

Bharat Heavy Electricals Limited,
Heavy Plates and Vessels Plant,
Visakhapatnam – 530012

Phone: 0891-6681842/1115/1296, Fax: 0891-6681700

E-Mail: pkm@bhelviz.co.in, yvrrao@bhelviz.co.in

Ref: E&C/5593/MECH.TEND/H/145

Date: 05.09.2015

NOTICE INVITING TENDER (NIT)

Dear Sir,

Sub: Tender for Mechanical work of unloading of materials, handling, erection, testing, supply and application of paints & insulation, providing assistance for pre-commissioning and commissioning of Purge Gas Recovery (PGR) Unit and its auxiliaries in Ammonia Plant-II at NFL, Vijaypur, Guna, Madhya Pradesh (MP). – Reg.

1.0 Sealed tenders are invited from financially sound and experienced contractors for the above subject work. The bidders can download the tender documents from the HPVP website www.bhelviz.co.in / Tenders / CONSTRUCTION or from BHEL website www.bhel.com.

2.0 LOCATION OF SITE:

The site is located in Ammonia Plant-II at National Fertilizers Limited (NFL), Vijaypur, Guna, Madhya Pradesh (MP). The tenderers are advised to visit the site before submission of the tender to assess for themselves the site conditions, the entry restrictions, safety requirements, labour regulations, local conditions etc. at M/s NFL, Vijaypur, Guna, MP.

3.0 BRIEF DESCRIPTION OF WORK:

Site work for unloading, handling and stacking of materials at site, fabrication of piping and structural, erection of equipments (statics & rotary), piping, structural, assembly, welding, NDT, supply and application of paints & insulations (cold & hot), testing, etc., as per drawings, pre-commissioning & providing commissioning assistance, including supply of skilled, semiskilled and unskilled labour, site supervisors, tools and tackles, all machineries such as welding machines, suitable capacity of cranes, hydra carne, grinding machines, gas cutting set, testing equipments, radiography sources, all consumables such as welding electrodes, gases, grinding and cutting wheels etc., for completion of mechanical works in all respect as per drawings, PDIL standard & Specification, SOQR, Special Conditions of the contract and General conditions of the contract.

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4.0 EARNEST MONEY DEPOSIT (EMD):

The tender shall be accompanied by a Demand Draft for Rs.2,00,000/- drawn in favour of BHEL – HPVP Visakhapatnam payable at Visakhapatnam towards EMD.

Tenders submitted without EMD are liable for rejection. Earnest Money Deposit shall not carry any interest.

5.0 PRICE:

Tenderer shall quote his best competitive price for the subject work detailed in Annexure-I, PDIL Standard & specifications and drawings in the pro-forma “**SCHEDULE OF QUANTITIES AND RATES**” (SOQR) enclosed at **Annexure – II**. Prices shall be inclusive of all taxes and duties except for Service tax. Service Tax shall be reimbursed against proof of payment and submission of documents as per prevailing act.

6.0 VALIDITY:

Offer shall be valid for a period of **Six months** from the due date of tender submission.

7.0 TIME SCHEDULE:

The entire scope of work is to be completed within **FOUR months** from the date of mobilization call or one month from the date of receipt of last materials at site whichever is later.

8.0 QUALIFICATION CRITERIA:

1. Average Annual Financial Turnover during the last 3 years ending 31st March of the previous financial year of the Bidders should be at least Rs. 34.0 Lacs.
2. Bidders should have Experience of having successfully completed similar works during last 7 years ending last day of month previous to the one in which applications are invited should be either of the following:

a) Three similar completed works costing not less than the amount equal to Rs.49.0 lacs.

Or

b) Two similar completed works costing not less than the amount equal to Rs. 56.0 lacs.

Or

c) One similar completed works costing not less than the amount equal to Rs. 90.0 lacs.

The bidder has to submit the documentary proof along with technical bid for the above.

Also Qualification Criteria shall be as per Clause 1.5 in Page No.6 of GCC (Document No. PS: MSX:GCC.Rev.01).

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- 9.0 The data/ documents as specified in clause 1.7 in Page No.6 of GCC (Document No. PS:MSX:GCC.Rev.01) are to be enclosed to technical bid.
- 10.0 The following documents are also to be submitted by bidder along with technical bid.
- Copy of PF Registration certificate
 - Copy of ESI Registration certificate
 - Copy of Service Tax registration
 - Copy of Sale Tax / WCT / Kerala VAT Registration certificate.

11.0 TENDER SUBMISSION:

Tenders shall be submitted in two sealed envelopes.

One envelope (1st) containing Technical bid along with EMD and all other documents / information required as per the tender duly signed and stamped. The envelope should be sealed and super scribed as "**Technical Bid for Mechanical work of PGR Unit at NFL, Vijaypur, Guna, MP**" and Tender Enquiry reference.

The other envelope (2nd) containing Price Schedule with covering letter as per SOQR duly signed and stamped. The envelope should be sealed and super scribed as "**Price Bid for Mechanical work of of PGR Unit at NFL, Vijaypur, Guna, MP**" and Tender enquiry reference.

Both the envelopes (Technical Bid & Price Bid) shall be put in another envelope (3rd) and sealed and super scribed as "**TENDER FOR MECHANICAL WORK OF PGR UNIT AT NFL, VIJAYPUR, GUNA, MP**", with Tender Enquiry reference number and Due date.

Tender shall be addressed to

MANAGER (E&C)
M/S BHARAT HEAVY ELECTRICALS LIMITED.
HEAVY PLATES & VESSELS PLANT,
(Formerly BHPV Ltd)
VISAKHAPATNAM – 530012,
ANDHRA PRADESH.

Tenders complete in all respects shall be dropped in the tender box of E&C department at Administrative Building of BHEL – HPVP Unit, Visakhapatnam or the tenders can be sent through REGISTERED POST WITH ACKNOWLEDGEMENT DUE / SPEED POST/COURIER so as to reach before due date.

The Due date for submission of Tender is 28.09.2015 at 12.30 PM. Technical bids will be opened at 2.00 PM on 28.09.2015

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12.0 REVERSE AUCTION:

BHEL – HPVP reserves the right to go for a Reverse Auction (RA) instead of opening the submitted sealed bid, which will be decided after technical evaluation. Information and general terms and conditions governing RA are given below.

TERMS AND CONDITIONS OF RA (REVERSE AUCTION)

Against this enquiry for the subject item/system with detailed scope of supply as per enquiry specifications, BHEL-HPVP may resort to "REVERSE AUCTION PROCEDURE" i.e., ON LINE BIDDING ON INTERNET.

- 1) For the proposed reverse auction, technically and commercially acceptable bidders only shall be eligible to participate.
- 2) Those bidders who have given their acceptance for Reverse Auction (quoted against this tender enquiry) will have to necessarily submit „online sealed bid“ in the Reverse Auction. Non-submission of „online sealed bid“ by the bidder for any of the eligible items for which techno-commercially qualified, will be considered as tampering of the tender process and will invite action by BHEL – HPVP as per extant guidelines in vogue.
- 3) BHEL – HPVP will engage the services of a service provider who will provide all necessary training and assistance before commencement of on line bidding on internet.
- 4) BHEL – HPVP will inform the vendor in writing in case of reverse auction, the details of service provider to enable them to contact & get trained.
- 5) Business rules like event date, time, start price, bid decrement, extensions etc. also will be communicated through service provider for compliance.
- 6) Bidders have to fax the Compliance form in the prescribed format (provided by Service provider) before start of Reverse auction. Without this, the bidders will not be eligible to participate in the event.
- 7) BHEL – HPVP will provide the calculation sheet (e.g., EXCEL sheet) to each of the vendor to enable them to fill-in the price and keep it ready for keying in during the Auction.
- 8) Reverse auction will be conducted on scheduled date & time.
- 9) At the end of Reverse Auction event, the lowest bidder value will be known on the auction portal.
- 10) The lowest bidder has to Fax the duly signed Filled-in prescribed format as provided on case-to-case basis to BHEL – HPVP through Service provider within two working days of Auction without fail.
- 11) Any variation between the on-line bid value and the signed document will be considered as sabotaging the tender process and will invite disqualification of vendor to conduct business with BHEL – HPVP as per prevailing procedure.

- 12) In case BHEL – HPVP decides not to go for Reverse Auction procedure for this tender enquiry, the Price bids and price impacts, if any, already submitted and available with BHEL – HPVP shall be opened as per BHEL – HPVP standard practice.
- 13) Bidders shall be required to read the “Terms and Conditions” section of the auctions site of Service provider, using the Login IDs and passwords given to them by the service provider before reverse auction event. Bidders should acquaint themselves of the „Business Rules of Reverse Auction“, which will be communicated before the Reverse Auction.
- 14) If the Bidder or any of his representatives are found to be involved in Price manipulation/ cartel formation of any kind, directly or indirectly by communicating with other bidders, action *as per extant BHEL – HPVP guidelines*, shall be initiated by BHEL – HPVP and the results of the RA scrapped/ aborted.
- 15) The Bidder shall not divulge either his Bids or any other exclusive details of BHEL – HPVP to any other party.
- 16) In case BHEL – HPVP decides to go for reverse auction, the H1 bidder (whose quote is highest in online sealed bid) may not be allowed to participate in further RA process.

13.0 GENERAL:

The extent of work at site shall be clearly understood by the Bidder from the **DETAILED SCOPE OF WORK** in Annexure-I, **Schedule Of Quantities and Rates (SOQR)** in Annexure-II, **Drawings, PDIL Standards & specifications, General Conditions of the Contract (Annexure –III), Special Conditions of the Contract (Annexure –IV) and other documents attached to NIT**. It shall be deemed that the contractor has fully understood the extent and the nature of work even otherwise not explicitly mentioned hither to and that the work shall be executed as per drawings, specifications etc., relevant to the job.

BHEL –HPVP reserves the right to reject any or all tenders without assigning any reason what so ever. We also do not bind ourselves to accept the lowest tender.

