facilitate removal of wires if necessary.

20.5.12. Earthing

The continuous earth shall be run for all the 3 pin sockets.

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The neutral will be earthed at distribution transformer and the three phase four wires distribution system shall be connected to the station earthing system at two or more places.

20.5.13. Maintenance ladders and platforms

Wheel mounted platform with ladder for maintenance of overhead lighting system shall be of collapsible type of height suitable for maintenance of outdoor fixtures.

20.5.14. Inspection lamps

Inspection lamps as follows shall be provided for routine inspection/maintenance purpose:

- ♦ Twenty four (24) nos. portable plug in type inspection lamps for 240V with 5 meter cable and one power plug.
- ♦ Twenty four (24) nos. portable plug in type inspection lamps for 24V with 5 meter cable and one power plug.
- ♦ Twelve (12) nos. portable battery operated hand lamps.

20.6. Drawings, Documents and Design Calculations

20.6.1. Design memorandum

The Contractor shall submit to Owner a design memorandum prepared in accordance to clause 1.6 "Record and Documentation" of "Section 1- General Technical Requirements."

20.6.2. Drawings and documents

The Contractor shall submit all the drawings and documents in accordance with requirements stipulated in "Section 2 - Technical Documents" of "General Technical Specification (GTS)".

These drawings and documents shall include at least the following:

- Outline, general arrangement and layout plan for illumination system,
- Cable and conduit routing diagram,
- Wiring and termination drawings,
- Type of luminaires, fittings, power sockets, switches etc.,
- Drawings for distribution boards, control points etc.,
- Lighting mast, lighting facade/panels details.

20.6.3. Design calculation

The Contractor shall submit the design calculation in accordance to Clause 2.6 of "General Technical Specification (GTS)" covering at least the following, for review / acceptance.

- Calculations for the illumination levels of the different areas with respect to installation plan,
- Cable and conduit sizing.

20.7. Delivery, Installation and Commissioning

The Contractor shall follow the requirements of Delivery, Installation and commissioning elaborated in clause 1.7 "Delivery, Installation and commissioning" of "Section 1 - General Technical Requirements".

20.8. Spare Parts

Recommended spare parts shall be supplied in accordance to clause 1.8 "Spare Parts" of "Section 1 - General Technical Requirements". Specified spare parts to be supplied under this section are as follows:

S. No.	Description	Quantity
1	Multiple plug power sockets suitable for 63A/32A/16 A 15A /5 A	5 % of installed quantity 5 % of installed quantity
2	Multi plug suitable for 63A/32A/16A 15A/5A	5 % of installed quantity 5 % of installed quantity
3	High-pressure mercury vapour lamps complete with all accessories and fittings	5 % of installed quantity
4	High pressure sodium vapour lamps complete with all accessories and fittings	5 % of installed quantity
5	Fluorescent lamps complete with all accessories and fittings	20 % of installed quantity
6	DC lamps complete with all accessories and fittings	20% of installed quantity
7	HPMV lamps and chokes	15 % of installed quantity
8	HPSV lamps and chokes	15 % of installed quantity
9	Low wattage lamps (24V)	20% of installed quantity

- | | | |
|----|---|----------------------------|
| 10 | All type of switches, contactors, terminal blocks, screws | 10 % of installed quantity |
| 11 | All type of cables, wires | 10% of Installed quantity |

20.9. Tools and Instruments

The Contractor shall supply all necessary tools and instruments etc. for installation, repair and maintenance in accordance to clause 1.9 "Tools and Instruments" of "Section 1 - General Technical Requirements".

20.9.1. Special tools

The Contractor shall propose the list of special tools including their make and detailed specification as recommended by manufacturer(s), to be accepted by the Owner.

20.10. Quality Assurance and Testing

The Contractor shall follow the quality assurance and testing requirements specified separately in "Quality assurance and Testing Specifications (QTS)".

20.11 Illumination system for Dam Complex, Power Intake, HRT Adits, Surge Shaft, Pressure Shafts and Tail Race shall in general be complying with the requirements given above excepting the power requirement which shall be met from DG Sets.



ILLUMINATION SYSTEM



20. ILLUMINATION SYSTEM

20.1. Type Tests

The contractor is required to carry out all type tests as per relevant IEC/International Standard on one apparatus of each type of similar rating and shall submit the reports to the employer. The type test may not be mandatory if similar equipment has been type tested and test certificates for relevant tests are accepted by the employer.

i) Following Test reports shall be submitted for each type of Luminaries

- ◆ Test for mechanical strength,
- ◆ Heating test,
- ◆ Endurance test,
- ◆ Protection against electric shock,
- ◆ Thermal shock proof test for glass (as applicable),
- ◆ Wind loading test on street light luminaries,
- ◆ Power factor measurement test.

ii) Following Test reports shall be submitted each type and rating of lamp

- ◆ Rating Test,
- ◆ Life Test.

20.2. Shop Tests

The components of illumination system shall be routine tested as per relevant IEC with latest amendments. All shop tests shall be carried out at the manufacturer works.

i) The following tests shall be done:

- ◆ Test on Lighting fixtures and Lamps shall be performed as per IS 10322 (part IV and V)
 - Resistance to dust and moisture,
 - Insulation resistance test,
 - High voltage test,
 - Photometric test,
 - Dry IR and HV test,
 - Photometry test.
- ◆ Test on steel and non-metallic conduits and accessories shall be performed as per IS 9537

- Screw threads,
- Bend Test.
- Compression Test,
- Galvanizing check,
- Marking Test,
- Test for resistance to heat,
- Test for Electrical characteristics.
- ◆ HV and IR test on Panels.

The Details of the tests are given in Model Quality Assurance Plan of Illumination System.

20.3. Field Tests

All field tests including tests during installation, pre-commissioning, commissioning, field acceptance tests shall be conducted by the contractor in presence of representative of the employer.

Procedure to be adopted for conducting the operational, pre-commissioning, commissioning performance and field acceptance test shall be submitted well in advance, at least six (6) months before start of relevant testing for approval of the employer.

Following tests shall be performed:

- ◆ Verification of electrical continuity between exposed conductive parts and the general earth circuit,
- ◆ Testing of main and auxiliary circuit insulation,
- ◆ Complete functional testing of illumination system,
- ◆ Lux level measurement as per approved drawings,

ILLUMINATION SYSTEM



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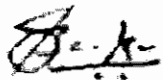
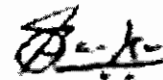
DESIGN PHILOSOPHY (MEMORUNDAM) FOR ILLUMINATION SYSTEM FOR KISHANGANGA HYDRO ELECTRIC PROJECT (3 X 110 MW) FOR NHPC LTD.

BHARAT HEAVY ELECTRICALS LIMITED
INDUSTRIAL SYSTEMS GROUP
BANGALORE

NHPC LTD./ एन एच पी सी लिमिटेड
 प्र.प्लान (ई एल एम) विभाग
 Design (E & M) Division
 ✓ I - Approved/ देवी I - अनुमोदित
 II - दिशनी मर.वेट करने पर अनुमोदित
 II - Approved Subject to Comments
 III - मर.वेट कर पुन: प्रेषण के
 III - Modify & Resubmit
 IV - मर.वेट हेतु स्वीकृत
 IV - Accepted for information

01/49 ILL
 24.09.14

24.09.14 10:17 P
 Mgr/SM CC

		
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SECTION – I

1.0 INTRODUCTION

The proposed Illumination system is provided at various important location of the Kishanganga Hydro-Electric Power plant. Our system design is based on the technical specifications of NHPC PTS.

The purpose of this document is to provide the design document for the supply of illumination system for 3 X 110 MW Kishanganga Hydro-Electric Project. This document covers the various types of lighting systems at different areas of the plant as indicated in the clause no: 3.0.



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SECTION -II

2.0 SCOPE OF WORK

Scope of work under this section covers the provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, site storage and preservation, installation, commissioning, performance testing, acceptance testing, training of Owner's personnel, handing over to Owner and guarantee for two years of illumination system), as per the specifications hereunder, each complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation.

The scope of work shall be a comprehensive functional system covering all supply and services including but not be limited to following:

2.1. Normal lighting system

Normal lighting system shall include indoor and outdoor lighting of complete power house and adjoining areas, comprising following major components;

- * Lighting cabinets,
- * Lighting equipment, including the light fittings, lighting facia/panels, warning/direction sign boards,
- * Power sockets of 5 A,
- * Control points, including:
 - Push-buttons or switches,
 - Dimmers, smart switches/sensors,
 - Indicator lights on the main control panel indicating on-off circuits.
- * Street light poles, masts for outdoor lighting,
- * All cabling and wiring including conduits, racks, ducts, channels or any other media of cable runs and associated accessories / fixtures/fasteners for normal lighting system.

2.2. Emergency lighting system

Emergency lighting system shall comprise of:

- * Emergency lighting boards,
- * Lighting equipment, including the light fittings,
- * All cabling and wiring including conduits, racks, ducts, channels or any


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A Maharatna company

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
Bharat Heavy Electricals Limited

(A Government of India Undertaking with Maharatna status)

पारेषण व्यापार समूह, नई दिल्ली / TBG, New Delhi

वाणिज्यिक प्रबंधन / Commercial Management, 5TH Floor, Advant Navis IT Business Park,

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फोन/Phone-+91-120-6748567; 9650094437 email: mojahid@bhel.in

To,

Ref: TBCM/2317/BWD/SCPCOMP

Date : 18.04.2016

DGM

Power Grid Corporation of India Ltd.

± 500 kV, 2500MW HVDC Bhiwadi Project

Distt.Alwar (Rajasthan)

LOA No: C-46002-S656-1/CA-II/2317 dt.12/3/2007

Sub: On Shore supply contract for ± 500 KV, 2500MW HVDC Ballia Bhiwadi Bipole Terminal Package associated with Ballia - Bhiwadi Transmission System - : Issuance of scope completion of Lot items

Dear Sir,

This is regarding the balance payment of the lot items as mentioned in annexure-I of the above referred contract. BHEL have been awarded the contract on Turnkey Basis and we had completed the scope of these items. These items are also erected. So, we request you to issue the scope completion certificate so that the balance payment of these items can be claimed.

Thanking you.

Yours sincerely,

(Mojahid Hussain)
Sr. Engineer/TBCM

S.No.	Item No.	Item description	Unit	Qty
1	II/A/21.1	ACSR Lapwing conductor for DC Yard	Lot	1
2	II/A/21.2	ACSR Bersimis Conductor for AC Bus Bar and Main Converter Diameter	Lot	1
3	II/A/21.9	AC clamps and connectors for stringing and equipment	Lot	1
4	II/A/21.11	AC Bus Post Insulators 400 kV and MV	Lot	1
5	II.A.22.4	DG Set Erection Material comprising of exit piping complete with hardware, fuel piping from day tank to engine complete with hard ware and fitting, Thermal insulation of exit piping and silencer beyond flexible, one lot of structure.	Lot	1
6	II/A/26	Illumination System	Set	1
7	II/A/27	Fire Fighting System	Set	1
8	II/A/28	Power and Control Cables		
	II/A/28.1	Medium Voltage Power Cables	Lot	1
	II/A/28.2	LV Power Cable	Lot	1
	II/A/28.3	LV Control Cables	Lot	1
9	II/A/29	Air Conditioning and Ventilation System	Set	1
10	II/A/35.2	Valve Cooling System Accessories and water tanks	Set	2
11	II/A/36	Building Management System	Set	1
12	II/A/37	Station Grounding System	Set	1

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other media of cable runs and associated accessories / fixtures/ fasteners for emergency lighting system.

2.3. Power supply network

Maintenance power supply network shall comprise of:

- * The power outlets circuits and individual sockets of single phase 5A/15A (normal and UPS),
- * Fixed wall mounted sockets of single-phase 16/32A,
- * Fixed wall mounted sockets of three-phase 63A,
- * Multiple plugs of 16A, 32A, & 63A shall be of metal clad type.
- * Fixed wall mounted sockets of single-phase 24V, 32A for inspection lamps for leakage prone areas,
- * 24V AC supply panels having 415V/24V, 3-phase, 5.0 kVA transformer and required nos. of MCCBs.
- * Six (6), portable socket cubicles supplied from a network of sockets distributed throughout the various areas,
- * All cabling and wiring including conduits, racks, ducts, channels or any other media of cable runs and associated accessories / fixtures/ fasteners for power supply network.

2.4. Miscellaneous Items

- i) One (1) no. wheel mounted platforms with ladder for maintenance of overhead lighting system.
- ii) Inspection lamps as per the requirements specified.

3.0 Areas under scope of Illumination

Lighting and service power supply network shall cover areas of power house and the areas listed below:

- * Indoor lighting
 - Power House Block Area complete
 - Complete floors of Control Block Area
 - Switchyard Control room, DG Hall/Oil handling area/Pump room and other adjoining area (IN BHEL-TBG SCOPE)
 - Transformer cum Tail Race Gate Cavern.
 - Bus duct tunnel.


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- Drainage gallery Staircases, lift well, toilets, kitchens and other utility areas
- Cable and Ventilation Tunnel
- Main access tunnel.
- TBM Adit.
- Penstock Butterfly valve cavern
- Any other gallery /cavern
- Outdoor lighting
 - Walkways and at the entrance of access tunnels to the Power House Cavern
 - Surge shaft area/valve house and its approach road (Up to 500m)
 - Switchyard area (IN BHEL-TBG SCOPE)
 - Approach road to Switch yard (Up to take off point from main road)
 - Outlet area of Tail race tunnel including approach road (Up to 500m)

4. Design considerations

The entire lighting network of the power house shall be supplied from two different boards, each board supplying the half power house lighting.

4.1. Normal lighting:-

Normal lighting i.e, Normal AC Supply shall cover 100% lux level as per GTS and PTS.

Normal lighting in each functional area shall be divided in four circuits, each circuit providing one fourth of specified lux level. Control points shall be arranged to provide lighting of varying intensity.

Smart switches / sensors shall be installed in office/facility areas to turn off or on the lights depending upon occupancy for the purpose of power saving.

Provisions shall be made to get glare free uniform intensity of light in the area.

Supply to control room and critical areas shall be through UPS for interruption free lighting.


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4.2. Emergency lighting:-

In case of failure of normal supply, the emergency supply shall be fed from 2 x 50 kVA inverter which is further fed from DG set and DC Distribution board.