14.0 The following documents shall form part of this tender enquiry (NIT):

S.NO	DESCRIPTION OF DOCUMENTS	DOCUMENT/DRAWING/ STANDARD/ SPECIFICATION NO.	REMARKS
1.0	DETAILED SCOPE OF WORK		Annexure-I (17 Pages)
2.0	SCHEDULE OF QUANTITIES & RATES		Annexure-II (7 Pages)
3.0	GENERAL CONDITIONS OF CONTRACT		Annexure-III (26 Pages)
4.0	SPECIAL CONDITIONS OF THE CONTRACT		Annexure- IV (44 Pages)
5.0	PDIL Engineering standard for fabrication, assembly and erection of piping	ES: 6004	28 Pages
6.0	PDIL Engineering standard for Inspection, examination and welding of piping	ES: 6005	16 pages
7.0	PDIL Engineering standard for Pressure Testing of piping	ES : 6006	6 pages
8.0	PDIL Teschnical Specifications Painting & protective coating on steel surfaces.	ES : 2001	12 pages
9.0	Insulation Schedule		4 pages
10.0	PDIL Teschnical Specifications for Thermal Insulation (general)	PC65 – TS – 6700, Rev.01	21 pages
11.0	PDIL Teschnical Specifications for Thermal Insulation – Hot Services	PC65 – TS – 6701, Rev.01	29 pages
12.0	PDIL Teschnical Specifications for Thermal Insulation – Cold Services	PC65 – TS – 6702, Rev.01	13 pages
13.0	Offer forwarding letter / Tender submission letter	Form No: F-01 (Rev. 00)	1 Page
14.0	Declaration by authorised signatory of bidder	Form No: F-02 (Rev. 00)	1 Page
15.0	No deviation certificate	Form No: F-03 (Rev. 00)	1 Page
16.0	Declaration confirming knowledge about site conditions	Form No: F-04 (Rev. 00)	1 Page
17.0	GA Drawings of Equipments, Equipment Layout, GA of Piping		15 pages

Thanking you

Yours faithfully
For **BHARAT HEAVY ELECTRICALS LIMITED**


MANAGER (E&C)

ANNEXURE-I

DETAILED SCOPE OF SITE WORKS OF PURGE GAS RECOVERY (PGR) UNIT :

1.0 The scope of work, in brief, involves unloading of all materials, vessels, equipments, machineries, pipes & pipe fittings, structural, mineral wool, electrical and instrumentation items etc., from trucks/ trailers, stacking at site, storing and handling, erection, assembly, alignment of machinery, equipments, grouting including supply of Non Shrink grout material etc., pre fabrication, assembly, erection of structural and piping, radiography, testing, painting including supply of paints, supply and application of insulation as per specifications, drawings, etc., and commissioning assistance.

2.0 TENTATIVE LIST OF EQUIPMENTS, MACHINERIES, BOCs & PIPING:

Sl. No.	W.O.NO.	Description	Qty.
A) STATIC EQUIPMENTS:			
1	5593-01	Condensate Tank (B-3702)	1 No.
2	5593-02	HP Scrubber (F-3701)	1 No.
3	5593-03	Feed Heater (E-3704)	1 No
4	5593-04	Membranes (M-3701 to M-3711)	11 Nos.
5	5593-05	Stripper Feed Exchanger (E-3701)	1 No
6	5593-06	Ammonia Stripper (F-3702)	1 No
7	5593-07	Ammonia Condenser (B-3701)	1 No
8	5593-08	Re-Boiler (E-3703)	1 No
9	5593-09	Condensate Cooler (E-3702)	1 No
B) ROTATING EQUIPMENTS:			
1	5593-42	HP Scrubber Pumps (P-3701 A & P-3702 B)	2 Nos.
C) BOUGHT OUT COMPONENTS (BOCs)			
1	5593-43	Valves including Safety valves	1 Lot
2	5593-44	Piping	1 Lot
3	5593-47	Internal for HP Scrubber & Ammonia Stripper	1 Lot
4	5593-48	Insulation Materials	1 Lot
5	5593-49	Membrane	11 Nos
6	5593-52	Tie-in area piping	1 lot

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3.0 MATERIALS HANDLING:

- a) Unloading of all materials such as vessels, equipments, machinery, pipe & pipes fittings, structural, mineral wool, valves, electrical, Instrumentation item etc., from trucks/trailers at erection site and stacking/keeping near respective foundations, site stores as per the instructions of Resident Manager'/ Resident Engineer.
- b) Collection of materials from stores (Site stores and NFL stores) including loading into trailer/trucks, transportation to erection site. Unloading from trailers and stacking at site of erection/keeping near foundations as per the instructions of Resident Manager'/ Resident Engineer.
- c) Contractor has to receive the materials, equipments by arranging gate passes, permission and liaisoning with CISF/ security/ customer / BHEL-HPVP and unload them at stores / site or a place to the site of erection as per the instructions of Resident Manager'/ Resident Engineer.

4.0 STATIC EQUIPMENTS

These equipments will be supplied to site by BHEL in finished conditions. Contractor's scope of work include erection on foundation /Skids/ supports, assembly, leveling, alignment, grouting, fixing including supply of shims, packing plates, taper wedges etc.

The following equipments are to be erected on the civil foundation.

- HP PUMPS (2 NOS.) (P-3701 A & P-3702 B)
- STRIPPER Feed Exchanger (E-3701)
- Condensate Cooler (E-3702)
- REBOILER (E-3703)
- HP Scrubber (F-3701)
- Feed Heater(E-3704)

The erection of the equipments on foundations are to be done at the required elevations as indicated in the layout drawing/ General Assembly drawings including, alignment, providing shims, packing plates, non-shrink grouting etc complete in all respect.

The following equipments are to be erected on the structural skids.

- Ammonia Condenser (B-3701)
- Ammonia Stripper(F-3702)
- Membranes (M-3701 to M-3711)
- Condensate tank(B-3702)

The erection of the equipments on structural skids are to be done at the required elevations as indicated in the layout drawing/ General Assembly drawings including, alignment, providing shims, packing plates, bolting/welding etc complete in all respect.

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5.0 ERECTION OF MEMBRANES (PRISM SEPARATOR)

Membrane housing and membranes shall be received at site in assembled conditions. Contractor has to carry out the erection of membranes (11 Nos.) on structural skid as per drawing in presence of Vendor representative M/s Air Products/ as directed by BHEL engineer. Contractor to arrange all tools and tackles, cranes, manpower, consumables etc for completion of works in all respect as per drawings.

6.0 FIXING OF INTERNALS (PACKINGS) IN HP SCRUBBER AND AMMONIA STRIPPER:

- a) Packing for HP SCRUBBER (19 Elements) along with Liquid Gravity Distributor, Locating Grid, Support Grid etc., shall be received at site in loose conditions. Contractor has to carry out the fixing / assembly of these items in the HP scrubber as per drawings at site in presence of Vendor representative. Contractor to arrange all tools and tackles, manpower, consumables etc for completion of works in all respect.
- b) Packing for AMMONIA STRIPPER (36 Elements) along with Reflux collector Assembly, Reflux Distributor, Feed Collector Assembly, Feed Distributor, Support Grids shall be received at site in loose conditions. Contractor has to carry out the fixing, assembly of these items in Ammonia Stripper as per drawings at site in presence of Vendor representative. Contractor to arrange all tools and tackles, manpower, consumables etc for completion of works in all respect.

7.0 MACHINERIES:

HP SCRUBBER PUMP (2 Nos).

The HP scrubber pumps are skid mounted which will be supplied in individual skid. Contractor scope of work includes erection, alignment, providing shims, packing plates, grouting of pump with non-shrink grouts etc., pre-commissioning activities like cleaning, alignment check and correction, lube oil filling etc., in presence of rotary expert by arranging all tools and tackles, lifting equipments, skilled manpower, millwright filler, grouting materials, consumables etc., to complete the work in all respect.

8.0 FABRICATION AND ERECTION OF STRUCTURAL:

Fabrication, erection, assembly, fixing, bolting, welding and painting of structural platforms, handrails, ladders, pipe supports etc., as per drawings, specifications, and technical conditions.

9.0 FABRICATION & ERECTION OF PIPING:

- a) Fabrication of piping includes cutting to required length and edge preparation of pipes as required, assembly of pipe fittings like elbows, tees, flanges, reducers etc., welding, NDT such as radiography, DPT, post weld heat treatment as per drawings, PDIL specifications at ground and in position, surface preparation by sand/ shot blasting (SA 2 ½), primer painting etc.,
- b) Erection of piping involves laying of fabricated piping spools at various elevation, trenches, walls, pipe racks as per drawing, assembly of position joints, welding, Radiography, DPT, providing supports to pipe lines and testing of CS/SS/LTCS pipes as per BHEL-HPVP drawings, specification and technical conditions. This includes total piping of plant, interconnection of machinery and its equipments also.
- c) PMI (positive material identification) is to be carried out before and after installation but prior to hydro static testing/painting /insulation if required as per PDIL specifications.
- d) Welding shall be done as per the WPS supplied by BHEL-HPVP. Welding shall be with any or combination of electric arc welding and TIG welding.
- e) All welds on pipe joints shall be of radiographic quality.