If the normal as well as the inverter supply fails, the dc emergency lighting (30 nos dc lighting fixtures of 200W GLS lamp) shall be switched ON. The dc lighting fixtures shall be automatically switched off on restoration of AC supply.

During running of DG sets, when normal supply is not available necessary provision in main lighting boards need to be made in order to cut lighting loads except emergency light loads, which will be again resumed after normal supply is restored. Contacts from DG sets shall be provided to LT switchboard panels.

4.3. Power supply

The illumination system for powerhouse complex shall be supplied from the powerhouse illumination boards, which shall be connected to station service board (SSB) as shown in single line diagram NH/DtM/KSG/LT/01 (Sheet 1 to 3).

Power outlet circuits for control room, office areas and individual sockets incorporated in cubicles and cabinets intended for electronic apparatus and computer sockets shall be supplied through UPS.

Single phase and three phase power outlets covering all areas shall be provided for maintenance power supply.

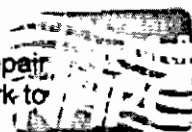
Control rooms, offices, facilities, utilities and all cabinets and cubicles shall be equipped with Power outlet circuits. These circuits shall comprise of :

- Sockets for normal power supply.
- Sockets for normal (UPS) power supply.

Each office rooms shall have at least 2 power sockets and all other areas shall atleast one socket for every 5 meter.

All rooms containing equipment requiring maintenance as well as all repair workshops shall be equipped with a maintenance power supply network to supply tools. This network shall comprise of:

- Fixed wall mounted sockets of single phase 16/32A.
- Fixed wall mounted sockets of 3-phase 63A.
- Portable socket cubicles supplied from network of sockets distributed throughout the various areas.



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All turbine and generator pit, machine shall and below floors, other leakage prone areas, drainage gallery shall be provided with fixed wall mounted sockets of single-phase 24V, 32A for inspection lamps. 24V AC supply panels as required having 415V/24V, 3-phase, 5.0kVA transformer and required nos of MCCBs shall be provided to feed the 24V power supply network.

4.3.1 Portable socket cubicles

Portable socket cubicles mounted on wheel trolleys with 10 m long Cable connected to the cubicle, and equipped with a male connector at the other end shall be provided to extend the maintenance power supply at required location by connecting these cubicles to fixed sockets, Cubicle shall include;

- * A protection circuit breaker,
- * An indicator light to show "On" and "Off" status,
- * The following sockets;
 - Two (2) nos. 63 A, 415 V five (5) pin socket,
 - Three (3) nos. 32 A, 240 V three (3) pin socket,
 - Three (3) nos. 32 A, 24 V two (2) pin socket.

4.4. Rating and Functional Characteristics

4.4.1. Service voltages

Normal lighting system		Three-phase, five wire, 415/240V, 50Hz
Emergency lighting system	1. AC Emergency	Three-phase, five wire, 415/240V, 50Hz
	2. DC Emergency	Two wire, 220 V DC
AC socket outlets single- phase		Single-phase, three pins, 240V, 50Hz
Power socket outlets three- phase		Three-phase, five pins,

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	415/240V, 50Hz I
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5.0. Lux levels, quality of direct glare limitation and Scheme of Illumination

The nominal illumination level for lighting, measured at the height of a worktable (0.9 m) shall have an average the following values:

Nature of area or activity	Lux levels	Quality class of direct glare limitation
Staircases	200 Lux	2
Stores, changeover rooms, wash rooms	200 Lux	1
Office area:		
Offices	500 lux	1
Conference room	500 lux	1
Data processing area	750 lux	1
Other Office areas	200 lux	1
Equipment areas:		
Power house machine hall, turbine pit, service bay area, transformer cum tail race gate cavern, electrical workshop, mechanical workshop, DG set room	300 lux	2
Generator barrel, high and low voltage switching installations in building, other floors & areas of power house	200 lux	2
Mechanical equipment areas	200 lux	2
Control room	500 lux	1

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Relay and telecommunication room	300 lux	2
Outdoor areas:		
Switchyard	200 lux	IN BHEL-TBG SCOPE
Entrance, exit and other areas	100 lux	-
Road and traffic areas	20 lux	-

Following types of luminaries and fittings are proposed to be installed at various indoor and outdoor locations. However, these shall be finalized during detailed engineering and the Contractor shall supply the fittings and luminaries as per the approved drawings.

Sl.no	Area	Fittings
1	Service Bay & Machine Hall	Metal Halide High Bay Lamp Fittings
2	Cable Spreading Area	Fluorescent type tube fittings
3	Control Room, Conference room, offices, Passage area close to control room and conference hall with false ceiling	Fluorescent type Decorative Fitting in false ceiling, Low wattage lamp(CFL)
4	1. Turbine Floor 2. Generator Floor 3. MIV Area 4. Compressor Room 5. Other Elevation Area 6. Pump galleries.	Fluorescent type tube fittings
5	1. AC Room 2. Test Lab 3. DC Distribution/LT Room/Battery Charger	Fluorescent type tube fittings
6	1. Generator Barrel (inside) 2. Turbine Pit	A Mixture of Fluorescent type tube & Bulbs
7	Transformer Cum Tail Race Gate Cavern	Metal Halide Lamp Fittings
8	DG Set room and Other area	Fluorescent twin tube fittings

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9	Battery rooms	Acid Fume Proof Fittings
10	Switch Yard	HPSV / Metal Halide Fittings
11	Other outdoor fitting on the approach roads etc	HPSV lamp Fittings
12	Emergency Lighting at all elevation of power house except control room	All lamp fitting
13	Emergency lighting in control room	Fitting suitable for false ceiling
14	1. Machine Hall. 2. Service bay 3. Transformer Cum tail race gate caven	Additional GLS Lamp fittings (Minimum 6nos. Or more of 500/1000W at each location suitably spaced)
15	Surge Shaft Area	HPSV / Metal Halide Fittings
16	1. Access Tunnel 2. Cable Cum Ventilation Tunnel 3. Bus Duct Tunnel 4. Drainage Gallery	Metal Halide Fittings

All the areas except control room, conference room, offices, engineers room and false ceiling areas if any, the fluorescent fixtures used shall be IP 65. Turbine pits, runner removal galleries and generator housings shall have water proof light fittings while DG set room(in TBG scope) and battery room shall have explosion proof light fittings.

6.0 Design and Construction

6.1. Standards

The system and equipment shall be designed, built, tested and installed to the latest revisions of the following applicable standards. In the event of other standards being, applicable they will be compared for specific requirement and specifically approved during detailed engineering for the purpose.

Standards		Description
IEC 60598		Luminaries
IEC 60309		Plugs, socket outlets and couplers for industrial requirements
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IEC 6665	Code of practice for industrial lighting
IS 10322	Specification for luminaires
IS 3646	Code of practice for interior illumination

7.0. Outdoor lighting/Road Lighting

Outdoor lighting and approach road shall be fed from outdoor lighting distribution board having photovoltaic cells or timer arrangement with manual control facility. These lighting boards shall be fed from MLDBs.

For approach road, lighting poles shall be used. For outdoor areas, Lighting masts shall be used. These poles shall be as per IS 2713. The lighting masts shall be designed for wind load as per IS 875.

Lighting poles shall be galvanised with suitable mounting arrangement of luminaires.

Buried cable used for lighting poles shall run in hume pipes/GI/steel pipes wherever it crosses the road.

Any cable laid directly either underground /overhead shall be armoured type and shall be earthed at one end.

8.0. Distribution boards

The boards shall be wall-mounted / panel type and shall be suitably located. The boards shall be made of sheet steel not less than 3mm thick and provided with front hinged cover for further enabling the board to be unscrewed for inspection of wiring in the boards.

Protection class for Indoor panels shall be IP 52 and for outdoor panels the same shall be IP 55.

Boards shall be waterproof and shall be provided with glands or adapters to receive a screwed conduit.

9.0. Switchboards

The switchboards shall be of heavy duty and modular type and shall be located 1.5meters above the floors. All the switches shall be of piono type and shall have silver cadmium contacts. Multiple plug sockets shall be capable of taking at least on 3-pin plug and one 2-pin plug simultaneously. Each type of power socket shall have elliptical spring loaded contacts.

10.0. Wires

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The wires shall be of at least 1100V grade, PVC insulated. All single core cables shall be of copper flexible conductor. Cables from lighting panels to switch boards and to light fixtures, single phase AC sockets shall be of copper flexible conductor. Minimum size of copper conductor for single core cable shall be 2.5 mm².

a) Lighting fixtures : 2nos 2.5 sq.mm Cu.

10.1. Wiring/Conduiting

It is proposed to carry out surface wiring for illumination circuits in equipment areas/floors. Concealed/recessed wiring shall be done in control room, offices, reception and any other area requiring aesthetic appeal below the false ceiling.

Conduits and/or wire ways shall be used for wiring between fixtures and control points. Separate conduits/wire ways shall be used for light, power and communication points.

Following minimum size of copper conductor wires shall be used.

- 2.5 sq.mm, 1100V grade, PVC insulated, single core, stranded copper conductor, for lighting fixtures (From lighting panels to Luminaires).
- 2.5 sq.mm, 1100V grade, PVC insulated, single core, stranded copper conductor, for 5/15A sockets.

For outdoor area lighting and approach road lighting, buried cable shall be PVC armoured cable of suitable size.

Wiring of lighting system shall be done as follows:

- Wiring installation shall be by multi-stranded, PVC insulated, color coded wires laid in G.I Conduits of 20mm/25mm Dia. min. size for all area.
- Conduits shall be of heavy duty type, hot dip galvanized steel conforming to IS 9537 or fibre glass reinforced epoxy conduits which have compressive and impact strength that of galvanized conduits. In corrosive areas galvanized conduits shall have additional suitable epoxy coating.

Wiring of AC normal and DC emergency services shall run in separate conduits.

Lighting and receptacles shall be fed from separate circuits. No two different phase circuits shall be run in the same conduit. However different circuits of same phase may be laid in the same conduit. Separate neutral

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shall run for all the three phases for luminaires and single phase socket connections.

Separate conduits/wire ways shall be used for lighting and power points.

11.0. Earthing

Earthing of lighting system shall be done by using following sizes:

- ii. 14 SWG GS wire for earthing of lighting fixtures, receptacles, conduits & switch boxes.
- iii. 8 SWG GS wire for earthing of junction boxes, lighting poles and mast.
- iii. 25 X 6 mm size galvanized MS flat for earthing of LDBs, OLDBs, DCLDBs
- iv. 50 X 6 mm size galvanized MS flat for earthing MLDBs

12.0. Installation

12.1. Fixture Installation

- i. Lighting fixture of appropriate type as per lighting layout drawings shall be installed. The type of mounting arrangement of fixtures shall be selected from the typical arrangement shown in the layout drawing. The exact mounting will be decided at site depending upon the actual space/other facilities available at site. The lighting fixtures shall be suspended directly from the circular JB on the main conduit run.
- ii. The flood lights shall be mounted on the steel base of structures/walls/columns/masts/poles. Fixing slots shall be provided to turn the fixture by about 5 degrees on both sides. Bolts shall be tightened with spring washer. Terminal connection to the floodlights shall be made through flexible conduits.
- iii. In the room where false ceiling are provided, the lighting fixtures shall be supported separately by false ceiling grid or roof over false ceiling and not by the ceiling boards.
- iv. All steel installation accessories shall be brushed up and shall be painted with red lead primer followed by two coats of aluminium paint.

12.2. Lighting Distribution Board/ Lighting Panels

Lighting Panels shall be mounted at the height of 1200mm from floor level unless otherwise specified on walls/columns/steel structures by fastening to suitably welded/grouted studs.
Main Lighting Distribution Board shall be floor mounted.

12.3 Conduit Installation



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- i. All accessories/fitting required for making the installation complete shall include Tees, elbows, pull boxes, saddles, spacers and required supporting steel works.
- ii. Exposed conduits shall run in straight lines parallel to building columns/beams and walls. Conduits shall be fixed by using metallic saddles/clamps secured to suitable nylon rawl plug with screw or secured to the building at an interval of 750mm for horizontal runs and 1000 mm for vertical runs.
- iii. In rooms with false ceiling, conduits shall be embedded in the wall below the false ceiling. Embedded conduits shall be securely fixed in position to preclude any movement.
- iv. All openings in the floor/wall/ceiling, etc made for conduit installation shall be sealed and made waterproof.
- v. For long conduit runs pull out boxes shall be provided at suitable intervals not exceeding 12m to facilitate wiring. However pull out boxes need not to be provided wherever junction box exists in circuit.
- vi. Conduits shall be securely terminated at lighting distribution boards, switch boxes, junction boxes, lighting fixture by proper fastening with a lock nut on inside and outside. The number of conduits terminating at lighting distribution board shall not exceed the permissible number considering the glanding area of lighting distribution board. Conduit termination shall be made water and vermin proof.
- vii. Conduits length shall be jointed by flushed couplers. Conduits joint and connections shall be thoroughly water-tight. Conduits shall be kept wherever possible at least 300mm away from hot pipes, heating device, etc.
- viii. All conduits installed outdoor shall be sloped towards pull boxes, hand holes/man holes for drainage. Low points of conduit not terminating in pull boxes, hand holes/man holes shall be provided with weep holes for drainage. Care shall be taken to see that no rough edge is left around the weep holes. Where no provision for drainage can be made, both ends of conduit shall be sealed after cable is laid through.
- ix. Where conduit terminates at lighting distribution boards, switch boxes, junction boxes and other enclosures, the designations shall be painted on the inside of the enclosures adjacent to the conduits.
- x. Size of conduits shall be selected considering the number of wires drawn in line with IS 732.



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12.4. Maintenance ladders and platforms

Wheel mounted platform with ladder for maintenance of overhead lighting system shall be of collapsible type of height suitable for maintenance of outdoor fixtures.

12.5. Inspection lamps

Inspection lamps as follows shall be provided for routine inspection/ maintenance purpose:

- * Twenty four (24) nos. portable plug in type inspection lamps for 240V with 5 meter cable and one power plug.
- * Twenty four (24) nos. portable plug in type inspection lamps for 24V with 5 meter cable and one power plug.
- * Twelve (12) nos. portable battery operated hand lamps.

13.0. Lighting Transformer

The transformers shall be impregnated cast resin dry type, natural air-cooled suitable mounting inside the cubicle. The core shall be made of cold rolled grain oriented sheet primary and secondary winding shall be separately cast as one solid coil. The core sheet be coated with resin as protection against corrosion. Factory test certificates for the transformer shall be as under:

Rating	:	To be decided during detailed engineering Stage.
Frequency	:	50 Hz
No of phases	:	Three
Voltage ratio	:	415 V / 415V
No.of windings	:	Two
Vector Group	:	YYO
Cooling	:	AN
Impedance	:	5%
Voltage tap	:	+5% to -5% of steps 2.5% each of primary
Earthing	:	Neutral shall be solidly earthed by 50x6 mm GI strip
Temp rise	:	As per IS:2026
Insulation class	:	1100 volts
Enclosure	:	Sheet metal enclosure



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14.0. Spare Parts

Recommended spare parts shall be supplied in accordance to clause 1.8 "Spare Parts" of "Section 1 - General Technical Requirements". Specified spare parts to be supplied under this section are as follows;

The following spare parts shall be furnished as per contract:

Sl. No	Description	Quantity
1	Multiple plug sockets suitable for	
	63A/ 32A/ 16A	5% of installed quantity
	15A /5A	5% of installed quantity
2	Multiple plug suitable for	
	63A/ 32A/ 16A	5% of installed quantity
	15A /5A	5% of installed quantity
3	Metal halide lamps complete with all accessories and fittings	5% of installed quantity
4	High pressure sodium vapor lamps complete with all accessories and fittings	5% of installed quantity
5	Fluorescent lamps with all accessories and fittings	20% installed quantity
6	DC lamp complete with accessories and fittings	20% installed quantity
7	Metal halide lamps and chokes	15% of installed quantity
8	HPSV lamps and chokes	15% of installed quantity
9	Low wattage lamps (24V)	20% of installed quantity
10	All type of switches, contactors, terminal blocks, screws	10% of installed quantity
11	All types of cable, wires	10% of installed quantity

15.0. Tools and Instruments

1 Set tool box containing cutters, pliers, screw drivers etc shall be supplied.

16.0. Special tools

No special tools are envisaged for Illumination package.



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SECTION - 3

PROJECT DETAILS AND GENERAL SPECIFICATIONS

3.0 INTRODUCTION

Kishanganga Hydroelectric project (3x110=330MW) is located in Baramulla district of Jammu and Kashmir state of India. As a part of the project, 220/33 kV Switchyard is being carried out.

3.1 PROJECT INFORMATION

SL. NO	DESCRIPTION	
a)	Customer	NATIONAL HYDRO ELECTRIC POWER CORPORATION LIMITED (NHPC) <u>KISHANGANGA CONSORTIUM:</u> Hindustan Construction Company (HCC) Ltd. HALCROW <u>Subcontractor: Bharat Heavy Electricals Ltd. (BHEL)</u>
b)	Project	220/33kV Switchyard for Kishanganga (3x110MW) HEP
c)	Project locations	Kishanganga Hydroelectric project(3x110=330MW) is located in Baramulla district of Jammu and Kashmir state of India. Refer Project Details from Contract Specification attached herewith.
d)	Nearest Airport	Srinagar is the nearest city, well connected by Air.
e)	Nearest Railway station /Gauge Distance from Railway Station	Jammu is the nearest broad guage railway head
f)	Road Approach	Refer Project Details from Contract Specification attached herewith.
	Transport Limit	Refer Project Details from Contract Specification attached herewith.

3.2 SITE CONDITIONS

SL. NO	DESCRIPTION	
i.	Altitude	About 1795 m above mean sea level.
ii.	Rainfall (Average annual rainfall)	Refer Project Details from Contract Specification attached herewith.
iii.	AMBIENT AIR TEMPERATURE (a) Max. temp (b) Min. temp	38 deg C -12 deg C
iv.	RELATIVE HUMIDITY (a) Maximum (b) Minimum	94% 62%

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Equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the above tropical conditions.

Seismic Design

The project is situated in a hilly seismic area and falls within Zone V of the seismic zoning Map of India. Value of horizontal component of peak ground acceleration for Maximum Credible Earthquake (MCE) and for Design basis Earthquake (DBE) shall be 0.36g and 0.18g respectively. The forces being caused by earthquake including hydraulic loads, which may occur additionally, shall be taken into account for the computations. Stresses resulting after including these loads shall not exceed permissible stresses.

The Contractor shall design all equipment supplied under this contract to satisfy the seismic criteria. The Contractor shall submit the method of calculation and relevant codes he intends to use for this purpose.

In addition to above, the IS 1893 shall be adopted for seismic design. Hydrodynamic forces due to seismic conditions shall be considered on HM or EM equipment in addition to hydro static loads.

3.2.1 Auxiliary Supply

Auxiliary electrical equipment pertaining to this project shall be suitable for operation at the following supply system.

Normal Voltage	Variation in Voltage	Frequency (Hz)	Phase/Wire	Neutral Connection
415 Volts	± 10%	50 ± 5%	3/4 wire	Grounded neutral
240 Volts	± 10%	50 ± 5%	½	effectively earthed
220 Volts	± 10%	DC	2 wire	Ungrounded, with earth fault detection
48 Volts	± 10%	DC	2 wire	Ungrounded, with earth fault detection

Combined variation of voltage and frequency shall be limited to ± 10%.

3.3 INSPECTION, TESTING AND INSPECTION CERTIFICATE

All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with relevant standards.

All tests and inspection of the equipment specified shall be performed to the extent and in the manner as stipulated in the relevant standards and in this specification. All type test/routine tests/acceptance tests as specified shall be conducted in the presence of BHEL/NHPC. Wherever equipment similar to the one being offered has already been type tested in an independent government laboratory or in the presence of representative of State Electricity Board or other reputed public undertakings, Type test reports of the same shall be submitted for approval of BHEL /NHPC.

If these are not found technically acceptable, contractor will have to carry out the type test without any extra cost and/ or delivery implications in presence of BHEL/NHPC.

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Where specified by the purchaser, type tests will have to be conducted by the sub-contractor on the equipment in the scope of supply. Such test shall be witnessed by the customer and BHEL, for which the test charges and delivery implications if any shall be indicated separately by the sub-contractor.

The contractor shall give the Owner/Inspector 3 week's written notice of any material being ready for inspection/testing. Such tests shall be to the Contractor's account except for the expenses' of the Inspector.

The purchaser NHPC/BHEL or their authorized representative shall have at all reasonable times free access to the contractor's works and shall have the power at all reasonable times to inspect the material and workmanship of the works during manufacturing or erection if part of the works is being manufactured or assembled at other premises. Inspection may be made at any stage of manufacture, dispatch or at site at the option of NHPC/BHEL and the equipment if found unsatisfactory due to bad workmanship or quality is liable to be rejected.

When the factory tests have been completed at the subcontractor's works the Owner/Inspector shall issue a certificate to this effect after completion of tests. But if the tests are not witnessed by the Owner/Inspector, the waiver shall be issued by the Owner/Inspector within fifteen (15) days of the receipt of the Contractor's test certificate. Failure of the Owner/Inspector to issue such a waiver shall not prevent the contractor from proceeding with the works. The completion of these tests or the issue of the waiver shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the Contract. However, in case of waivers, the contractor shall ensure to carry out the testing as per approved quality plans and specification requirements and send two copies of all the test results to the Owner for his review and approval.

In all cases where the Contract provides for tests at the premises or works of the contractor, the contractor, except where otherwise specified shall provide free of charge such items as labor materials, electricity, fuel; water, stores, apparatus and instruments as may be reasonably demanded by Owner/Inspector or his authorized representatives to carry out such tests.

The Inspection by Employer and issue of inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the contract.

The owner will have the right of having at his own expenses any other test(s) of reasonable nature carried out at contractor premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.

The Employer reserves the right for getting any field tests conducted on the completely assembled equipment at site.

3.4 QUALITY ASSURANCE PROGRAMME

The supplier should adopt suitable quality assurance programme to control all necessary activities to ensure that the equipment and / or services under the scope are in accordance with this specification. A quality plan detailing out the specific quality measure and procedures adopted for controlling the quality characteristics to be submitted for BHEL and NHPC approval.

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The quality programme is defined by ISO 9001, 1994 Quality systems - Model for quality assurance in design, development, production, installation and servicing.

3.5 DOCUMENTATION

The Contractor shall submit a detailed list of all drawings he proposes to submit for approval/information after the award of the contract. This list shall be revised and extended, as necessary, during the progress of work.

All drawings submitted by the Contractor shall be in sufficient detail to indicate the type, size, arrangement weight of each component, breakdown for packing and shipment, the external connections, fixing arrangements required, the dimensions required for installation and interconnections with other equipment and materials. clearances and spaces required between various portions of equipment and any other information specifically requested.

After the award of the Contract, the Contractor shall submit, (as per the Distribution Schedule enclosed at the end of this section as a Table) copies of design basis reports/concept notes, design calculations, material specifications and detailed drawings as called for in the Contract for the Owner's / Owner's Representative review. The Contractor must satisfy the Owner's / Owner's Representative as to the validity of his design with reference to the requirements of Statutory Codes / Authorities, local regulations and the contract specifications.

All dimensions on drawings shall be in Metric Units, unless otherwise specified. The details in the drawings shall be in English language only.

Drawings submitted by the Contractor will be checked/reviewed by the Owner/Engineer and comments, if any, on the same will be conveyed to the Contractor. It is the responsibility of the Contractor to incorporate correctly all the comments conveyed by the Owner/Engineer on the Contractor's drawings. The drawings which are approved with comments are to be resubmitted to the owner/Engineer for purpose of records. Such drawings will not be checked/reviewed by the Owner/Engineer to verify whether all the comments have been incorporated by the Contractor. If the Contractor is unable to incorporate certain comments in his drawings he shall clearly state in his forwarding letter such non-compliance along with valid reasons and justification.

The Contractor shall not be relieved of his obligations under the Contract if he has not included features in the specification, including but not limited to his Guarantee obligations stated herein, by incorporating the Owner's / Owner's Representative comments.

Any work performed or material ordered by the Contractor prior to receipt of drawings stamped 'Approved with comments as noted', by the Owner/Engineer Shall be at the risk of the Contractor. After print of any drawing has been returned 'Approved', the Contractor may release the parts covered by the drawing, for production.

Drawings prepared by the Contractor and approved by the Owner/Engineer shall be considered as a part of the Contract Specification. However, examination and approval of the drawings by the Owner/Engineer shall not relieve the Contractor of his responsibility for engineering, design, workmanship, materials and construction under the Contract.

If, at any time before the completion of the work, changes are made necessitating revision of approved drawings, the Contractor shall make such revisions and proceed in the same routine as for the original approval.

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3.5.1 OTHER REQUIREMENTS OF DOCUMENTATION

Upon completion of the installation, the Contractor shall furnish a complete set of drawings on reproducible tracing film on which the VENDOR/Contractor shall make in a neat and accurate manner, a complete record of all changes and revisions to, the original design, as installed in the completed work. These drawings shall be submitted to the Owner/Engineer.

AS BUILT DRAWINGS

The Contractor shall prepare and submit to the Owner/Engineer "As- Built drawings" of the Works, showing all Works as executed. The drawings shall be prepared as the Works proceed, and shall be submitted to owner/Engineer for his inspection. The Contractor shall obtain the consent of the Owner as to the drawing size, the referencing system and other pertinent details.

The drawings/documents distribution schedule shall be as indicated below.

The title block of drawings shall contain the following information incorporated in all contract drawings

CUSTOMER	National Hydroelectric Power Corporation Limited (NHPC)			
PROJECT	220/33kV Switchyard for Kishanganga (3x110MW) HEP <u>KISHANGANGA CONSORTIUM:</u> Hindustan Construction Company (HCC) Ltd. HALCROW <u>Subcontractor:</u> Bharat Heavy Electricals Ltd. (BHEL)			
BHEL P.O. No.		PROJ. DOC. No.		REV. No.
CONTRACTOR	BHARAT HEAVY ELECTRICALS LIMITED			
VENDOR'S STANDARD TITLE BLOCK				

DOCUMENTS TO BE SUBMITTED ALONGWITH OFFER

- 1) Drawings
- 2) Guaranteed Technical Particulars
- 3) Type Test Reports
- 4) Manufacturing Quality Plan

DOCUMENTATION SCHEDULE AT CONTRACT STAGE

A	For Approval
7 (6+1)	Copies of GA drawings with projects details, dimension, equipment weight, fixing details, tolerances and terminal details etc.
7 (6+1)	Copies of type test reports
7 (6+1)	Copies of shipping list detailing the description & quantities of all items being dispatched separately, with shipping weights, number of cases and dimensions.
7 (6+1)	Copies of manufacturing and field quality plan.
B	After Approval and For Information/Distribution.
11 (10+1)	Copies of All drawings plus 2 Set Reproducibles.
11 (10+1)	Bound sets containing all 'as built' drawings/manuals, type and routine test reports etc. along with sub-vendor's test reports for all bought out assemblies/components/parts including Internal wiring diagrams and exploded diagrams of assemblies/ parts, shall be furnished plus 2 Set IR

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11(10+1)	Copies of Installation, Operation & Maintenance manual.
11(10+1)	Sets of Spare parts catalogue.
5	Set of Computer CD-ROMs containing all 'as-built' drawings/documents.

All the technical documents and drawings required to be furnished under this contract as per specification shall be prepared in internationally accepted software of latest version used for preparation of documents and drawings.

All the drawings and documents shall be submitted in presentable folders properly bound and catalogued for easy retrieval / reference. Drawings shall be submitted in A0 / A2 / A3 and all documentation in A4 size. All drawings shall be digitally printed/ plotted. Ammonia print/ blue print shall not be accepted.

Time schedule of drawings/documents required at contract stage shall be furnished by the supplier.

Material shall not be dispatched without the approval of test certificates by purchasers.

3.6 MATERIALS AND WORKMANSHIP

3.6.1. GENERAL REQUIREMENTS

Where the specification does not contain characteristics with reference to workmanship, equipment materials and component of the covered Equipment, it is understood that the same must be new, of highest grade of the best quality of their kind, conforming to the best engineering practice and suitable for the purpose for which they are intended.

The equipment must be new, of highest grade, the best quality of their kind, to best engineering practice, latest state of art and in accordance with purpose for which they are intended and to ensure satisfactory performance throughout the service life.

In case where the equipment material or components are indicated in the specification as "similar" to any special standard, the employer shall decide upon the question of similarity. When required by the specification or required by the employer the supplier shall submit, for approval, all the information concerning the material or components supplied, installed or used. Without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Supplier.