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- f) In piping, installation, assembly and welding of flanges, elbows, tees, bends, instrumentation tapings, compensators and installation tapings, compensators and installation of valves and orifice pates are also included.
- g) All pipes are to be pneumatically / hydraulically pressure tested as per BHEL / PDIL standards. The contractor shall rectify defect if any noticed during the pressure test and re-testing is to be carried out after attending the defects with out any additional cost.
- h) The contractor, if required, shall carry out revisioning of valves before installation.
- i) For pipe lines below 50NB, where elbows are not provided, the pipe may be bent at a radius of three times the nominal size of the pipe by using proper bending machine not by adopting gas heating and bending methods.
- j) Wherever bending is involved, maximum thinning should not more than 15% of nominal thickness.
- k) The distance between two successive circumferential welds should not be less than 200mm or 1xDia whichever is more.
- l) Temporary spool pieces are to be fabricated and fitted where ever necessary to facilitate Testing, blowing, cleaning the systems and remove them after cleaning.
- m) There is piping work which comes under IBR purview and are to be fabricated & erected at site. Drawing approval from local IBR authority prior to start the work, material inspection by IBR inspector, fabrication, erection & testing of pipe lines, arranging IBR qualified welders with valid certificate and final certification from IBR for charging the pipe lines, liasoning with IBR authority for permission and approval, etc., are in the contractor's scope of work and rates/prices quoted are inclusive of the same. However all required documents for getting approval from IBR will be provided by BHEL-HPVP.**

10.0 **RADIOGRAPHY:**

- a) Radiography of piping joints shall be carried out as mentioned in the piping drawings and specifications by deploying radiography agency at site by contractor. The tentative radiography requirements for piping are given below for reference.

-Ammonia lines, Fuel Gas, MP Steam Lines, MP condensate Lines, Recyclic water lines : 20%

-Hydrogen lines, Purge gas lines : 100%

-LP steam lines, Nitrogen lines : 10%

However contractor has to carry out the radiography based on the requirements given in drawings.

- b) All the necessary arrangements like brackets, supports, platforms etc for holding the radiography unit in position and facilities to carry out the radiography job successfully shall be arranged by the Contractor at his cost.
- c) The identification marks, codification marks for each radiography film should be given as directed by BHEL Resident Engineer.

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- d) Contractor's quality engineer having Level-II certificate shall check all radiography films before submit to BHEL/ PDIL/NFL Quality engineers. All radiography films will be examined by BHEL /PDIL/ NFL and their decision shall be final. Any film rejected due to Contractor's fault such as leakage of light, surface marks, poor sensitivity etc., shall have to be re-radiographed by the Contractor at no extra cost to BHEL-HPVP.
- e) The radiography work is to be carried out in close coordination with site erection and welding work. The radiography work shall normally be carried out after normal working hours. If necessary some times, this radiography work shall be carried out in the normal working hours. i.e., day time also. The Contractor shall employ only BARC certified Radiographers.
- f) BHEL-HPVP reserves the right to reinforce radiography equipment and crew to carry out the radiography work by, any other contractor at site, in case the Contractor fails to cope up with the work both in quality and quantity. In such a case the additional cost incurred by BHEL-HPVP would be recoverable from the Contractor' bills.
- g) The contractor shall arrange (at his cost) radiography camera, radiography pit (for storing camera), dark room facilities, gamma rays, films, all chemicals, identification marks, and necessary approvals from BARC for carrying out the works at site.
- h) Decision with regard to acceptability of a film shall be by BHEL /PDIL/ NFL. No dispute shall be entertained.
- i) Re-shots on account of bad films and such other defects attributable to radiography technique and chemical washing shall be repeated at no extra cost.
- j) The rate quoted shall be inclusive of all above.

11.0 **TESTING:**

After completion of Mechanical works the entire plant including piping are to be made free of dust, rust etc., by air blowing. This is to be followed by pneumatic testing / Hydraulic testing as specified in drawings/ QAP/ procedures. The air/water required for blowing and testing shall be provided by NFL at one point and further distribution including high pressure hose connections are to be arranged by contractor. In case NFL failed to provide air/water for blowing & testing, then the same shall be arranged by contractor with out any extra cost.

12.0 **PAINTING:**

CS Piping and structural fabricated at site are to be sand / short blast cleaned to SA 2 ½ and painted as per drawings / painting specification and PDIL Technical Specifications.

Supply of paints is in contractor's scope and contractor has to procure the paints as per painting specification mentioned in SOQR from approved venders which will be intimated to the contractor. The rate quoted for painting shall be inclusive of cost of paint and surface cleaning.

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13.0 **SUPPLY AND APPLICATION OF HOT AND COLD INSULATION:**

13.1 **Hot insulation**

- a) Supply of all insulation materials such as Rock wool LRB mattresses and Preformed pipe sections, cladding materials (Aluminium sheets both plain & corrugated), and all materials used for insulation like Securement Bands / Wires, Rivets, Screws, S & J Clips etc., as per Insulation Schedule, Schedule Of Quantities & Rates (SOQR), drawings and PDIL Technical Specifications no. PC65-TS-6700 & PC65-TS-6701
- b) Application of hot insulation shall be carried out using Rock wool LRB mattresses and Preformed Pipe sections as insulating material. Insulation thickness, Installation and other details shall be as per insulation Schedule, SOQR, drawings, and PDIL Technical specification no. PC65-TS-6700 & PC65-TS-6701.

13.2 **Cold insulation**

- a) Supply of all insulation materials like Polyurethane foam-PUF (Pre formed pipe section), cladding materials (Aluminium sheets), all materials used for insulation, like fixing, sealing and protection such as Wire netting, Lacing & Binding wire, Bands, Adhesive, Vapor seal, Filler materials, Joint sealer, Glass cloth, Anti-corrosive paints, Bituminized Roofing Felt etc., as per PDIL Technical Specifications specification no. PC65-TS-6700 & PC65-TS-6702, Insulation Schedule, Schedule Of Quantities and Rates (SOQR), and drawings.
- b) Application of cold insulation shall be carried out using polyurethane foam as insulating material. Insulation thickness, Installation and other details are as per Insulation Schedule, SOQR, drawings, and PDIL Technical Specification specifications no. PC65-TS-6700 & PC65-TS-6702

14.0 **GROUTING:**

Grouting is to be carried out for the equipments and machineries etc., as per the drawings including supply of Non shrink grouting material. Contractor to submit the material TC before taking up the job.

15.0 Wherever the material is in the scope of contractor, he shall supply the same with materials test certificates to the mentioned specifications.

15.0 **STAGING/ SCAFFOLDING AND BARRICADING:**

15.1 All the requisite temporary staging/ scaffolding required for the erection & welding and for working at heights are to be arranged by the contractor including supply of scaffolding materials.

15.2 Since the work is to be carried out in a running unit and near existing pipelines and running equipments, the present working area is to be barricaded locally on all sides with temporary barricading arrangement constituting of scaffolding pipes and GI sheets / asbestos cloth to the satisfaction of the PDIL / NFL. Supply & Installation of total barricading arrangement required for smooth execution of the site works of the PGR Unit are to be carried out by contractor to satisfaction of BHEL/ PDIL /NFL.

16.0 **WORKMANSHIP:**

- a) Workmanship shall be in accordance with the established engineering practice and specified standards. Erection shall be done in approved manner, taking care to see that location and alignment of piping, confirming exactly to the requirement inclusive of any modifications and changes that might be necessary. During erection, care shall be taken adequately to support the equipments and piping until they are satisfactorily welded in position and permanent supports provided.
- b) The contractor shall be responsible for the proper workmanship and he shall not be relieved of his obligations in this regard just because no objection was raised by BHEL-HPVP during the progress of work.

17.0 **INSPECTION:**

- a) Erection, assembly, alignment, welding etc., at all stages shall be subject to inspection by BHEL / PDIL/ NFL. All instructions or directions given by them are to be complied with by the Contractor. The contractor shall provide all facilities for inspection to be undertaken in an effective manner. They shall have full right to reject all or any portion of work they may consider defective or inferior in quality of workmanship. The Contractor shall arrange to remove / rectify the defective work to the satisfaction of BHEL/PDIL/ NFL.
- b) The welding work shall be executed by qualified welders and as per the welding procedures furnished by BHEL.
- c) Only qualified welders as per ASME SEC. IX shall be put on the job. The welders shall be tested under BHEL / PDIL and the testing charges shall be borne by the Contractor.
- d) Only approved brand and batch of electrodes as furnished by BHEL/ PDIL/ NFL shall be procured and utilized by the contractor for works after obtaining necessary permissions.
- e) The checking of weld joints stage wise right from joint preparation shall be done as per specifications by BHEL / PDIL.

18.0 **COMMISSIONING ASSISTANCE:**

Contractor has to provide 12 persons a day (4 in each shift as mentioned below) with tools tackles and consumables for a period of one month towards commissioning assistance for carrying out pre commissioning and commissioning activities including PGTR. The duration of performance testing shall be 72 hours.

Manpower:

Fitter - 1
Rigger - 1
Helpers - 2

19.0 **ENABLING WORKS:**

The contractor shall carry out all enabling works such as jigs and fixtures, cleats, temporary supports, shims, packing, templates etc., required for fabrication and erection at his own cost. No extra payment shall be claimed in this account. All such temporary construction shall be dismantled, debris removed and site shall be cleared as soon as work is completed.

20.0 **SAFETY & HOUSEKEEPING:**

Contractor has to deploy a qualified Safety Engineer at fabrication yard & Erection site to coordinate and for implementation of safety measures, as per standards. If any penalty imposed by NFL/PDIL to BHEL, the same shall be deducted from RA bills of the contractor without any intimation.

21.0 **SITE MODIFICATION:**

Contractor has to carryout site modification as found necessary during sustained checks/ inspection and from view point of operability, maintenance and safety of the plant. Site approaches as available shall be utilized and incase any special additional approaches are required, they should be arranged by the contractor at his own cost including providing wooden sleepers etc.

22.0 **RECTIFICATION OF DAMAGES:**

The contractor shall rectify any damages caused in the course of his work. All necessary rectification shall be done by the contractor to the satisfaction of BHEL/PDIL / NFL at his own cost and no claim on this account shall be entertained.

23.0 **COOPERATION WITH OTHER CONTRACTORS**

Work should be carried out with very good co-ordination with other agencies at site. Since the progress of construction work is linked with other works such as civil, heat treatment, radiography, electrical and Instrumentation, the contractor shall arrange his work in coordination with other agencies and in consultation with BHPV site In charge for proper and timely execution of work.