The design of the work shall be such that Installation, future expansions, replacement and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements and shall be used throughout the design. All Joints and fastenings shall be devised, constructed and documented so that the component part shall be accurately positioned and retained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Employer.

Whenever possible, all similar part of the works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall be interchangeable with, and shall be made of the same material and workmanship as the corresponding parts of the equipment supplied under specification. Where feasible, common component units shall be

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employed in different pieces of the equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

All material and equipment shall be installed in strict accordance with the manufacturer's recommendation(s). Only first-class work in accordance with the best modern practice will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouping, leveling, aligning, coupling of or bolting down to previously installed equipment bases/ foundation, performing the alignment check and final adjusting prior to initial operation, testing and commissioning in accordance with the manufacturer's tolerances and instruction and the specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer's limits suitable guards shall be provided for the protection of personnel on all exposed rotating and/or moving machine parts and shall be designed for easy installation and removal for maintenance purpose. The spare equipment(s) shall be installed at designated location and tested for healthiness.

The Supplier shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment Lubricants used for installation purpose shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Supplier shall apply all operational lubricants to the equipment installed by him.

All oil, grease and other consumables used in the Works/Equipment shall be purchased in India unless the Supplier has any special requirement for the specific application of a type of oil or grease not available in India. If such is the case he shall declare in the proposal, where such oil or grease is available. He shall help Employer in establishing equivalent India make and Indian supplier. The same shall be applicable to other consumables too.

A cast iron or welded steel base plate shall be provided for all rotating equipments which are to be installed on a concrete base unless otherwise agreed to by the Employer. Each base plate shall support the units and its drive assembly, shall be of design with pads for anchoring the units and shall have a raised up all around and shall have threaded in air connections, If so required.

All components exposed to rain shall be designed with sloped upper surface to avoid water pools.

3.7 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

All power clamps and connectors shall confirm to IS:5561 & NEMA CCI and shall be made of materials listed below:

a	For connecting ACSR	Aluminium alloy casting conforming to designation A6 of IS:617 and shall be tested for all test as per IS:617
b	For connecting equipment terminals made of copper with ACSR conductors	Bimetallic connectors made from Aluminium alloy casting conforming to designation A6 of IS:617 with 2mm thick liner and shall be tested as per IS:617

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c	For connecting GI shield wire	Galvanised mild steel
d	I) Bolts, nuts & plain washer galvanised II) Spring washers for items 'a' to 'c'	i) Electro galvanisation for sizes below M12, for others hot dip Galvanised ii) Electro Galvanised mild steel suitable for at least service condition-3 as per IS: 1573

Each equipment shall be supplied with the necessary terminals and connectors, as required by the ultimate design for the particular installation. The conductor termination of equipment shall be suitable for Twin/ single Zebra/ Moose ACSR Conductor with 250 mm Sub-Conductor spacing. The requirement regarding external RIV as specified for any equipment shall include its terminal fittings and the equipment shall be factory tested with the connectors in position

Where copper to aluminium connections are required, bi-metallic clamps shall be used, which shall be properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress. The design details of the joint shall be furnished to the employer by the supplier.

Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified in each particular case, are also included in the scope of work.

No current carrying part of any clamp shall be less than 12 mm thick. All ferrous parts shall be hot dip galvanized. Copper alloy liner of minimum 2 mm thickness shall be cast integral with aluminium body for Bi-metallic clamps.

Lateral load deflection test shall be carried out as an acceptance test. The test procedure and accepted norms shall be mutually discussed and agreed to.

All casting shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified with respect to the specified reference ambient temperature shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

All current carrying parts shall be designed and manufactured to have minimum contact resistance.

Clamps and connectors shall be designed to be corona controlled. RIV level for 220 kV/ 132 kV system shall not be more than 1000 micro volts respectively at the specified test voltage as per IS/NEMA

3.7.1. TESTS

Clamps and connectors shall confirm to type tests and shall be subjected to routine tests as per IS:5561

3.7.2. HIGH VOLTAGE TERMINAL

The high voltage terminals shall be preferably made of aluminium or aluminium alloy. If copper terminals are used, they shall be tin-plated. The conductor termination of equipment shall be either expansion, sliding or rigid type suitable for ACSR Conductor./Aluminium tube.

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3.7.3. GROUND TERMINAL EARTHING

Positive earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of star of self etching washer. Earthing of hinged door shall be done by using a separate earth wire.

3.8 NAME PLATES, RATING PLATES AND LABELS

- a) Each main and auxiliary item of equipment is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved the following:

- i) Manufacturer's name
- ii) Type number
- iii) Serial number
- iv) Rated voltage
- v) Rated impulse withstand voltage
- vi) Rated power frequency withstand voltage
- vii) Rated frequency
- viii) Rated current
- ix) Rated short circuit breaking current
- x) Rated short time current (rms) & duration.

together with details of the loading conditions under which the item of substation in question has been designed to operate and such diagram plates as may be required by the Employer. The rating plate shall confirm to IEC requirement.

- b) All such name plates, instruction plates, rating plates etc. shall be in bilingual with Hindi inscription first followed by English. Alternatively, two separate plates one with Hindi & the other with English inscription may be provided.

3.9 PROVISIONS FOR EXPOSURE TO HOT AND HUMID CLIMATE

Outdoor and indoor equipment supplied shall be suitable for service and storage under tropical conditions of high & low temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mild dew.

3.9.1. SPACE HEATERS

The heater shall be suitable for continuous operation at 240 V AC supply voltage and shall be provided with on – off switch and fuse.

One or more adequately rated, thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heater shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heater to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

The heaters shall be suitably designed to prevent any contact between the heater wire and air and shall consist of coiled resistance wire centred in metal sheath and completely encased in a highly compacted powder of Magnesium Oxide or other material to prevent any contact between the wires. Alternatively, they shall consist of a resistance wire mounted into a tubular ceramic body built in to an envelop of stainless steel or the resistance wire is wound on a tubular ceramic body and embedded in vitreous glaze. The surface temperature of the heaters shall be restricted to a value, which will not shorten the life of the heater sheaths or that of

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insulated wire or other component in the compartments.

3.9.2. FUNGISTATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied to parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

3.9.3. VENTILATION OPENING

In order to ensure adequate ventilation, components shall have ventilation openings provided with fine wire mesh of brass or galvanized steel to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

3.9.4. DEGREE OF PROTECTION

The enclosures of the control cabinets, junction boxes and marshalling boxes to be installed shall provide degree of protection as detailed here under:

- a) Installed outdoor: IP-65
- b) Installed Indoor in air conditioned area: IP-40 or higher
- c) Installed in covered area: IP-52
- d) Installed indoor in non-air conditioned area where possibility of entry of water is limited: IP-41
- e) For LT Switchgear (AC & DC Distribution Boards): IP-52

The degree of protection shall be in accordance with IS: 13947(Part-1) or IEC-947 (Part-1). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

3.9.5. TROPICALISATION

All equipment shall be suitable for installation in a tropical monsoon area having hot, humid climate and dry and dusty seasons with ambient conditions as specified. All control wiring, equipment and accessories shall be protected against fungus growth, condensation, vermin and other harmful effects due to a tropical environment.

3.10 SURFACE TREATMENT, PAINTING AND FINISHING OF METAL SURFACES

3.10.1. GENERAL

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro-galvanized to service condition. All steel conductors including those used for earthing/grounding (above ground level shall also be galvanized according to IS:2629.

3.10.2. HOT DIP GALVANIZING

The minimum weight of the zinc coating shall be 610g/sq.m and minimum thickness of coating shall be 85 microns for all items thicker than 6mm. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM.

The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surfaces shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, plate which is

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loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

After galvanizing, no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IS-2633.

Sharp edges with radii less than 2.5mm shall be able to withstand four immersions of the standard preece test. All other coating shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.

- Coating
- Uniformity of zinc
- Adhesion test
- Mass of zinc

Galvanized material must be transported properly to ensure that galvanized surfaces are not damaged during transit Application of zinc rich paint at site shall not be allowed.

3.10.3. PAINTING

All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005 'code of practice for phosphating Iron and sheet'. All surfaces which will not be easily accessible after shop assembly, shall before hand to be treated and protected for the life of the equipment The surface which are to be finish painted after installation, shall be shop painted with atleast two coats of primer. Oil, grease, dirt and swart shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats or ready mixed, stoving type zinc chromate primer, the first coat may be flash dried, while the second coat shall be stoved.

After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

The exterior colour of the paint shall be as per shade No.:631 of IS-5 and inside shall be glossy white. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments.

In case the bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc. the procedure shall be submitted along with the bids for employer's review & approval.

3.11 CASTING

All castings shall be true to pattern, free from defects and of uniform quality and condition.

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The surface of castings, which do not undergo machining, shall be free from foundry irregularities. The casting shall be tested for NDT, chemical, mechanical and metallographical tests. This shall be specified in quality plan for the specific equipment. Iron casting material shall be in accordance with ASTM A 126 class B. Steel casting shall be manufactured in accordance with ASTM A 27 and shall be subject to appropriate tests and inspection.

3.12 FORGINGS

If requested by purchaser, forging shall be tested by magnetic particle, dye penetration, radiographic, ultrasonic or any combination of methods, which may suit material type and forging design. The testing is to be carried out according to appropriate ASTM standards. The forging shall be tested for mechanical and metallographical tests as per ASTM.

3.13 FABRICATED COMPONENTS

All components machined or fabricated from plate, sheet or bar stock shall meet the material requirements of ASTM. Structural steel, rolled shapes, bars etc. shall comply with the latest ASTM for A36.

All or a representative number of such components shall be subjected to one or more of the tests: visual, dye penetration, magnetic particle (transverse and longitudinal), ultrasonic or radiograph. These tests shall be in accordance with the ASTM. The acceptance shall be as per ASTM Specifications.

3.14 CONTROL CABINETS, JUNCTION BOXES, TERMINALS BOXES AND MARSHALLING BOXES FOR OUTDOOR EQUIPMENTS

Unless otherwise specifically called for or described in these Contract documents all electrical appliances shall conform to the applicable IEC Publications.

The cubicles and enclosures shall be of protection class IP 40 or higher according to their location. For outside installation and area which are humid, corrosive, and prone to dripping and/ or spray of water, the protection class of cubicles shall be IP 65. Cubicles housing electronic cards/modules such as of unit control boards/local control boards, digital governors, static excitation equipment shall be of protection class of IP 5X.

Cables shall have at least 1000 V PVC insulation except for 220V DC and tele-metering or communication system equipment for which 650V and 300 V ratings respectively are acceptable.

For current and potential transformer secondary circuits the minimum cross section of the conductors shall not be less than 4.0 mm².

Wiring shall terminate at terminal blocks at one side only. Where tap connections are required, they shall be made on terminal blocks. Wiring shall be neatly arranged and laid in wire ways accessible from the front door. The wire ways shall not be filled more than 70 %.

Each cubical shall be provided with an earthing bar (PE) of sufficient cross section carrying any possible fault current without undue heating. All metallic parts of the cubicle not forming part of the live circuits, all instrument transformer terminals to be earthed and other earthing terminals as well as all cable screens and PE-wires shall be connected to the earthing bar.

All internal equipment and wiring shall be neatly and clearly marked as indicated on the schematic and wiring diagrams. Internal wiring and cables shall be marked with sleeve type

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engraved marking. Marking system and marking material shall be subject to approval by Employer. Identification of the respective conductors shall be in accordance with the requirements of IEC publication 60204. In cable, having five conductors or more the individual conductors shall be numbered throughout the entire length. In cables having less than five conductors colour coding in accordance with IEC Recommendations 60204 shall be used.

Cubicles and control panel enclosures shall be of cold rolled sheet steel with minimum thickness for load bearing members as 2.5mm and non load bearing as 2 mm, of rigid, self-supporting construction and supplied with channel bases made to ensure no bulging takes place.

Cubicles shall be fitted with close fitting, gasketed, hinged, lift-off doors capable of being opened through 180 deg. The doors shall be provided with integral lock and master key.

Cubicles and panels shall be vermin proof. Removable gland plates shall be supplied and located to provide adequate working clearance for the termination of cables. Under no circumstances shall the floor/roof plate be used as a gland plate. The cables and wiring shall enter from bottom or top as approved or directed by the Engineer.

The cubicles and panels shall be adequately ventilated, if required, by vents or louvers, and shall be so placed as not to detract from the appearance. All ventilating openings shall be provided with corrosion-resistant metal screens or a suitable filter to prevent entrance of insects or vermin. Space heating elements with thermostatic control shall be included in each panel.

Where cubicles are split between panels for shipping, terminal blocks shall be provided on each side of the split with all necessary cable extensions across the splits. These cable extensions shall be confined within the panels with suitable internal cable ducts.

Unless stated otherwise, all cubicles and panels shall be provided with a ground bus with 40mm copper bar extending through out the length. Each end of this bus shall be drilled and provided with lugs for connecting ground cables ranging from 70 to 120mm².

The standard phase arrangement when facing the front of the motor control centres and switchboard shall be RYB from left to right, from top to bottom and front to back. All instruments, devices, buses and other equipments involving 3 phase circuits shall be arranged and connected in accordance with the standard phase arrangement, where possible. Electrical clearances shall conform to applicable standards and shall not require cutting away of adjacent framework.

All instruments, control knobs and indicating lamps shall be flush mounted on the panels. Relays and other devices sensitive to vibration shall not be installed on doors or hinged panels, and no equipment shall be installed on rear access doors.

The instrument and control wiring, including all electrical interlocks and all interconnecting wiring between sections, shall be completely installed and connected to terminal blocks by the manufacturer.

The arrangement of control and protection devices on the panels and the exterior finish of the panels shall be subject to the approval of the Engineer. The interior of all cubicles and panels

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shall have a mat white finish unless specified otherwise.

Switched interior light and socket outlets shall be provided for all cubicles and control panels.

All cubicles and control panels shall be provided with lamacoid nameplates, identifying the purpose of the panel and all of its components.

Control switches, indicating lamps and instruments

Measuring converters

The converters shall be suitable for direct connection to the secondary circuits of the potential and current transformers used, or other sensors, each as they apply. The converters shall be static type, having all accessories to provide an output signal of 4-20 mA, filtered DC.

For the measuring converters the following minimum requirements shall be fulfilled:

Current transducers shall be single-phase, of accuracy class 0.5 or better.

Voltage transducers shall be single-phase of accuracy class 0.5 or better.

W and VAr transducers shall be two elements, three-phase. Accuracy class of the transducers shall be 0.5 or better.

Measuring transformers

Potential transformer secondary windings shall be rated $110/\sqrt{3}$ V

Current transformer secondary windings shall have a rated current of 1A/2.5A /5A.

3.14.1. EARTHING:

Positive earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of star of self etching washer. Earthing of hinged door shall be done by using a separate earth wire.

3.14.2. TESTS

a) The marshalling kiosks shall be subject to routine tests as per IS:5039

b) The following routine tests shall also be conducted:

- I) Check for wiring
- II) Visual and dimension check

Marshalling kiosks shall be provided with danger plate and a diagram showing the numbering /connection / ferruling by pasting the same on the inside of the door.

3.15 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS:

Bushings shall be manufactured and tested in accordance with IS: 2099 & IEC: 137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5621. The support insulators shall be manufactured and tested as per IS 2544/IEC 168 and IEC 273. The insulators shall also conform to IEC 815 as applicable.

Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar

	PROJECT: 3X110 MW KISHANGANGA HEP, CUSTOMER: NHPC LIMITED TITLE: TECHNICAL SPECIFICATION OF SWITCHYARD ILLUMINATION SYSTEM	DOC NO. TB 329 316 028 REV: 00
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30

other defects.

Supports insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.

Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

All iron parts shall be hot dip galvanized and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

3.16 SEISMIC WITHSTAND TEST PROCEDURE

The seismic withstand test on complete equipment shall be carried out along with the supporting structure. The Supplier shall arrange to transport the structure from the structure supplier's works/ project site or alternatively arrange the structure as per approved drawings for the purpose of seismic withstand test only.

The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the terminal pads of the equipment and any other point as agreed by BHEL / customer. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of BHEL / customer.

3.17 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering / brazing material for all copper piping of circuit breakers and essential chemicals etc which will be required to put the equipment covered under the scope of the specifications, into successful operations, shall be furnished by the contractor unless specifically excluded under the exclusions in these specifications and documents.

3.18 PACKING AND SHIPPING

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken account.

The Contractor shall mark all containers with the implementing document number pertinent to the shipment. Each shipping container shall also be clearly marked on at least two sides as follows:

- ◆ Consignee : to be furnished at a later date
- Contract No. :

	PROJECT: 3X110 MW KISHANGANGA HEP, CUSTOMER: NHPC LIMITED TITLE: TECHNICAL SPECIFICATION OF SWITCHYARD ILLUMINATION SYSTEM	DOC NO. TB 329 316 028 REV: 00
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- Country of Origin :
- Port of entry :
- Item number (if applicable) :
- Package number, in sequence :
- and quantity per package :
- Description of Works :
- Net and gross weight, volume :

The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to Improper packing. Employer takes no responsibility of the wagons.

-- X X --

(33)

Section - 4



KISHANGANGA H.E PROJECT

Volume 3C (TDS)

20 ILLUMINATION SYSTEM

20.1 Guaranteed Technical Particulars

Item / Clause No.	Parameter	Units	Contractor's Data
1	Type / designation		
2	Lux levels		
2.1	General areas		
	- Store	Lux	
	- Washrooms and toilets	Lux	
	- Staircases	Lux	
2.2	Office areas		
	- Offices	Lux	
	- Conference room	Lux	
	- Reception lobby, model room	Lux	
2.3	Equipment areas		
	- Power house machine hall		
	- MIV floor, Turbine floor, generator floor	Lux	
	- Turbine pit, runner removal gallery	Lux	
	- Switchyard area	Lux	
	- Transformer hall	Lux	
	- Service bay area	Lux	
	- Generator barrel	Lux	
	- Mechanical equipment areas	Lux	
	- Butterfly Valve House area	Lux	
	- Control room	Lux	
	- High and low voltage switching installation in building	Lux	
	- E&M workshop area	Lux	
	- DG set area	Lux	
2.4	Emergency lighting, all areas	Lux	
2.5	Out door areas		
	- Tail Race area	Lux	
	- Switchyard	Lux	
	- Entrance, exit and other areas	Lux	
	- Road and traffic areas	Lux	
3	Illumination panels		
3.1	Minimum number of panels	Nos.	
3.2	Rating of bus bar	A	
3.3	Minimum number of outgoing feeders	Nos.	
3.4	Rating of feeder	A	
3.5	Protection class	IP	
4	Circuit breakers/fused load breaker switches		

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20 ILLUMINATION SYSTEM

20.1 Guaranteed Technical Particulars

Item / Clause No.	Parameter	Units	Contractor's Data
4.1	Type / designation		
4.2	Design voltage	V	
4.3	Protection class	IP	
4.4	Rated short circuit making current	kA _{peak}	
4.5	Rated symmetrical short circuit breaking current	kA _{rms}	



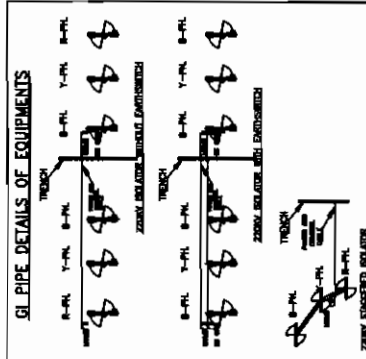
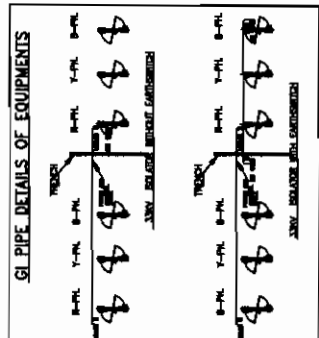
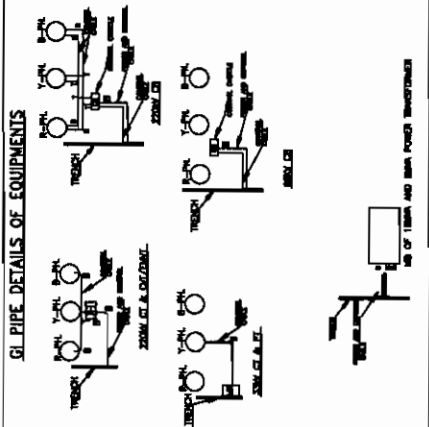
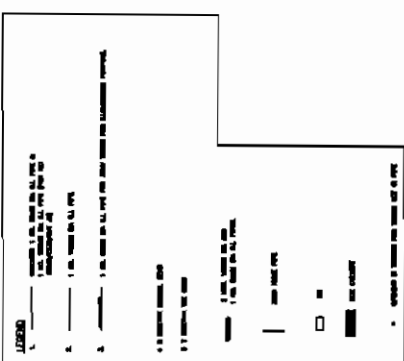
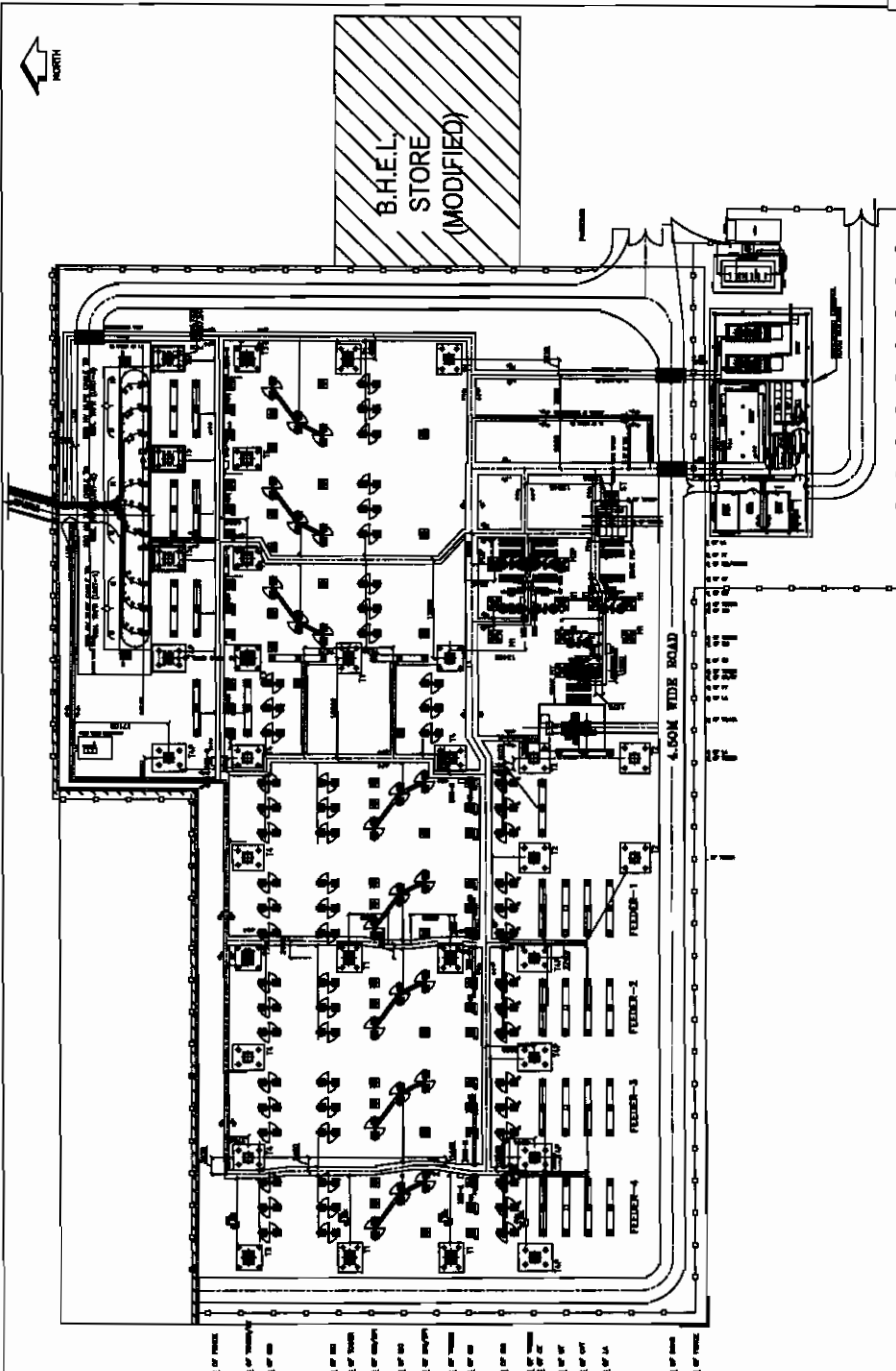
PROJECT: 3X110 MW KISHANGANGA HEP,
CUSTOMER: NHPC LIMITED
TITLE: TECHNICAL SPECIFICATION OF SWITCHYARD
ILLUMINATION SYSTEM

DOC NO.
TB 329 316 028
REV: 00

SECTION 5

ENCLOSURES TO SPECIFICATIONS

- ANNEXURE 1 NO DEVIATION CERTIFICATE (1SHEET): ATTACHED WITH SECTION-1
- ANNEXURE 2 QUALITY ASSURANCE PLAN (MODEL) FOR ILLUMINATION SYSTEM (PAGE NOS. 835 to 842: 8 SHEETS)
- ANNEXURE-3: BILL OF QUANTITY (2 SHEETS) (INCLUDED IN SECTION-1)
- ANNEXURE-4: LIST OF DRAWINGS OF SECTION-2 (10 sheets)



1. ALL INDICATIONS ARE IN MILLIMETERS UNLESS SPECIFIED.
2. REFERENCE IS MADE TO THE CABLE AND CONTROL CABLES.
3. QUANTITY AND LOCATION OF CABLE SHALL BE AS PER ACTUAL SITE REQUIREMENT.
4. CHANGES OF TRENCHES AND ROUTES SHALL BE DONE THROUGH THE PIPES / CABLES.
5. ALL CABLES SHALL BE Laid IN-1200 AND BURIED IN THE GROUND AT A DEPTH OF 100MM BELOW FROM GROUND LEVEL. THE SIZE OF THE CABLE SHALL BE AS PER THE REQUIREMENT.
6. CONTROL CABLES SHALL BE Laid IN MULTIPLE OF CABLE TRAYS.
7. ONE NO. 1200mm TRAY FOR EACH CABLE SHALL BE PROVIDED ON THE SIDE OF THE TRENCH BARRIERS FOR THE TRENCH CABLE TO THE EQUIPMENT LINE CIRCUIT.
8. EQUIPMENT POWER CABLES TO BE Laid ON THE TOP TRENCH AND CONTROL AND INTERCOMPARISON CABLES BOTTOM TRENCH.
9. AFTER LAYING THE CABLES THE TOP OF THE PIPES SHALL BE FULLY SOILED TO PREVENT WATER FROM ENTERING THE PIPES.
10. THE PLACEMENT OF TRENCH LAYOUT SHOWN IN THE LAYOUT AS FOLLOWS:
 - FOR TRENCH LAYOUT
 - FOR TRENCH LAYOUT
 - FOR TRENCH LAYOUT
11. CABLES SHALL BE ROUTED THROUGH SHORTEST ROUTE AS POSSIBLE.
12. RAMP AND DRAINAGE SHALL BE DONE IN SEPARATE CABLE CHANNEL.
13. CABLE TRAY AND CABLE SUPPORT SHALL BE LOCATED TYPE/CLAMP TYPE.
14. BURIED CABLES (IF ANY) FOR LAYING PURPOSE SHALL BE AS PER LAYING LAYOUT.
15. DESIGN OF TRENCH, FOUNDATIONS AND RATES SHALL BE SUBMITTED IN SEPARATE DRAWING.
16. BURIED CABLES SHALL BE Laid IN MULTIPLE OF CABLE TRAYS.
17. TRENCH SHALL BE Laid IN MULTIPLE OF CABLE TRAYS.
18. LOCATION OF CABLE TRENCHES MARKED IN THIS DRAWING MAY BE SLIGHTLY MODIFIED TO SUIT THE SITE CONDITIONS.
19. CABLE SUPPORT SHALL BE PROVIDED AT EVERY 1.0M INTERVAL.
20. FOR POWER AND CONTROL CABLES, SEPARATE PIPES SHALL BE USED CONTINUOUSLY AND NOT FOR EACH PIPE 1.0M AND FILLING INTERVAL.
21. MULTIPLE CABLES (M/C) SHALL BE PLACED IN THE TRENCH BARRIERS. EXISTING CABLES TO BE REMOVED (REMOVED) AT SITE.
22. CRUISE FOR TRENCH CUT IS PIPES TO EQUIPMENT SHALL BE PROVIDED IN CABLE TRENCHES. OPERATOR OF SITE IDENTIFICATION SHALL BE PROVIDED BELOW FOR CABLE SUPPORT.
23. ALL TRENCHES SHALL BE FULLY COVERED IN CABLE TRENCH SHALL BE COVERED PROOF GATES.
24. ANYTHING STOP IN THE TRENCH SHALL BE CONNECTED TO GROUND WIRE AT AN INTERVAL OF 500M.
25. FOR CABLE TRENCH BARRIERS, REINFORCEMENT SHALL BE PROVIDED IN CABLE TRAYS.
26. ALL OTHER DETAILS PERTAINING TO CABLE TRAYS SHALL BE REFLECTED IN THE SEPARATE CABLE DRAWING.
27. TRENCHES SHALL BE CONTROL ROOM ARE TRENCHES AND TRENCHES WITH ARCHITECTURAL DRAWINGS.
28. THE DESIGN OF PLANS OF CONTROL ROOM IS SHALL BE DONE ABOVE GROUND LEVEL.
29. MULTIPLE CABLES SHALL BE DONE ABOVE GROUND LEVEL OF EXISTING TRENCH WALL HEIGHT NOT MORE THAN 100MM.