24.0 **SITE TO BE CLEARED ON COMPLETION OF WORK:**

During erection, contractor shall at all times keep the working and storing area used by him free from accumulation of waste materials, rubbish etc., Immediately, after completion of work the contractor shall clear the temporary structures, waste ,debris, rubbish etc., and leave the site in a clean condition to the satisfaction of BHEL site In charge /PDILL/NFL. The contractor has to undertake daily housekeeping. Any amount paid by BHEL for housekeeping shall be charged to the contractor without any intimation.

25.0 **LIGHTING AND SECURITY ARRANGEMENTS:**

The contractor shall provide lighting, watchman etc. for safety and security at the site.

26.0 **MONITORING OF WORK PROGRESS:**

The contractor shall have to work in consultation with representative of BHEL /PDIL/ NFL. The contractor shall submit detailed activity schedules to complete the work within stipulated time period. BHEL reserves the right to fix and revise the schedule. The contractor will I submit weekly and monthly account of all the materials issued to him.

BHEL shall be notified promptly by the contractor of any defects in other contractors work or supplies that could affect contractor work immediately.

The contractor shall submit the following reports to BHEL as required by the Resident Manager/Resident Engineer.

- a) Daily manpower report category wise.
- b) Progress Report indicating total work content, planned / achieved in the reporting week, cumulative figures etc.,
- c) Periodic progress photographs.

27.0 WELDERS QUALIFICATION:

Only qualified welders shall be deployed by the contractor as per relevant code. Contractor shall arrange for qualification of welders at his cost. However, raw material for test pieces will be provided by BHEL free of cost. The welding shall be executed by the contractor as per BHEL approved welding procedures.

Contractor has to arrange IBR qualified welders with valid certificate for IBR Job.

28.0 ELECTRODES:

- a) Electrodes for Structural works like equipment platforms, pipe supports etc.
- b) Electrodes & filler wire for CS,SS & LTCS Piping.

All the electrodes are to be arranged by the contractor at his own cost. Approved brands for different types of electrodes will be furnished to contractor and electrodes of these brands are only to be procured and used at site.

29.0 CONSTRUCTION POWER:

Customer shall provide required Construction Power to the contractor free of cost at one point. Further distribution including installation of Electrical panel, cabling, main switches, ELCB accessories, energy meter etc along with all safety devices as per standard norms prevailing at NFL - Vijaipur are to be arranged by contractor at his own cost. Qualified electrician and all liasioning activities required for energizing the panel and further distribution from the panel to the site are to be taken care by the contractor. Any additional power requirement shall be arranged by contractor at his own cost. In special circumstances when customer/ BHEL-HPVP is not in a position to provide power, the contractor has to make his own arrangements for power and carry out the job without any interruption.

30.0 CONSTRUCTION WATER:

Water shall be provided to the contractor at one point free of cost. Further distribution to work spot with necessary piping, water meters etc as per the safety rules and regulations in vogue at site shall be carried out by the contractor at his own cost. In special circumstances when customer is not in a position to provide water, the contractor has to make his own arrangements for water and carry out the job without any interruption.

31.0 Since the job is to be carried out in the operating unit, Contractor has to obtain work permits viz. Hot Work permit , Cold work permit etc. on daily basis before start of the job and all the formalities required to obtain the same are to be fulfilled by the contractor.

32.0 MEASUREMENT OF WORK

For all payment purposes measurements will be based on the execution drawings. Wherever details are not available or inadequate in the execution drawings, physical measurements will be taken by the contractor in the presence of the representative of Engineer-in-charge. In such cases payment will be made on actual measurements. Measurements will be made in units as indicated in Schedule Of Quantities and Rates (SOQR).

33.0 RESPONSIBILITY OF CONTRACTOR

- a) Contractor has to receive the materials, equipments by arranging gate passes, permission and liaisoning with CISF/ security/ customer / BHEL and unload them at stores / site or a place to the site of erection as per the directives of Resident Engineer.
- b) Contractor has to arrange suitable capacity Cranes for erection of the Equipments, piping, structural etc.,
- c) Hydra cranes or suitable cranes for unloading and handling of materials & equipments at site is to be arranged by contractor.
- d) All expenses towards mobilization & demobilization including bringing in equipments, clearing the site etc., shall be deemed to be included in the prices quoted and no separate payments on account of such expenses shall be entertained.
- e) It shall be entirely the contractor's responsibility to provide, operate and maintain all necessary construction equipments, scaffoldings and safety gadgets, cranes and other lifting tools & tackles, and appliances to perform the work in a workman like and efficient manner and complete all the jobs as per time schedules.
- f) Preparing approaches and working area for the movement and operation of the cranes, leveling the areas for assembly and erection shall also be the responsibility of the contractor. The contractor shall acquaint himself with access availability, facilities such as railway siding, local labour etc., to provide suitable allowances in this quotation. The Contractor may have to build temporary access roads to aid his own work & rates quoted are will be inclusive of supply of all these items.
- g) The contractor should ensure that workmen engaged at site should have Bank A/c No and photo Identity card. The wages to be paid to the workmen / supervisor etc should be deposited to their Bank Account. No cash payment is acceptable.
- h) Exclusive Safety Supervisor/ Engineer is to be deployed at site by the contractor. Housekeeping is to be maintained as per the NFL/PDIL/BHEL. Any penalties imposed by NFL/PDIL for non compliance of safety practices and for poor housekeeping, the same amount will be deducted from the RA bills of the contractor.
- i) Materials will be handed over to contractor as and when they are received at site and are to be acknowledged as per packing list. Contractor has to arrange covered storage for small items like pipe fittings, fasteners, gaskets, valves, instruments, electrical items etc.. Contractor has to provide round the clock security arrangement for materials machineries etc., for safe custody and storage of these materials within his quoted rates.

34.0 CONSTRUCTION EQUIPMENT AND SITE ORGANISATION

34.1 CONSTRUCTION EQUIPMENT

- i. The Contractor shall without prejudice to his overall responsibility to execute and complete the work as per specifications and time schedule, progressively deploy adequate equipments, tools & tackles and augment the same as decided by the engineer-in-charge depending on the exigencies of the work so as to suit the construction schedule. **The Contractor shall submit a list of construction equipments he proposes to deploy for the subject work along with deployment schedule. No construction Equipment shall be supplied by the BHEL – HPVP.**
- ii. The Contractor must have adequate number of the following equipments along with skilled operators for the same as per the exigencies for execution of works.
 - Crane of suitable capacity for erection of equipments, pipe lines, structural work and pipe rack structures etc., Hydra crane for material handling, Tractor- Trailer.
 - Working platforms along with ladders, inspection cage, wire ropes/ slings of required capacity, D shackles etc.,
 - Welding rectifier/machines with welding cables, electrode ovens (Mother ovens and portable ovens) & Drilling Machines, gas cutting sets, measuring equipments, as per the requirement.
 - Laboratory equipment.

34.2 In case contractor does not own the above equipment they should satisfy BHEL with necessary documentary evidence of their arrangements made to hire/acquire the same along with skilled operators. Decision of Engineer-in-Charge regarding deployment of equipment in sufficient numbers shall be final.

34.3 Subject to the provision in the tender document and without prejudice to contractor's liabilities and responsibilities to provide adequate qualified and skilled personnel on the work, contractor shall deploy and augment the same at site as decided by the Engineer-in-charge depending on the exigencies of work. **The bidder shall submit the details of tentative site organization proposed by him.**

Qualified & experienced Site In-charge with legal power of attorney should be posted for effective site management.

35 SUB-CONTRACTORS

The contractor shall not sublet any portion of the contract work without the prior written approval of the BHEL-HPVP/Owner.

36 COORDINATION WITH OTHER AGENCIES

Work shall be carried out in such a manner that the work of other agencies operating at the site is not hampered due to any action of the contractor. Proper co-ordination with other agencies will be contractor's responsibility. In case of any dispute, the decision of Engineer-in-charge shall be final and binding on the Contractor.

37 FINAL INSPECTION

After completion of all tests as per specification, the whole work will be subject to a final inspection to ensure that job has been completed as per requirement. If any defects noticed in the work are attributable to contractor, these shall be attended by the contractor at his own cost, as and when they are brought to his notice by the Owner/ PDIL. Owner & BHEL - HPVP shall have the right to have these defects rectified at the risk and cost of the contractor if he fails to attend to these defects immediately.

The following documents shall be submitted by the contractor,

- a) Material test certificates for all incoming material like welding electrodes, Paints, Insulation materials, Grouting materials, etc., etc,
- b) Welders qualification tests and report.
- c) All Quality Documents like inspection report, Site Test (Hydrostatic/Pneumatic) reports and other test results.
- d) Any other certificates / reports / guarantees etc., as required for the works.

38 SITE ORGANISATION:

The Contractor shall deploy qualified and experienced Engineers for execution of site works. However, deployment of one Resident Engineer / Site In-charge to organise all the site activities, one Quality Engineer and one Safety Supervisor exclusively for the job along with all supporting engineers / Supervisors is mandatory.

Also contractor has to deploy all necessary skilled / semiskilled / unskilled labour including highly skilled workmen.

All responsibilities of the contractor towards Labour, Supervisory staff etc as mentioned in Special Conditions and General Conditions of the Contract are to be strictly complied with.

39.0 SITE MOBILISATION:

The contractor has to commence the work as per time indicated in Letter Of Intent from BHEL and shall proceed with the same with due expedition without delay.

40.0 BHEL - HPVP RESPONSIBILITY:

- a) All equipments will be supplied to site in finished condition.
- b) All raw materials for piping like pipe & pipe fittings, valves, all permanent materials etc., .
- c) All drawings and Specifications required for site execution.

PART – B (COMMERCIAL)

1. **PRICE:**

Tenderer shall quote his best competitive price for the subject work detailed in Annexure-I, PDIL Standard & specifications, drawings, Special Conditions of Contract and General Conditions of Contract in the pro-forma “SCHEDULE OF QUANTITIES AND RATES” (SOQR) enclosed at **Annexure – II. Prices shall be inclusive of all taxes and duties except for Service tax. Service Tax shall be reimbursed against proof of payment and submission of tax invoice and other documents as per prevailing act.**

2. **TERMS OF PAYMENT:**

90 % progressive payment based on work done against monthly RA bills.