N H P C LIMITED	
KSHANANGA CONSORTIUM	
KSHANANGA HYDROELECTRIC PROJECT	
220 KV SWITCHYARD - LAYOUT OF TRENCH ROAD, FENCE, FOUNDATIONS & GATES	
PROJECT NO.	KSG-PYD/10004
DATE	10/1-27/00
SCALE	1:100
DESIGNER	TRASHA-10/04
CHECKED BY	
APPROVED BY	
DATE	

MINI FIRING DETAIL ON TRENCH

Trench Type TR-4
SECTION 4-4

Trench Type TR-1
SECTION 1-1

TYPICAL FLOOR ARRANGEMENT OF CABLE BACK ASSEMBLY FOR 11KV CABLES, POWER AND CONTROL CABLES IN CABLE TUNNEL FROM SWITCHYARD TO CVT PORTAL (TO BE PROVIDED AT 200MM CENTER TO CENTER)

DETAIL LHS & RHS

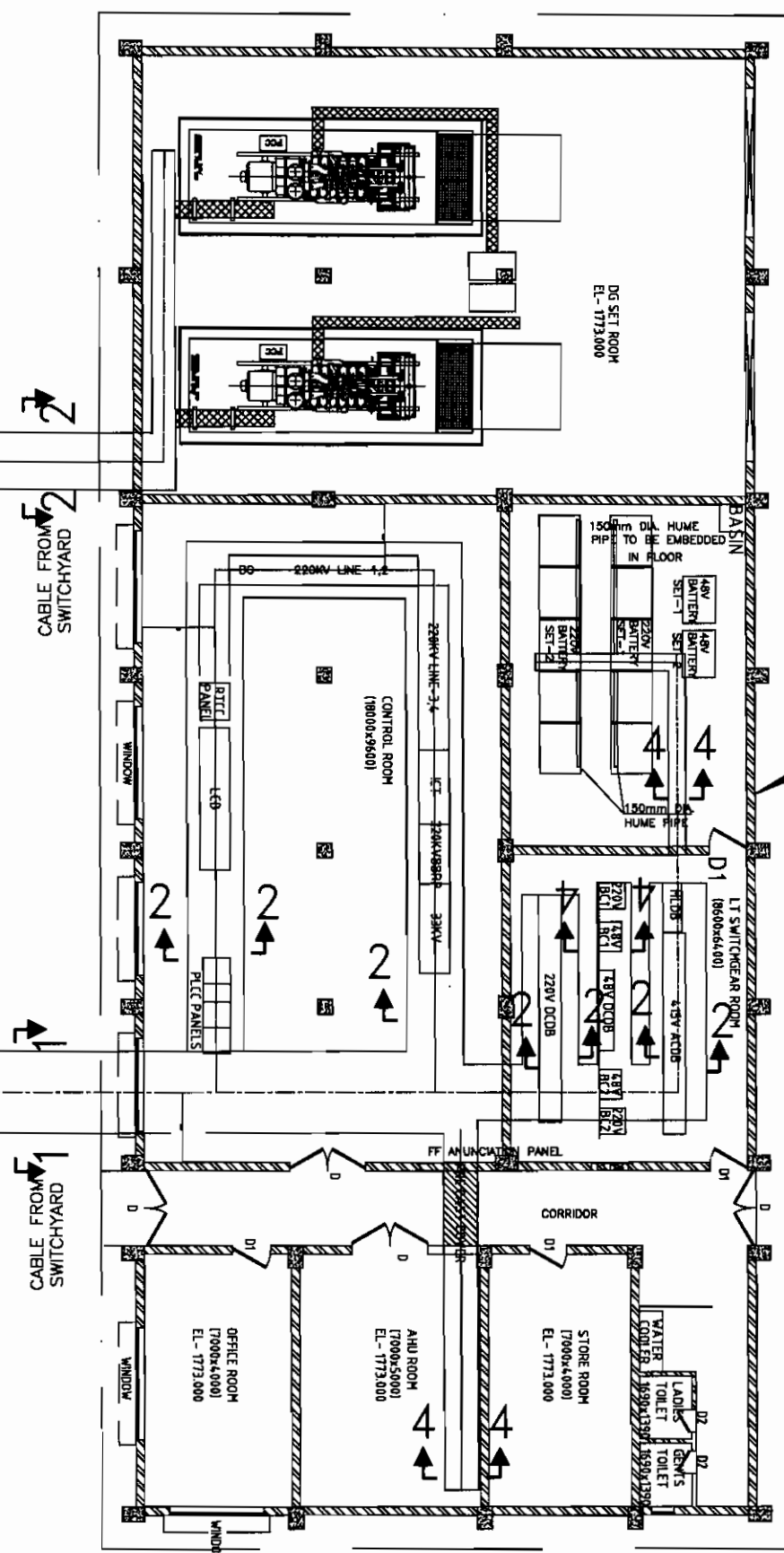
16 PAGES
DETAIL SHOWING ROUTING OF
CABLE INSIDE OF PIPE, FROM
CABLE TRENCH TO EQUIPMENT
ROOM BOX / JB

Trench Type TR-2
SECTION 2-2

Trench Type TR-3
SECTION 3-3

[illegible][illegible]

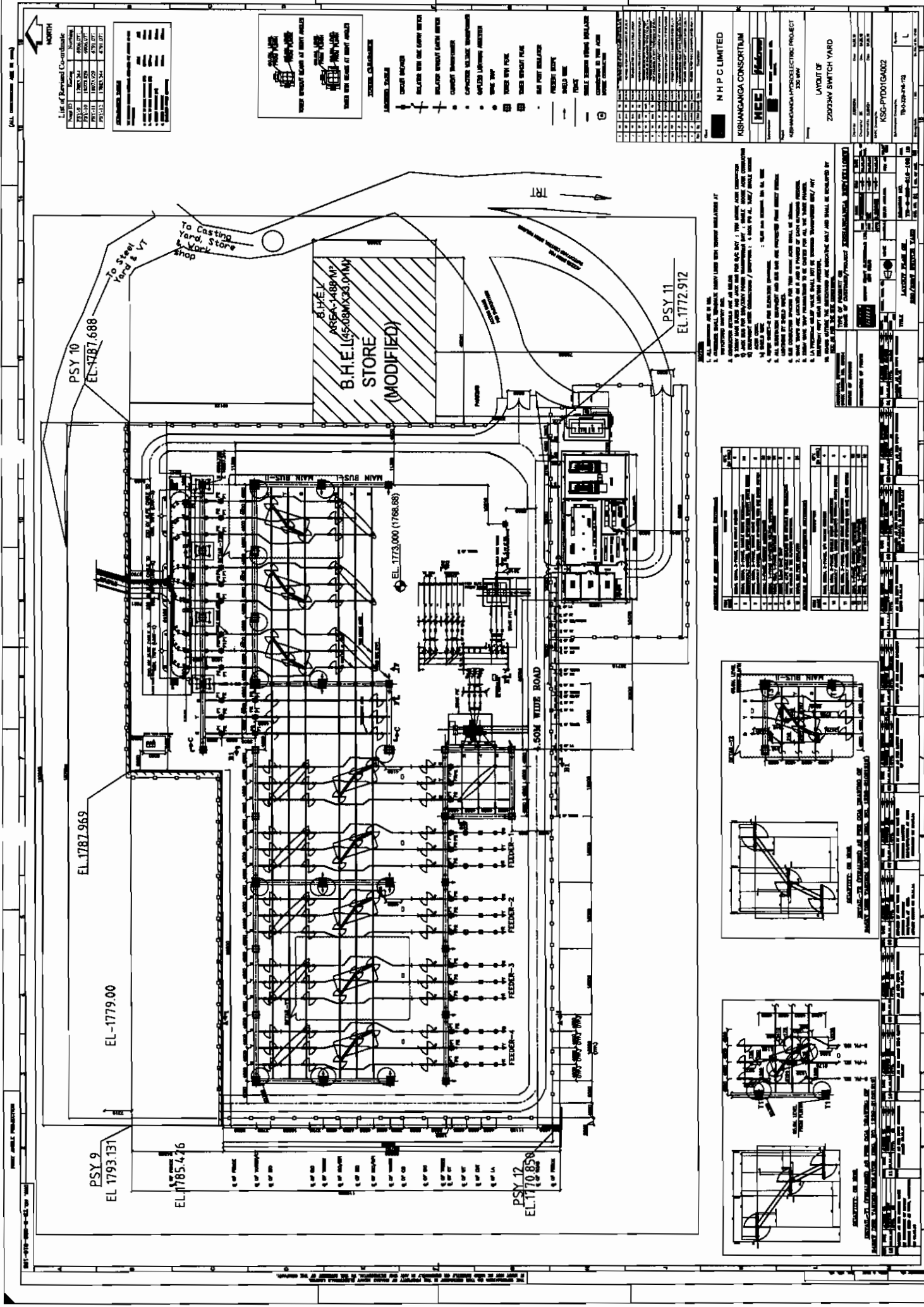
DATE	TIME	LOCATION	WIND DIRECTION	WIND SPEED	WAVE HEIGHT	SEA STATE	WATER TEMPERATURE	AIR TEMPERATURE	RELATIVE HUMIDITY	VISIBILITY	BAROMETRIC PRESSURE	REMARKS
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10/10/2010	09:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW
10/10/2010	10:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW
10/10/2010	11:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW
10/10/2010	12:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW
10/10/2010	13:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW
10/10/2010	14:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW
10/10/2010	15:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW
10/10/2010	16:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW
10/10/2010	17:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW
10/10/2010	18:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW
10/10/2010	19:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW
10/10/2010	20:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW
10/10/2010	21:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW
10/10/2010	22:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW
10/10/2010	23:00	SEAVIEW	090	10	1.5	3	18	22	85	10	1010	SEAVIEW



SWITCHYARD CONTROL
ROOM BUILDING

ENLARGED VIEW OF CABLE TRENCH IN SWITCHYARD CONTROLROOM BUILDING

[illegible]

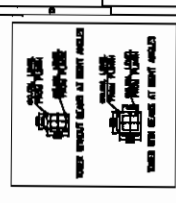


List of Proposed Coordinates

Point	N	E	U
PSY-10	17887.84	1779.00	0.00
PSY-11	17879.29	1779.00	0.00
PSY-12	17879.29	1779.00	0.00
PSY-13	17879.29	1779.00	0.00

Legend

Symbol	Description
[Symbol]	1. 11KV BUSBAR
[Symbol]	2. 11KV C.B.
[Symbol]	3. 11KV M.C.B.
[Symbol]	4. 11KV FUSE
[Symbol]	5. 11KV DISCONNECT
[Symbol]	6. 11KV SWITCH
[Symbol]	7. 11KV BREAKER
[Symbol]	8. 11KV CIRCUIT BREAKER
[Symbol]	9. 11KV FUSE CUT-OUT
[Symbol]	10. 11KV FUSE LINK
[Symbol]	11. 11KV FUSE BOX
[Symbol]	12. 11KV FUSE MOUNTING
[Symbol]	13. 11KV FUSE SUPPORT
[Symbol]	14. 11KV FUSE BRACKET
[Symbol]	15. 11KV FUSE CLAMP
[Symbol]	16. 11KV FUSE WIRE
[Symbol]	17. 11KV FUSE TERMINAL
[Symbol]	18. 11KV FUSE JUNCTION
[Symbol]	19. 11KV FUSE CONNECTION
[Symbol]	20. 11KV FUSE ISOLATION



- Legend
- 1. 11KV BUSBAR
 - 2. 11KV C.B.
 - 3. 11KV M.C.B.
 - 4. 11KV FUSE
 - 5. 11KV DISCONNECT
 - 6. 11KV SWITCH
 - 7. 11KV BREAKER
 - 8. 11KV CIRCUIT BREAKER
 - 9. 11KV FUSE CUT-OUT
 - 10. 11KV FUSE LINK
 - 11. 11KV FUSE BOX
 - 12. 11KV FUSE MOUNTING
 - 13. 11KV FUSE SUPPORT
 - 14. 11KV FUSE BRACKET
 - 15. 11KV FUSE CLAMP
 - 16. 11KV FUSE WIRE
 - 17. 11KV FUSE TERMINAL
 - 18. 11KV FUSE JUNCTION
 - 19. 11KV FUSE CONNECTION
 - 20. 11KV FUSE ISOLATION

Legend

Symbol	Description
[Symbol]	1. 11KV BUSBAR
[Symbol]	2. 11KV C.B.
[Symbol]	3. 11KV M.C.B.
[Symbol]	4. 11KV FUSE
[Symbol]	5. 11KV DISCONNECT
[Symbol]	6. 11KV SWITCH
[Symbol]	7. 11KV BREAKER
[Symbol]	8. 11KV CIRCUIT BREAKER
[Symbol]	9. 11KV FUSE CUT-OUT
[Symbol]	10. 11KV FUSE LINK
[Symbol]	11. 11KV FUSE BOX
[Symbol]	12. 11KV FUSE MOUNTING
[Symbol]	13. 11KV FUSE SUPPORT
[Symbol]	14. 11KV FUSE BRACKET
[Symbol]	15. 11KV FUSE CLAMP
[Symbol]	16. 11KV FUSE WIRE
[Symbol]	17. 11KV FUSE TERMINAL
[Symbol]	18. 11KV FUSE JUNCTION
[Symbol]	19. 11KV FUSE CONNECTION
[Symbol]	20. 11KV FUSE ISOLATION

Project Information

N H P C LIMITED

KISHANGANGA CONSORTIUM

MEC

MECHANICAL ENGINEERING PROJECT

2003/2004 SWITCH YARD

PSY-10

EL. 1787.688

PSY-11

EL. 1772.912

PSY-12

EL. 1785.476

PSY-13

EL. 1779.00

PSY-14

EL. 1787.969

PSY-15

EL. 1787.969

PSY-16

EL. 1787.969

PSY-17

EL. 1787.969

PSY-18

EL. 1787.969

PSY-19

EL. 1787.969

PSY-20

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PSY-21

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PSY-22

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PSY-23

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PSY-24

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PSY-26

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PSY-40

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PSY-41

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PSY-42

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PSY-46

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PSY-82

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PSY-83

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PSY-85

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PSY-86

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PSY-88

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PSY-89

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PSY-90

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PSY-91

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PSY-92

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PSY-93

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PSY-94

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PSY-95

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PSY-96

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PSY-97

EL. 1787.969

PSY-98

EL. 1787.969

PSY-99

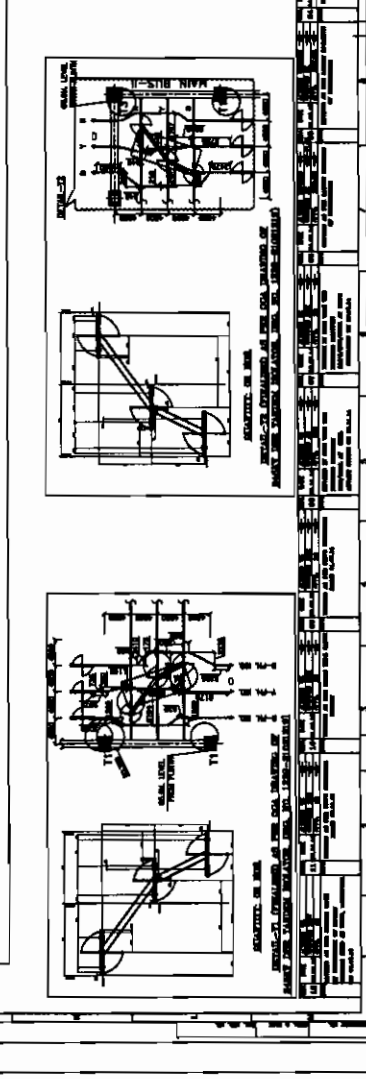
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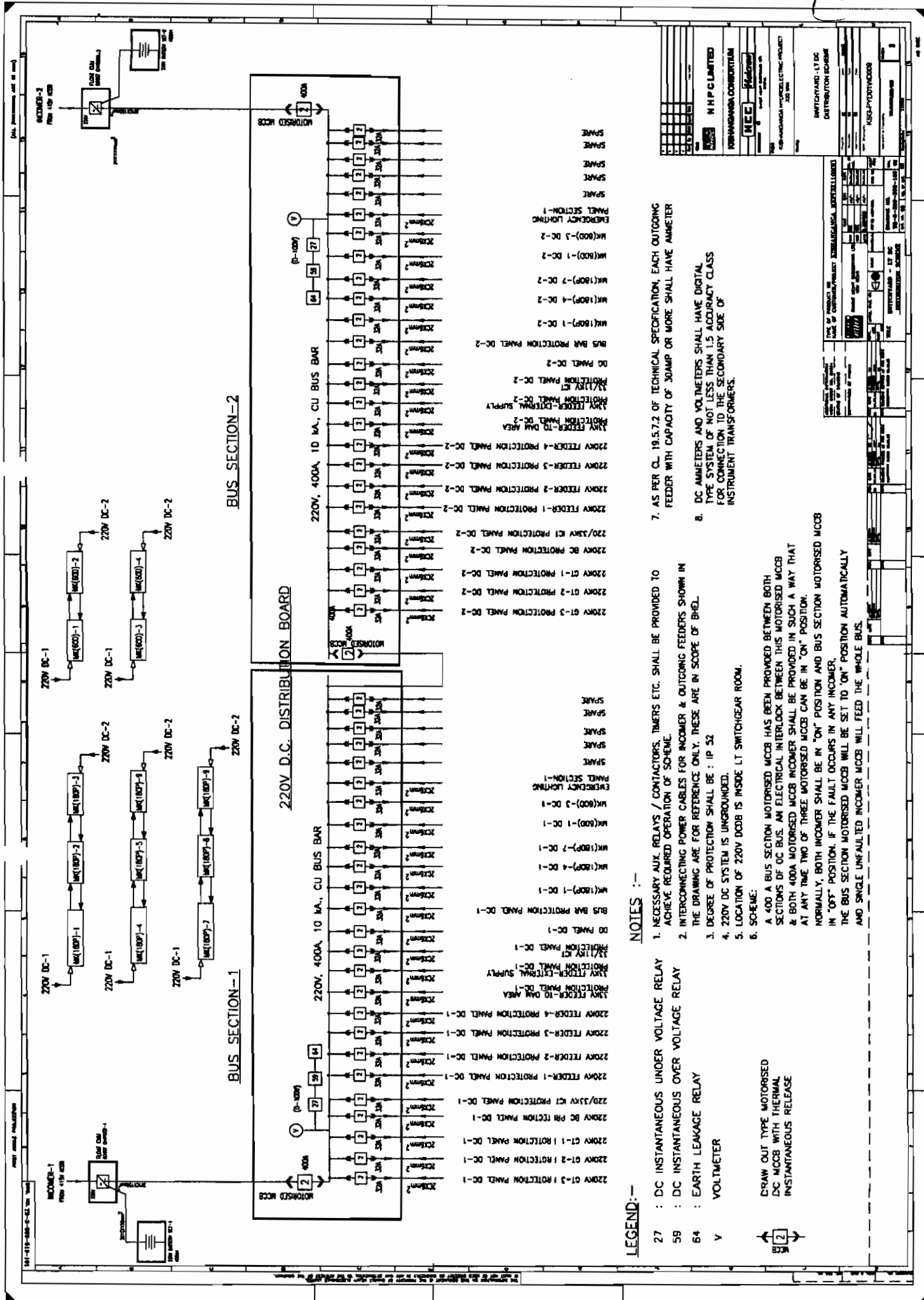
PSY-100

EL. 1787.969

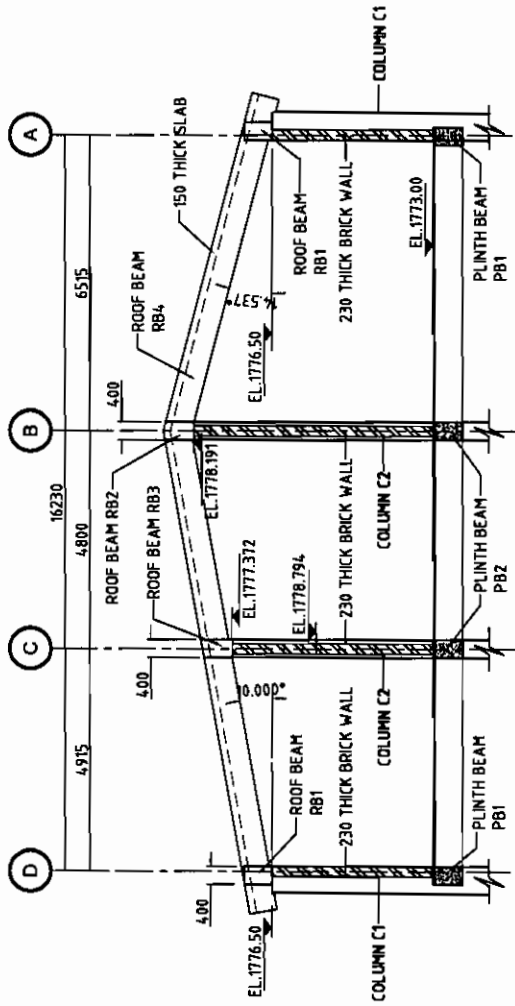
Table with 10 columns: No., Description, Remarks, Date, By, Check, Status.

No.	Description	Remarks	Date	By	Check	Status
1	11KV BUSBAR	11KV BUSBAR				
2	11KV C.B.	11KV C.B.				
3	11KV M.C.B.	11KV M.C.B.				
4	11KV FUSE	11KV FUSE				
5	11KV DISCONNECT	11KV DISCONNECT				
6	11KV SWITCH	11KV SWITCH				
7	11KV BREAKER	11KV BREAKER				
8	11KV CIRCUIT BREAKER	11KV CIRCUIT BREAKER				
9	11KV FUSE CUT-OUT	11KV FUSE CUT-OUT				
10	11KV FUSE LINK	11KV FUSE LINK				
11	11KV FUSE BOX	11KV FUSE BOX				
12	11KV FUSE MOUNTING	11KV FUSE MOUNTING				
13	11KV FUSE SUPPORT	11KV FUSE SUPPORT				
14	11KV FUSE BRACKET	11KV FUSE BRACKET				
15	11KV FUSE CLAMP	11KV FUSE CLAMP				
16	11KV FUSE WIRE	11KV FUSE WIRE				
17	11KV FUSE TERMINAL	11KV FUSE TERMINAL				
18	11KV FUSE JUNCTION	11KV FUSE JUNCTION				
19	11KV FUSE CONNECTION	11KV FUSE CONNECTION				
20	11KV FUSE ISOLATION	11KV FUSE ISOLATION				

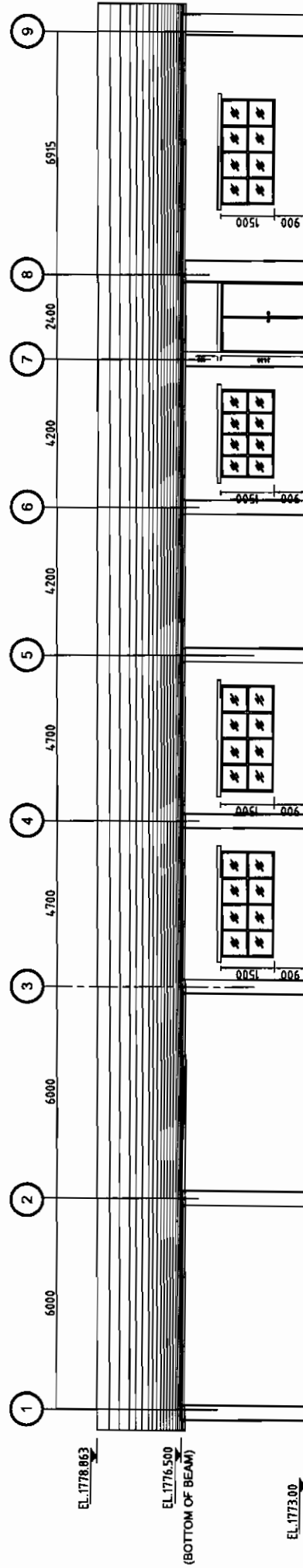








SECTION B
SCALE 1/50 (A1)
1/150 (A3)



FRONT ELEVATION
SCALE 1/75 (A1), 1/150 (A3)

22



DESIGNED BY AN INTERIOR DESIGNER

20. MODEL QUALITY ASSURANCE PLAN (QAP) FOR ILLUMINATION SYSTEM**Special instructions: -**

1. Contractors/Manufacturers/Sub-suppliers are advised to submit QAP for equipments/ materials after incorporating all tests for bought out items, in process inspection and final inspections as per their latest manufacturing practice and Indian/ International Standards (with latest amendments, if any).
2. Contractors/Manufacturers/Sub-suppliers are required to use properly calibrated instruments /equipments during testing/inspection, for which necessary calibration certificates are required to be provided/presented to the Inspecting Officer.
3. Contractors/Manufacturers/Sub-suppliers has to make on their own all arrangements for testing facilities at their works for testing of equipments/materials.
One set of complete test certificates as per the requirement of QAP be made available to the Inspecting Officer at the time of inspection/testing.
5. All the records, as per the requirement of QAP are to be made available for review by the Inspecting Officer during inspection.
6. Field tests are to be carried out as per the requirements of the contract / purchase order.



PROJECT : KUSHANGANGA H.E. PROJECT
 NAME OF EQUIPMENT : Illumination System
 QUALITY ASSURANCE PLAN (MODEL)
 CLIENT: NATIONAL HYDROELECTRIC POWER CORPORATION LTD.
 VENDOR :
 NHPC O. REFERENCE : —

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SR. NO.	ITEM / COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE / ACCEPTANCE DOCUMENTS / NORMS	RECORD FORMAT	INSP. AGENCY		REMARKS
						Perform	Witness	
1	Raw Material							
1.1	Aluminium Casting	Measurement	Sample	Tech. Spec./Appd.drg / IS:817/IEC	TC	3/2	-	TC
a)	Dimensional	Visual	-do-	-do-	TC	3/2	-	TC
b)	Surface finish	Chemical test	-do-	-do-	TC	3/2	-	TC
c)	Chemical composition	Measurement	-do-	Tech. Spec./Appd.drg / IEC	TC	3/2	-	TC
d)	Weight							
1.2	Super enamelled copper wire for Ballast							
a)	Thickness of wire	Measurement	-do-	Tech. Spec./Appd.drg / IS:4800/IEC	TC	3/2	-	TC
b)	P/n hole test	Test	-do-	-do-	TC	3/2	-	TC
c)	H V test	-do-	-do-	-do-	TC	3/2	-	TC
1.3	Polyester resin quartz mix							
a)	Viscosity of resin	Measurement	Sample	Tech. Spec./Appd.drg / IEC	TC	3/2	-	TC
b)	Powder resin mix	-do-	-do-	-do-	TC	3/2	-	TC
2	Components							
2.1	Ballast							
a)	Make & Rating	Visual	100%	-do-	TC	3/2	-	TC
b)	Visual examination for painting/markings etc.	Visual	100%	-do-	TC	3/2	-	TC

Note: a. In 'Inspection Agency' column figure 1,2, or 3 to be filled. 1- will indicate 'supplier' & 2- will indicate 'sub-supplier'.
 b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission & C/P - Customer Hold Point.
 c. Test certificates shall be submitted at the time of final inspection.