10% shall be retained towards Performance Guarantee for Workmanship and shall become refundable after expiry of guarantee period/defect liability period, provided all the defects noticed during the guarantee period have been rectified and after deducting all expenses/other amounts due to BHEL. This retention amount can be released on commencement of guarantee period and submission of equivalent Performance bank guarantee valid for Defect liability period plus claim period of 3 months.

Contractor shall submit detailed billing break-up which is to be approved by BHEL-HPVP for submission of monthly RA bill after award of job.

3. **Mode of payment:**

Payment shall be made based on the quantities executed at site and certified by BHEL Resident Engineer.

90% of the gross admitted value will be paid from HO after making deductions for materials/ services provided at site, IT and any other recoveries within 30 days of submission of bills and all requisite documents complete in all respects.

Payment will be released only through RTGS/ NEFT and all documents required for the same as specified in SCC are to be submitted by contractor along with the bill.

FINAL BILL

Final bill shall be submitted after completion of all works and material reconciliation along with following documents as specified in General Conditions of contract.

- a) Work Completion Certificate by BHEL Site In charge.
- b) No Claim certificate by Contractor.
- c) Material reconciliation statement
- d) Clearance Certificates wherever applicable viz. Clearance Certificates from Customer for gate pass clearance, labour wage clearance, stores clearance various Statutory authorities like Labour Department, PF authorities, Commercial Tax Dept. etc.
- e) Indemnity Bond as per prescribed format.

4. **SECURITY DEPOSIT:**

The successful tenderer shall submit Security Deposit before start of the work as per Clause No. 1.10 of Page 8 of General Conditions of Contract (Doc. No. PS: MSX: GCC. Rev.01)

5. **INCOME TAX:**

Income Tax will be recovered from each RA bill of the contractor as per the rules and regulations in force in accordance with the income tax act prevailing from time to time. TDS certificate to that effect will be issued by BHEL-HPVP.

6. **TAXES & DUTIES**

- a) The price shall be inclusive of all taxes & duties, levies such as Excise duty, Sales Tax/VAT, Works Contract Tax (WCT), Octroi etc as applicable in Madhya Pradesh.
- b) Contractor has to pay the applicable service tax (presently 14%) to authority against each RA bill and copy of proof of payment is to be enclosed to RA bill. Original Tax Invoice along with copy of the service tax remittance shall be submitted to BHEL-HPVP immediately after payment for reimbursement.
- c) Contractor has to pay the applicable WCT to authority against each RA bill and copy of proof of payment is to be submitted to BHEL-HPVP for reference and records. In case, the contractor fails to pay the WCT, then BHEL will recover the same from contractor RA bills.

7. **LAW GOVERNING CONTRACT AND COURT JURISDICTION:**

The contract shall be governed by the law for the time being in force in the republic of India. The Civil court having original civil jurisdiction at Visakhapatnam for HPVP shall alone have exclusive jurisdiction in regard to all claims in respect of the contract. No other civil court shall have jurisdiction in case of any dispute under this contract.

8. **MATERIAL ACCOUNTING:**

The contractor shall fully account all the materials issued to them and submit the material reconciliation statement which will be verified and certified by Resident Engineer, BHEL- HPVP. The store clearance has to be taken by the contractor and to be submitted along with final bill for processing final bill.

The surplus materials as well as the scrap after the material accounting shall be returned to BHEL by the contractor.

9. **GUARANTEE / DEFECT LIABILITY PERIOD:**

The contractor will be responsible for quality of the workmanship and shall guarantee the work done and materials supplied for a period of 18 (Eighteen) months from the date of mechanical completion or 12 (Twelve) months from acceptance whichever is earlier. Should any defects be noticed in the materials (supplied by contractor) and /or workmanship within 18 months from the date of mechanical completion or 12 months from acceptance of plant, whichever is earlier, BHEL-HPVP shall inform the Contractor and Contractor shall immediately on receipt of such intimation depute their personnel within 7 days to investigate the cause of defects and arrange rectification/replacement the defect at site without any cost to BHEL within a reasonable period.

10. **LIQUIDATED DAMAGES:**

In the event of any delay in completion of work or part thereof as per the contractual completion period due to the reasons attributable to contractor, BHEL - HPVP shall have the right to impose Liquidated Damage at the rate of 1% of the contract value for every complete week of delay or part thereof subject to a maximum of 5% of the contract value.

11. **OVER RUN COMPENSATION (ORC) /IDLE CHARGES:**

The contractor shall not be entitled to claim and the company shall not be liable to pay any amount on account of over run compensation and idle charges, the overrun/ idling may be for whatsoever reasons.

12. **PRICE VARIATION COMPENSATION (PVC):**

The contractor shall be paid only at contract rate/ rates for the work executed and the contractor shall not be entitled to claim or receive any extra amount on account of any price escalations either in materials, labour, taxes/ duties etc., or for any reasons whatsoever and the contract rates are firm and fixed till the completion of the work in all respects.

13. **PATENTS:**

M/s BHEL - HPVP warrant on their part that any design instructions given by BHEL-HPVP shall not be such, as will cause contractor to infringe any letters of patents, registered designs, trademarks, copy right or other protected right valid in India the performance of work. Subject to this, contractor has to indemnify BHEL-HPVP against any claim for infringement by Contractor or any letters of patent, registered designs, registered trademarks or copy right or other protected right valid in India in performance of contract.

14. **SECRECY :**

All the drawings, designs, specifications and other documents and information contained herein and any instruction given by BHEL-HPVP in the performance of contract, whether parenthetic or pardonable or not shall always remain the exclusive property of M/s BHEL - HPVP and contractor at no time shall question or dispute such right of M/s BHEL - HPVP. Such documents are given on loan by M/s BHEL - HPVP to contractor for the limited purpose of execution of work and shall be returned to M/s BHEL - HPVP in whole on completion of work. Contractor shall not publish or cause to be published any information on project, contract work covered by contract or contractors participation in it without the prior written concerned of M/s BHEL - HPVP. The provisions of this article shall survive expiry or earlier termination/ suspension of contract.

15. **SITE OFFICE / STORES SHED:**

No land will be provided for labor hutments. However for temporary site office, stores (covered & open), to the extent area available can be provided. The contractor has to construct his site office, stores etc., at his own cost and no material will be given for the same. Site office, storage area and fabrication yard allotted to the contractor shall be barricaded and should keep his own security personnel for the safety of the materials etc.

Owner can ask the contractor to vacate the premises in 7 days time on security reasons, National interest or otherwise. The services shall be maintained in most hygienic condition at all times. On completion of the job this shall be dismantled, cleared of debris and handed over, and necessary site clearance certificate shall be obtained from BHEL, HPVP/PDIL/NFL.

16. **SAFETY:**

Contractor shall adhere to safe construction practices and shall comply with the safety rules of M/s BHEL - HPVP / PDIL /NFL in vogue at site and as per HSE & OHSAS in Chapter IX of Special Conditions of Contract.

- a) Contractor and his employees shall follow all fire and safety, security regulations of customer.
- b) Before starting any work contractor shall apply & obtain well in advance not less than a day safety permit/hot permit etc., for execution of work. Liasioning with BHEL-HPVP / PDIL / NFL for obtaining the above permits is to be taken care by contractor.

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- c) The safety items required for the workers and staff shall be provided by the contractor within his quoted rates viz.
 - i) Safety Helmets, Safety Belts, Safety Shoes, Safety gloves etc.
 - ii) Welders Gloves, Apron etc.,
 - iii) Gas cutters Goggles, Grinders mask etc.,
 - iv) Safety Cloths when needed.

- d) During the fabrication, the contractor at all times shall keep the work and storage area free from accumulation of waste materials, rubbish etc.

Schedule Of Quantities and Rates (SOQR) for Mechanical Work of unloading of materials, handling, erection, testing, supply and application of paints & insulation, providing assistance for pre-commissioning and commissioning of PGR Unit.

PROJECTS : PGR PLANT AT M/s NFL-Vijaypur, Guna, MP.

SL. NO	DESCRIPTION	UNIT	QTY	UNIT Rate (Rs)	TOTAL (Rs)
I	Unloading of materials from trucks/trailer at site including arranging entry permission of vehicles at NFL gate, liasoning with CISF for entry of equipments/vessels, machinery, membranes , packings for scrubber, electrical/instrumentation packages cable drums etc., at the stores (Located inside the factory). Contractor shall provide cranes/handling facilities for safe unloading, and provide sleepers wherever required to unload the materials. The materials unloaded are to be stacked properly inside the covered stores or in the open fenced areas as per directions of BHEL-HPVP Engineer.	MT	95		
II	ERECTION OF STATIC EQUIPMENTS: Transportation from stores to erection site, handling, unloading, removing of transportation supports & erection on foundations/structural skids at various elevations. This includes leveling, alignment, bolting/ welding, grouting including supply of Non - Shrink grouting material etc. complete in all respects as per drawings/specifications. Contractor shall provide suitable capacity cranes for erection and handling and provide sleepers where ever required for safe handling and erection. Temporary supports by bolting / welding are in the scope of contractor. Final completion of all works for the following CS and SS eqpts., as per drawings / specifications / and instructions by BHEL-HPVP Engineer.				
1	Condensate tank (B-3702)	MT	0.90		
2	HP Scrubber(F-3701)	MT	6.63		
3	Ammonia stripper (F-3702)	MT	2.30		
4	Membranes (Prism separators) (M-3701 to M-3711)	MT	9.74		
5	Feed Heateer(E-3704)	MT	0.33		
6	Stripper Feed Heat Exchanger(E-3701)	MT	0.54		
7	Reboiler(E-3703)	MT	2.30		
8	Condensate Cooler (E-3702)	MT	0.66		
9	Condenser(B-3701)	MT	1.50		