Signature & Seal
 (VENDORS Q.C. DEPT. OR REPRESENTATIVE)

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QUALITY ASSURANCE PLAN (MODEL)

PROJECT : KISHANGANGA M.E. PROJECT
NAME OF EQUIPMENT : Illumination System

CLIENT: NATIONAL HYDROELECTRIC POWER CORPORATION LTD.
VENDOR: _____
NTPCO REFERENCE : _____

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SR. NO.	ITEM COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE / DOCUMENTS / NORMS	RECORD FORMAT	INSP. AGENCY		REMARKS
						Perform	Witness	
c)	Dimensional Check	Measurement	100%	Tech. Spec./Appd.dwg./IEC	TC	3/2	-	TC
d)	Electrical parameters running current/watt loss/ short circuit current.	Test	100%	Tech. Spec./Appd. Dwg./IS:1504 & 6616/IEC	TC	3/2	-	TC
e)	IR dry Test	Electrical	100%	-do-	TC	3/2	-	TC
f)	HV Test	Electrical	100%	-do-	TC	3/2	-	TC
2.2	Capacitor							
a)	Make & Rating	Visual	100%	Tech. Spec./Appd.dwg./IEC	TC	3/2	-	TC
b)	Surface finish	Visual	Sample	Tech. Spec./Appd.dwg./IEC	TC	3/2	-	TC
c)	Discharge Resistance Test	Test	-do-	Tech. Spec./Appd. Dwg./IS:1504/IEC	TC	3/2	-	TC
d)	Value of capacitance	Measurement	-do-	-do-	TC	3/2	-	TC
e)	Thermal Stability Test	-do-	-do-	-do-	TC	3/2	-	TC
2.3	PVC wire							
a)	Make & Rating	Visual	100%	Tech. Spec./Appd.dwg./IEC	TC	3/2	-	TC
b)	Dimensional conformity (Conductor/insulation)	Measurement	Sample	Tech. Spec./Appd.dwg./IEC	TC	3/2	-	TC
c)	HV test	Electrical	-do-	Tech. Spec./IS:984/IEC	TC	3/2	-	TC
d)	Surface finish/colour	Visual	-do-	As per Tech. Specification.	TC	3/2	-	TC
e)	IR Test	Electrical	-do-	-do-	TC	3/2	-	TC
2.4	Diffuser							
a)	Make & Rating	Visual	100%	Tech. Spec./Appd.dwg./IEC	TC	3/2	-	TC
b)	Dimensional conformity	Measurement	-do-	-do-	TC	3/2	-	TC
c)	Surface finish	Visual	-do-	-do-	TC	3/2	-	TC

a. In 'Inspection Agency' column figure 1,2,3 to be filled. 1- will indicate 'supplier' & 2- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RQ-Review of Records, T.C. - Test Certificate Submission & C/P - Customer Hold Point.
c. Test certificates shall be submitted at the time of final inspection.

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QUALITY ASSURANCE PLAN (MODEL)

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PROJECT : KISHANGANGA H.E. PROJECT
NAME OF
EQUIPMENT : Illumination System
CLIENT : NATIONAL HYDROELECTRIC POWER CORPORATION LTD.
VENDOR :
NTPC O. REFERENCE : _____

SR. NO.	ITEM / COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE / ACCEPTANCE DOCUMENTS / NORMS	RECORD FORMAT	INSP. AGENCY		REMARKS
						Perform	Witness	
2.5	Porcelain Lamp							
a)	Holder	Visual	100%	Tech.Spec./Appd.drg./IEC	TC	3/2	-	TC
b)	Make & Rating	Visual	100%	Tech.Spec./IS:10276/11258/IEC	TC	3/2	-	TC
c)	Surface finish	Electrical	100%	Tech.Spec./Appd.drg./IEC	TC	3/2	-	TC
d)	HV Test	-do-	100%	-do-	TC	3/2	-	TC
e)	IR dry Test	Mechanical	100%	-do-	TC	3/2	-	TC
2.6	Mech. Strength Test							
a)	Paint	Visual	100%	Tech.Spec./Appd.drg./IEC	TC	3/2	-	TC
b)	Paint shade	Measurement	100%	-do-	TC	3/2	-	TC
c)	Viscosity							
d)	Starter	Visual	100%	Tech.Spec./Appd.drg./IEC	TC	3/2	-	TC
2.7	Make & Rating							
a)	Dimensional conformity	Visual	100%	Tech.Spec./Appd.drg./IEC	TC	3/2	-	TC
b)	HV test	Measurement	100%	Tech.Spec./Appd.drg./IS:2215/IEC	TC	3/2	-	TC
c)	IR Test	Electrical	100%	-do-	TC	3/2	-	TC
d)	Luminaire (Assembly)	-do-	100%	-do-	TC	3/2	-	TC
3	Final Inspection							
3.1	Type tests							
a)	Visual examination	Visual	Sample	Tech.Spec./Appd.Drg./IS:10322/IEC	TC	3/2	-	TC
b)	Endurance test	Test	-do-	-do-	TC	3/2	-	TC
c)	Heat run test	-do-	-do-	-do-	TC	3/2	-	TC
d)	Dust tight test	Test	-do-	-do-	TC	3/2	-	TC
e)	Jet proof / Splash proof/ Rain proof Test	-do-	-do-	-do-	TC	3/2	-	TC

Note: a. In 'Inspection Agency' column figures 1,2 or 3 to be filled. 1- will indicate 'supplier', 2- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - R/R-Review of Records, T.C. - Test Certificate Submission & C/P - Customer Hold Point.
c. Test certificates shall be submitted at the time of final inspection.



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QUALITY ASSURANCE PLAN (MODEL)

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PROJECT : KISHANGANGA H.E. PROJECT
NAME OF
EQUIPMENT : Illumination System

CLIENT : NATIONAL HYDROELECTRIC POWER CORPORATION LTD.
VENDOR :
NITIP.O. REFERENCE : _____

SR. NO.	ITEM / COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS / ACCEPTANCE / NORMS	RECORD FORMAT	INSPECTION AGENCY			REMARKS
						Perform	Witness	Verify	
1)	Insulation Resistance Test	Electrical	Sample	Tech. Spec./Appd.Drg./IS:10322/REC	TC	3/2	-	1	TC
g)	High voltage Test	-do-	-do-	-do-	TC	3/2	-	1	TC
h)	Photometric Test	-do-	-do-	-do-	TC	3/2	-	1	TC
3.2	Acceptance Tests	Visual	-do-	-do-	TC	3/2	-	1	TC
a)	Visual Examination	Test	-do-	-do-	TC	3/2	-	1	TC
b)	Jet proof/splash proof/rain proof	Electrical	-do-	-do-	TC	3/2	-	1	TC
c)	Insulation Resistance Test	-do-	-do-	-do-	TC	3/2	-	1	TC
d)	High Voltage Test	-do-	-do-	-do-	TC	3/2	-	1	TC
e)	Photometric Test	-do-	-do-	-do-	TC	3/2	-	1	TC
3.3	Routine Tests	Measurement	-do-	Tech.Spec./ Appd.drg./REC	TC	3/2	-	1	TC
a)	Dimensional conformity	-do-	100%	-do-	TC	3/2	-	1	TC
b)	Assembly / layout of components	Test	100%	-do-	TC	3/2	-	1	TC
c)	Provision of earthing	Electrical	100%	Tech.Spec./Appd.Drg./IS:10322/REC	TC	3/2	-	1	TC
d)	IR dry Test	-do-	-do-	-do-	TC	3/2	-	1	TC
e)	HV Test	Visual	-do-	-do-	TC	3/2	-	1	TC
f)	Visual examination	-do-	-do-	-do-	TC	3/2	-	1	TC

1. In Inspection Agency column figure 1,2,or 3 to be filled. 1- will indicate 'supp', 2- will indicate 'sub-supplier'.
In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission & C/P - Customer Hold Point.
Test certificates shall be submitted at the time of final inspection.



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NHPC (QMS DEPT.)

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QUALITY ASSURANCE PLAN (MODEL)

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PROJECT : KISHANGANGA H.E. PROJECT
 NAME OF EQUIPMENT : Illumination Panels & Distribution Board.
 CLIENT: NATIONAL HYDROELECTRIC POWER CORPORATION LTD.
 VENDOR :
 MTP/Q. REFERENCE : _____

SR. NO.	ITEM / COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTITY OF CHECKS	REFERENCE / DOCUMENTS	RECORD FORMAT	INSP. AGENCY		REMARKS
						Perform	Verify	
1	Raw Material & Bought out items							
1.1	Steel Sheets	Measurement	As per sampling plan	Tech. Spec/ Appd.drg./ IS:513/IEC	TC	2/3	1	TC
a)	Dimension (Size of sheet, Uniformity of thickness, surface finish)							
b)	Hardness	Mechanical	-do-	-do-	TC	2/3	1	TC
c)	Bend test	-do-	-do-	-do-	TC	2/3	1	TC
1.2	Copper/ Copper Alloy flats for Bus-bars & Links.							
a)	Dimension	Measurement	-do-	Tech. Spec/ Appd.drg./ IS:613/IEC	TC	2/3	1	TC
b)	Bend test	Mechanical	-do-	Tech. Spec/ Appd.drg./ IS:191/IEC	TC	2/3	1	TC
c)	Hardness	-do-	-do-	Tech. Spec/ Appd.drg./ IS:191/IEC	TC	2/3	1	TC
d)	Tensile Strength	-do-	-do-	Tech. Spec/ Appd.drg./ IS:1897/IEC	TC	2/3	1	TC
e)	Chemical Composition.	Chemical	-do-	Tech. Spec/ Appd.drg./ IS:5160/IEC	TC	2/3	1	TC
f)	Conductivity	Electrical	-do-	Tech. Spec/ Appd.drg./IEC	TC	2/3	1	TC

Note: a. In 'Inspection Agency' column figures 1,2, or 3 to be filled. 1- will indicate 'supplier', 2- will indicate 'sub-supplier'.
 b. In 'Remarks' column following abbreviations shall be used - FR-Review of Records, T.C. - Test Certificate Submission & Chp - Customer Hold Part.
 c. Test certificates shall be submitted at the time of final inspection.

Signature & Seal
 (VENDOR'S Q.C. DEPT. OR REPRESENTATIVE)

Signature
 NHPC (QA&I DEPT.)

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QUALITY ASSURANCE PLAN (MODEL)

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PROJECT : KUSHANGANGA H.E. PROJECT
 NAME OF :
 EQUIPMENT : Illumination Panels & Distribution Board.

CLIENT: NATIONAL HYDROELECTRIC POWER CORPORATION LTD.
 VENDOR :
 NITP.O. REFERENCE : _____

SR. NO.	ITEM / COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE / DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSPECTION AGENCY		REMARKS
							Perform	Witness	
1.3	Aluminium & Aluminium alloys (if applicable) Dimension	Measurement	As per Sampling Plan	Tech. Spec./ Appd.drg./ IS-5082/IEC	TC	TC	2/3	1	TC
a)	Bend Test	Mechanical	-do-	-do-	TC	TC	2/3	1	TC
b)	Tensile Strength	-do-	-do-	-do-	TC	TC	2/3	1	TC
c)	Chemical Composition	Chemical	-do-	-do-	TC	TC	2/3	1	TC
d)	Conductivity	Electrical	-do-	-do-	TC	TC	2/3	1	TC
1.4	Tests for Switches & Control Switches, Power & Auxiliary Contactor, Current Transformer, Electrical Meters/Ammeter, Voltmeter, Freq. meter etc.), Miniature Circuit Breaker, Air Circuit Breaker, Power & Auxiliary Contactor, Timers (Electronic, Electro-pneumatic & Annunciators), PVC Wire.	Visual Test	100%	Tech. Spec./ Appd.drg./ IEC	TC	TC	3/2	1	TC
a)	Make & Rating	Visual	-do-	-do-	TC	TC	2/3	1	TC
b)	Routine Test	Test	-do-	-do-	TC	TC	2/3	1	TC

Notes: a. In 'Inspection Agency' column figure 1, 2 or 3 to be filled. 1- will indicate 'NHP', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
 b. In 'Remarks' column following abbreviations shall be used - R.R. Review of Records, T.C. - Test Certificate Submission & Clrp - Customer Hold Point.
 c. Test certificates shall be submitted at the time of final inspection.

Signature
 NHP (O&I DEPT.)

Signature & Seal
 (VENDORS Q.C. DEPT. OR REPRESENTATIVE)

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QUALITY ASSURANCE PLAN (MODEL)

PROJECT : KISHANGANGA H.E. PROJECT

CLIENT : NATIONAL HYDROELECTRIC POWER CORPORATION LTD.

VENDOR :

NTPP.O. REFERENCE : _____

NAME OF

EQUIPMENT : Illumination Panels & Distribution

Board.

SRL NO.	ITEM/COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE / ACCEPTANCE DOCUMENTS / NORMS	RECORD FORMAT	INSP. AGENCY		REMARKS
						Perform	Witness	
2	Final inspection	Visual	100%	Tech. Spec/ Appd.org / IS:8823/IEC	TC	3/2	-	TC
2.1	Mechanical checks	Visual	100%		TC	3/2	-	TC
a)	BOM verification	Measurement	100%	-do-	TC	3/2	-	TC
b)	Layout of components							
c)	Dimensional checks							
	Sheet thickness, Paint thickness, Paint shade & overall dimension)							
d)	Name plate details	Visual	100%	-do-	TC	3/2	-	TC
e)	Mechanical operation of equipments.	Mechanical	100%	-do-	TC	3/2	-	TC
2.2	Electrical	Electrical	100%	-do-	TC	3/2	-	TC
a)	Electrical operation of equipments.							
b)	Scheme checking	Electrical	100%	-do-	TC	3/2	-	TC
c)	IR Test	Electrical	100%	-do-	TC	3/2	-	TC
d)	HV Test	Electrical	100%	-do-	TC	3/2	-	TC

Note: a. In Inspection Agency column figure 1,2 or 3 to be filled. 1- will indicate 'supplier', 2- will indicate 'sub-supplier', 3- will indicate 'sub-supplier'.

b. In Remarks column following abbreviations shall be used - R/R-Review of Records, T.C. - Test Certificate Submission & Chp - Customer Hold Point.

c. Test certificates shall be submitted at the time of final inspection.

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