SL. NO	DESCRIPTION	UNIT	QTY	UNIT Rate (Rs)	TOTAL (Rs)
III	<p>ROTARY EQUIPMENTS</p> <p>Erection of Machinery including grouting: Collection and transportation from stores to erection site, handling, erection on foundations/structures, assembly of components, alignment to the required accuracy, grouting including supply of Non shrink grouting materials, revisioning, cleaning prior to commissioning and test runs, flushing, greasing, oil filling etc., as per drawing & specifications. Contractor shall provide suitable capacity cranes and handling facilities, mill wrighte fitter, provide required packing plates and shims and provide sleepers where ever required for safe handling / erection.</p>				
1	HP Scrubber pumps(P3701A & P3701B) - 2 nos.	MT	2		
IV	<p>FABRICATION & ERECTION OF SS, CS & LTCS PIPING: The raw materials will be supplied by BHEL-HPVP free of cost. The Scope includes:</p> <p>Fabrication of piping includes handling, lifting, transportation from stores to work spot for pre-fabrication including cutting, edge preparation, branch connections, instrumentation primary tappings, threading, welding of pipe to pipe, all pipe fittings like elbows, mitre bends, forged tees, reducers, stub ends, flanges, caps bolting/ welding of valves, pipe supports, pipe clamps, cleaning/revisioning of al valves given in B.O.M, welding / bolting of all valves, radiography, DPT,PWHT Tests etc., as per drawings. Erection of piping includes lifting, placing on pipe sleepers/racks, providing pipe supports at all elevations, leveling, alignment, welding of site joints, fixing of flange joints, insertion of gasket, orifice plates and bolting, jointing by threading/bolting/welding and erection of all types of pipe supports as per drawings. All pipe lines shall be shot/sand blasted, air blown/cleaned and pressure tested (Hydraulic/pneumatic) and painted as per the drawings/specifications and as per the instructions of BHEL-HPVP Engineer. Any rectification work during testing is to be carried out free of cost by the contractor. Pipes shall be blown with oil free air for drying out after hydraulic test. Fabrication/Erection/testing are to be carried out as per BHEL-HPVP drgs./PDIL spec. standrad and as per instructions of BHEL-HPVP Engineer at site. Temporary spool pieces are to be fabricated, fitted wherever necessary to facilitate blowing, clean systems and remove them after cleaning. After pre –fabrication of pipe lines, sand/shot blasting is to be carried out followed by one coat of primer painting for all CS piping. Contractor shall arrange all required consumables such as welding electrodes, Tig wires, argon gases, cutting gases, cutting and grinding wheels etc., including manpower, machineries, tools and tackles for completion of works in all respect as per drawings/ specification.</p>				

SL. NO	DESCRIPTION	UNIT	QTY	UNIT Rate (Rs)	TOTAL (Rs)
1	SS PIPING (SA 312 TP 304) 1) 15 NB (OD 21.3 X 2.77 THK) 2) 40 NB (OD 48.3 X 3.68 THK)				
	i. Pre-fabrication of SS Piping	Inch.dia	305		
	ii. Erection & Supporting of SS Piping	Inch.Mtr	300		
2	CS PIPING (SA 106 GR.B / API 5L GRB) 1) 15 NB (OD 21.8 X 2.77 to 4.78 THK) 2) 20 NB (OD 26.7 X 2.87 to 5.56 THK) 3) 25 NB (OD 34.2 X 3.38 to 6.35 THK) 4) 40 NB (OD 48.3 X 3.68 to 6.35 THK) 5) 50 NB (OD 60.3 X 3.91 to 8.74 THK) 6) 80 NB (OD 88.9 X 5.49 to 11.13 THK) 7) 100 NB (OD 114.3 X 6.0 to 8.56 THK) 8) 150 NB (OD 168.3 X 7.1 THK & 14.27 THK) 9) 250 NB (OD 273.0 X 6.35 THK)				
	i. Pre-fabrication of CS Piping	Inch.dia	5300		
	ii. Erection & supporting of CS Piping	Inch.Mtr	5200		
3	LTCS PIPING (SA 333-1) 1) 15 NB (OD 21.8 X 2.77 THK) 2) 20 NB (OD 26.7 X 2.87 THK) 3) 25 NB (33.4 X 3.38THK) 4) 40 NB (OD 48.3 X 5.1 THK) 5) 50 NB (60.3 X 3.91 THK) 6) 80 NB (OD 88.9 X5.49 THK)				
	i. Pre-fabrication of LTCS Piping	Inch.dia	270		
	ii. Erection & supporting of LTCS Piping	Inch.Mtr	162		

SL. NO	DESCRIPTION	UNIT	QTY	UNIT Rate (Rs)	TOTAL (Rs)
4	CS PIPING (SA 106 GR.B) /IBR PIPING 1) 15 NB (OD 21.8 X 3.73 THK) 2) 20 NB (OD 26.7 X 3.91 THK) 3) 25 NB (33.4 X 4.55 THK) 4) 50 NB (60.3 X 5.54 Thk) 5) 80 NB (OD 88.9 X5.49 THK) 6) 100 NB (OD 114.3 X 8.56 THK) 7) 40 NB (OD 48.3 x 5.08 THK)				
	In addition to the scope of works for fabrication and erection of piping mentioned above contractor has to arrange drawing approval from IBR authority, material inspection by IBR inspector, permission for site fabrication and erection, arranging IBR Inspector for witnessing test, final permission for charging the pipe lines etc., in all respect for total completion of works for IBR piping. Contractor to engage IBR certified welders with valid certificate for IBR jobs.				
	i. Pre-fabrication of Piping	Inch.dia	350		
	ii. Erection & supporting of Piping	Inch.Mtr	435		
V	VALVES Contractor's scope of work includes collection from stores, transportation to erection site, unpacking, revisioning, erection in position with mating flanges in all pipe lines at various elevations, welding of valves, gasket fixing, bolting / screwing etc., as per drawings and specifications. Temporary spool pieces are to be fabricated, fitted wherever necessary, to facilitate blowing clean systems and remove them after cleaning.				
1	SS VALVES (BW) -1/2" to 1½"	Nos	7		
2	CS VALVES (BW/ SW) - ½" to 3"	Nos	143		
3	CS VALVES (FLANGED) - ¾" to 4"	Nos	53		
4	CS VALVES (FLANGED) - 6" to 10"	Nos	7		
VI	Assembly and fixing of SS PACKING/INTERNALs in HP Scrubber and Ammonia Stripper.	MT	2.5		

SL. NO	DESCRIPTION	UNIT	QTY	UNIT Rate (Rs)	TOTAL (Rs)
VII	PIPE SUPPORTS(STRUCTURALS) Plates and structural steel will be supplied by BHEL-HPVP for fabrication and erection of pipe supports & clamps etc. Contractor's scope of work includes collect the materials from stores, fabrication of pipe supports, erection of the supports, clamping of various sizes of pipe lines and for the equipments as per drawings complete in all respect. Stainless steel clamps will be provided by BHEL-HPVP for SS pipe lines. Fabrication involves marking, gas cutting, grinding, bending, drilling and threading etc., sand/shot blasting and primer coat of paint to be applied as per specifications of the structurals. All the pipe lines are to be properly supported at various levels as per drawing/ as per the instructions of Site Engineer and the clamps to be properly tightened with fasteners. Supply of fasteners is in BHEL-HPVP scope.	MT	2		
VIII	PAINTING (As per PDIL Specification ES2001 Rev 0) Surface preparation to SA 2 1/2, Supply and application of paints are in contractor scope.				
1	Piping Supports. Total DFT 190 Microns PRIMER: Two Coats Two pack zinc rich epoxy polyamide cured Primer paints of 35 microns for each coat.(Total 70 microns) FINISH PAINT: Three (3) Coats: Two packs Polyamide Cured Epoxy paints of 40 microns for each coat (Total- 120 microns.)	MT	2		
2	UNINSULATED Piping operating temperature up to 90 degrees. Total DFT 190 Microns PRIMER: Two Coats Two pack zinc rich epoxy polyamide cured Primer paint of 35 microns for each coat (Total- 70 microns). FINISH PAINT: Three Coats: Two packs Polyamide Cured Epoxy paints of 40 microns for each coat (Total- 120 microns)	Sq.M	420		
3	INSULATED Piping: Operating temp up to 90 deg.C . Total DFT 200 Microns PRIMER: One Coat. High temperature phenolic epoxy paint of 100 microns per coat. FINISH PAINT: One Coat. High temperature phenolic epoxy paint of 100 micron per coat.	Sq.M	72		
4	INSULATED Piping : Operating temp over 200 deg.C. Total DFT 100 Microns PRIMER: One coat Ethyl Silicate zinc rich with solvent paints of 75 microns per coat. FINISH PAINT: One coat. Heat resisting Silicon Aluminium paint paint 25 micron per coat.	Sq.M	32		

SL. NO	DESCRIPTION	UNIT	QTY	UNIT Rate (Rs)	TOTAL (Rs)
5	STRUCTURAL: operating temperature up to 90 deg.C. Total DFT190 Microns PRIMER: Two Coats Two pack zinc rich epoxy polyamide cured Primer paint of 35 microns For each coat (Total- 70 microns). FINISH PAINT: Three Coats: Two packs Polyamide Cured Epoxy paints of 40 microns for each coat (Total- 120 microns).	Sq.M	900		
IX	Supply and Application of Insulation for Equipments and Pipe Lines				
	a) Supply of all hot insulation materials include supply of Rock wool LRB mattresses and Preformed pipe sections, cladding materials (Aluminium sheets both corrugated & plain), and all materials used for insulation like Securement Bands / Wires, Rivets, Screws, S & J Clips etc., as per PDIL Technical Specification No. PC65-TS-6700, Rev.0 & PC65-TS-6701, Rev.0, Insulation schedule, drawings etc., b) Application of hot insulation shall be carried out using Rock wool LRB mattresses and Preformed Pipe sections plain & corrugated aluminium sheets etc., Insulation thickness, Installation and other details shall be as per insulation schedule, drawings, and PDIL Technical Specification No. PC65-TS-6700, Rev.0 & PC65-TS-6701, Rev.0.				
	A) EQUIPMENTS (Hot Insulation)				
1	stripper feed heat exchanger(E3701): Insulation thickness: 76.2 mm.	Sq.M	4		
2	Feed Heater(E-3704). Insulation thickness: 65 mm.	Sq.M	2.5		
3	Reboilor(E-3703). Insulation thickness: 80 mm & 130 mm.	Sq.M	15		
4	Membarane housing(M3701 TO M3711). Insulation thickness: 40 mm.	Sq.M	35		
5	Condensate cooler(E-3702). Insulation thickness: 30 mm.	Sq.M	6		
6	Ammonia striper(F-3702). Insulation thickness: 80 mm.	Sq.M	20		
	B) Pipe Lines (Hot Insulation)				
1	25NB (65mm thk)	RM	8		
2	25 (70mm thk)	RM	31		
3	40NB (25mm thk)	RM	40		
4	40NB (40mm thk)	RM	26		
5	40NB (65mm thk)	RM	34		
6	40 (70mm thk)	RM	37		

SL. NO	DESCRIPTION	UNIT	QTY	UNIT Rate (Rs)	TOTAL (Rs)
7	50NB (40mm thk)	RM	33		
8	80NB (30mm thk)	RM	95		
9	80NB (40mm thk)	RM	73		
10	80NB (65mm thk)	RM	17		
11	80 (70mm thk)	RM	40		
12	100NB (30mm thk)	RM	5		
13	150NB (65mm thk)	RM	5		
	C) Pipe Lines (Cold Insulation)				
	a) Supply of all insulation materials like Polyurethane foam-PUF (Pre formed pipe section), cladding materials (Aluminium sheets), all materials used for insulation, like fixing, sealing and protection such as Wire netting, Lacing & Binding wire, Bands, Adhesive, Vapor seal, Filler materials, Joint sealer, Glass cloth, Anti-corrosive paints, Bituminized Roofing Felt etc., as per PDIL Technical Specification No. PC65-TS-6700, Rev.0 & PC65-TS-6702, Rev.0, Insulation schedule, drawings etc.,				
	b)Application of cold insulation shall be carried out using polyurethane foam, Aluminium cladding and other materials specified above. Insulation thickness, Installation and other details shall be as per as per PDIL Technical Specification No. PC65-TS-6700, Rev.0 & PC65-TS-6702, Rev.0, Insulation schedule, drawings etc.,				
1	40 (25mm thk)	RM	60		
X	COMMISSIONING ASSISTANCE: Contractor shall provide manpower towards commissioning assistance 12 persons a day (4 in each shift Fitter - 1 No, Rigger - 1 No, Helpers - 2 Nos) for a period of 1 (ONE) month with tools, tackles, and consumables including over time, Sundays & holidays and supervisor as required and directed by BHEL-HPVP Engineer. Contractor to quote average manday rates including all.	Man days	360		
TOTAL NR					
(In words Ruppes					
Note:	1. The quantities indicated above against each item are tentative and may vary. The prices/rates quoted shall be remain firm till completion of work as per contract.				
	2. Payment shall be made based on the quantities executed at site and certified by BHEL-HPVP engineer.				

SIGNATURE OF CONTRACTOR WITH SEAL

ANNEXURE - III

GENERAL CONDITIONS OF CONTRACT

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CHAPTER -1

1. GENERAL INSTRUCTION TO TENDERERS

1.1. DESPATCH INSTRUCTION

- i) The General Conditions of Contract form part of the Tender specifications. **All pages of the tender documents shall be duly signed, stamped and submitted along with the offer in token of complete acceptance thereof.** The information furnished shall be complete by itself. The tenderer is required to furnish all the details and other documents as required in the following pages
- ii) Tenderers are advised to study all the tender documents carefully. Any submission of tender by the tenderer shall be deemed to have been done after careful study and examination of the tender documents and with the full understanding of the implications thereof. Should the tenderers have any doubt about the meaning of any portion of the Tender Specification or find discrepancies or omissions in the drawings or the tender documents issued are incomplete or shall require clarification on any of the technical aspect, the scope of work etc., he shall at once, contact the authority inviting the tender well in time (so as not to affect last date of submission) for clarification before the submission of the tender. Tenderer's request for clarifications shall be with reference to Sections and Clause numbers given in the tender documents. The specifications and terms and conditions shall be deemed to have been accepted by the tenderer in his offer. Non compliance with any of the requirements and instructions of the tender enquiry may result in the rejection of the tender.

1.2. SUBMISSION OF TENDERS

- 1.2.1 The tenderers must submit their tenders to Officer inviting tender as per instructions in the NIT
- 1.2.2 Tenders submitted by post shall be sent by 'REGISTERED POST ACKNOWLEDGEMENT DUE / by COURIER' and shall be posted with due allowance for any postal/courier delays. BHEL takes no responsibility for delay, loss or non-receipt of tenders sent by post/courier. **The tenders received after the specified time of their submission are treated as 'Late Tenders' and shall not be considered under any circumstances.** Offers received by Fax/Email/Internet shall be considered as per terms of NIT.
- 1.2.3 Tenders shall be opened by authorised Officer of BHEL at his office at the time and date as specified in the NIT, in the presence of such of those tenderers or their authorised representatives who may be present

1.2.4 Tenderers whose bids are found techno commercially qualified shall be informed the date and time of opening of the Price Bids and such Tenderers may depute their representatives to witness the opening of the price bids. BHEL's decision in this regard shall be final and binding.

1.2.5 Before submission of Offer, the tenderers are advised to inspect the site of work and the environments and be well acquainted with the actual working and other prevalent conditions, facilities available, position of material and labour, means of transport and access to Site, accommodation, etc. No claim will be entertained later on the grounds of lack of knowledge of any of these conditions.

1.3. **LANGUAGE**

1.3.1 The tenderer shall quote the rates in English language and international numerals. These rates shall be entered in figures as well as in words. For the purpose of the tenders, the metric system of units shall be used.

1.3.2 All entries in the tender shall either be typed or written legibly in ink. Erasing and over-writing is not permitted and may render such tenders liable for rejection. All cancellations and insertions shall be duly attested by the tenderer.

1.4 **PRICE DISCREPANCY:**

1.4.1 **Conventional (Manual) Price Bid opening** : In the case of price bid opening without resorting to Reverse Auction, if there are differences between the rates given by the tenderer in words and figures or in amount worked out by him, the following procedure for evaluation and award shall be followed:

i) When there is a difference between the rates in figures and in words, the rates which corresponds to the amounts worked out by the contractor, shall be taken as correct

ii) When the amount of an item is not worked out by the contractor or it does not correspond with the rate written either in figure or in words, then the rate quoted by the contractor in words shall be taken as correct

iii) When the rate quoted by the contractor in figures and words tallies but the amount is not worked out correctly, the rate quoted by the contractor shall be taken as correct and not the amount.

iv) In case of lumpsum price, if there is any difference between the amount in figures and in words, the amount quoted by the bidder in words shall be taken as correct.

v) In case of omission in quoting any rate for one or more items, the evaluation shall be done considering the highest quoted rate obtained against the respective items by other tenderers for the subject tender. If the tenderer becomes L-1, the notional rates for the omission items shall be the lowest rates quoted for the respective items by the other tenderers against the respective omission items for the subject job and the 'Total quoted price (loaded for omissions)' shall be arrived at. However the overall price remaining the same as quoted originally, the rates for all the items in the 'Total quoted price (loaded for omissions)' shall be reduced item wise in proportion to the ratio of 'Original' total price and the 'Total quoted price (loaded for omissions)'.

vi) The 'Final Total Amount' shall be arrived at after considering the amounts worked out in line with 'i' to 'iv' above.

1.4.2 **Reverse Auction**: In case of Reverse Auction, the successful bidder shall undertake to execute the work as per overall price offered by him during the Reverse Auction process. In case of omission of rates, the procedure shall be as per 'Guidelines for Reverse Auction' enclosed.

1.5 **QUALIFICATION OF TENDERERS**

i) Only tenderers who have previous experience in the work of the nature and description detailed in the Notice Inviting Tender and/or tender specification are expected to quote for this work duly detailing their experience along with offer.

- ii) Offers from tenderers who do not have proven and established experience in the field shall not be considered
- iii) Offers from tenderers who are under suspension (banned) by any Unit/Region/Division of BHEL shall not be considered.
- iv) Offers from tenderers who do not comply with the latest guidelines of Ministry/Commissions of Govt of India shall not be considered.

1.6. EVALUATION OF BIDS

- i) Technical Bids submitted by the tenderer will be opened first and evaluated for fulfilling the Pre Qualification criteria and other conditions in NIT/Tender documents, based on documentary evidences submitted along with the offer
- ii) In case the same qualifying experience is claimed by more than one agency, then the agency who has executed the work as per documentary evidence submitted shall only be qualified. Scope of qualifying work should be totally with the agency who has executed and in case it is only labour+consumables without T&P, then the responsibility of execution is assigned to the first agency and not to the agency who has executed only as labour supply contractor. Further, BHEL reserves the right to ask for further proofs including submission of TDS certificates for the said job
- iii) In case the qualifying experience is claimed by private organizations based on Work Order and completion certificates from another private organization, BHEL reserves the right to ask for further proofs including submission of TDS certificates for the said job
- iv) Assessing Bidder Capacity for executing the current tender shall be as per Notice Inviting Tender
- v) Price Bids of shortlisted bidders shall only be opened either through the conventional price bid opening or through electronic Reverse Auction, at the discretion of BHEL
- vi) Price Bids of unqualified bidders shall not be opened. Reasons for rejection shall be intimated in due course after issue of LOI/LOA to successful bidder and receipt of unqualified acceptance from the successful bidder

1.7. DATA TO BE ENCLOSED

Full information shall be given by the tenderer in respect of the following. Non-submission of this information may lead to rejection of the offer.

- i) **INCOME TAX PERMANENT ACCOUNT NUMBER**
Certified copies of Permanent Account Numbers as allotted by Income Tax Department for the Company/Firm/Individual Partners, etc. shall be furnished along with tender.
- ii) **ORGANIZATION CHART**
The organization chart of the tenderer's organization, including the names, addresses and contact information of the Directors/Partners shall be furnished along with the offer.
- iii) An attested copy of the Power of Attorney, in case the tender is signed by an individual other than the sole proprietor
- iv) **IN CASE OF INDIVIDUAL TENDERER:**
His / her full name, address and place & nature of business.

v) IN CASE OF PARTNERSHIP FIRM

The names of all the partners and their addresses, A copy of the partnership deed/instrument of partnership duly certified by the Notary Public shall be enclosed.

vi) IN CASE OF COMPANIES:

- a. Date and place of registration including date of commencement certificate in case of Public Companies (certified copies of Memorandum and articles of Association are also to be furnished).
- b. Nature of business carried on by the Company and the provisions of the Memorandum relating thereof.

1.8 AUTHORISATION AND ATTESTATION

Tenders shall be signed by a person duly authorized/empowered to do so. An attested copy of the Power of Attorney, in case the tender is signed by an individual other than the sole proprietor shall be submitted along with the tenders

1.9 EARNEST MONEY DEPOSIT

1.9.1 Every tender must be accompanied by the prescribed amount of Earnest Money Deposit (EMD) in the manner described herein.

- i) EMD shall be furnished along with the offer in full as per the amount indicated in the Special Conditions of Contract / NIT
- ii) EMD is to be paid in cash (as permissible under Income Tax Act), Pay order or Demand Draft in favour of 'Bharat Heavy Electricals Limited' and payable at Regional HQ issuing the tender.
- iii) No other form of EMD remittance shall be acceptable to BHEL
- iv) Bidder may opt to deposit "One Time EMD" of Rs. 2.0 lakhs (Rupees Two lakhs only) with BHEL: HPVP HQ issuing the tender, which will enable them to participate in all the future tender enquiries in respect of Erection and Commissioning services issued from the respective office. Interested bidders may clearly send their consent for converting the present EMD into a "One Time EMD" in their offer.
Note : The 'One Time EMD' cannot be withdrawn by the tenderers within 3 years from the date of deposit, under any circumstances. The Tenderer who wishes to withdraw after three years will not be allowed to submit 'One Time EMD' again.

v) Bidders who have already deposited such "One Time EMD" of Rs. 2.00 lakh are exempted from submission of EMD for this tender. However a copy of 'One Time EMD' certificate issued by BHEL Regional HQ issuing the tender shall be enclosed along with the offer.

1.9.2 EMD by the bidder will be forfeited as per Tender Documents if

- i) After opening the tender, the bidder revokes his tender within the validity period or increases his earlier quoted rates.
- ii) The bidder does not commence the work within the period as per LOI/Contract. In case the LOI / contract is silent in this regard then within 15 days after award of contract.

1.9.3 EMD shall not carry any interest.

1.9.4 In the case of unsuccessful bidders, the Earnest Money will be refunded to them within a reasonable time after acceptance of award by successful tenderer.

1.10 SECURITY DEPOSIT

1.10.1 Upon acceptance of Tender, the successful Tenderer should deposit the required amount of Security Deposit for satisfactory completion of work, as per the rates given below:

SN	Contract Value	Security Deposit Amount
1	Up to Rs. 10 lakhs	10% of Contract Value
2	Above Rs. 10 lakhs Upto Rs. 50 Lakhs	1 lakh + 7.5% of the Contract Value Exceeding Rs. 10 Lakhs
3	Above Rs. 50 lakhs	Rs 4 lakhs + 5% of the Contract Value Exceeding Rs. 50 Lakhs

1.10.2 The security Deposit should be furnished before start of the work by the contractor.

1.10.3 Security Deposit may be furnished in any one of the following forms

- i) Cash (as permissible under the Income Tax Act)
- ii) Pay Order / Demand Draft in favour of BHEL.
- iii) Local cheques of scheduled banks, subject to realization.
- iv) Securities available from Post Offices such as National Savings Certificates, Kisan Vikas Patras etc. (Certificates should be held in the name of Contractor furnishing the security and duly pledged in favour of BHEL and discharged on the back).
- v) Bank Guarantee from Scheduled Banks / Public Financial Institutions as defined in the Companies Act. The Bank Guarantee format for Security Deposit shall be in the prescribed formats
- vi) Fixed Deposit Receipt issued by Scheduled Banks / Public Financial Institutions as defined in the Companies Act. The FDR should be in the name of the contractor, A/C BHEL, duly discharged on the back.
- vii) Security deposit can also be recovered at the rate of 10% from the running bills. However in such cases at least 50% of the Security Deposit should be deposited in any form as prescribed before start of the work and the balance 50% may be recovered from the running bills.
- viii) EMD of the successful bidder can be converted and adjusted against the cash portion of Security Deposit excepting for such bidders who have remitted One Time EMD.

NOTE: Acceptance of Security Deposit against Sl. No. (iv) and (vi) above will be subject to hypothecation or endorsement on the documents in favour of BHEL. However, BHEL will not be liable or responsible in any manner for the collection of interest or renewal of the documents or in any other matter connected therewith.

1.10.4 The Security Deposit shall not carry any interest.

1.10.5 In case the value of work exceeds / reduces from the awarded / accepted value, the Security Deposit shall be correspondingly enhanced / reduced as given below:

- i) The enhanced part of the Security Deposit shall be immediately deposited by the Contractor or adjusted against payments due to the Contractor.
- ii) There will be no reduction in Security Deposit value in case of variation in contract value upto the lower limit specified in Quantity variation clause. In case of reduction of contract value beyond the lower limit specified in Quantity Variation clause, then the Security Deposit shall be re adjusted in proportion.
- iii) In case of reduction, the reduced Contract value shall be certified by BHEL Construction Manager after ascertaining / freezing of BOQ / Drawings from the Design / Engineering Centre. The reduced Security Deposit value can only be considered after taking into account the adequacy of the

securities held by BHEL to meet the liabilities of the contractor for the contract, and the performance of the contract in general. **In such cases, the revised value of Security Deposit shall be worked out only after execution of not less than the lower limit of the revised scope of work/contract value as per quantity variation clause, and as certified by Construction Manager. This reduction in value of Security Deposit shall not entitle the contractor to any amendment of Contract and shall be operated at the discretion of BHEL**

iv) Void.

1.10.6 The validity of Bank Guarantees towards Security Deposit shall be initially upto the completion period as stipulated in the Letter of Intent/Award + 3 months, and the same shall be kept valid by proper renewal till the acceptance of Final Bills of the Contractor, by BHEL

1.10.7 BHEL reserves the right of forfeiture of Security Deposit in addition to other claims and penalties in the event of the Contractor's failure to fulfill any of the contractual obligations or in the event of termination of contract as per terms and conditions of contract. BHEL reserves the right to set off the Security Deposit against any claims of other contracts with BHEL.

1.11 RETURN OF SECURITY DEPOSIT

Security Deposit shall be refunded/Bank Guarantee(s) released to the Contractor along with the 'Final Bill' after deducting all expenses / other amounts due to BHEL under the contract / other contracts entered into with them by BHEL.

1.12 BANK GUARANTEES

Where ever Bank Guarantees are to be furnished/submitted by the contractor, the following shall be complied with

- i) Bank Guarantees shall be from Scheduled Banks / Public Financial Institutions as defined in the Companies Act.
- ii) The Bank Guarantees shall be as per prescribed formats.
- iii) It is the responsibility of the bidder to get the Bank Guarantees revalidated/extended for the required period (subject to a minimum period of six months), as per the advice of BHEL Site Engineer / Construction Manager. BHEL shall not be liable for issue of any reminders regarding expiry of the Bank Guarantees.
- iv) In case extension/further extensions of any Bank Guarantees are not required, the bidders shall ensure that the same is explicitly endorsed by the Construction Manager and submitted to the Regional HQ issuing the LOI/LOA.
- v) In case the Bank Guarantees are not extended before the expiry date, BHEL reserves the right to invoke the same by informing the concerned Bank in writing, without any advance notice/ communication to the concerned bidder
- vi) Bidders to note that any corrections to Bank Guarantees shall be done by the issuing Bank, only through an amendment in an appropriate non judicial stamp paper.
- vii) The Original Bank Guarantee shall be sent directly by the Bank to BHEL under Registered Post (Acknowledgement Due), addressed to the Subcontracting Department of the respective Region.

1.13 VALIDITY OF OFFER

The rates in the Tender shall be kept open for acceptance for a minimum period of **SIX MONTHS** from latest due date of offer submission (including extension, if any) . In case BHEL (Bharat Heavy Electricals Ltd) calls for negotiations, such negotiations shall not amount to cancellation or withdrawal of the original offer which shall be binding on the tenderers.

1.14 EXECUTION OF CONTRACT AGREEMENT

The successful tenderer's responsibility under this contract commences from the date of issue of the Letter of Intent by Bharat Heavy Electricals Limited. The Tenderer shall submit an unqualified acceptance to the Letter of Intent/Award within the period stipulated therein.

The successful tenderer shall be required to execute an agreement in the prescribed form, with BHEL, within a reasonable time after the acceptance of the Letter of Intent/Award, and in any case before releasing the first running bill. The contract agreement shall be signed by a person duly authorized/empowered by the tenderer. The expenses for preparation of agreement document shall be borne by BHEL

1.15 REJECTION OF TENDER AND OTHER CONDITIONS

1.15.1 The acceptance of tender will rest with BHEL which does not bind itself to accept the lowest tender or any tender and reserves to itself full rights for the following without assigning any reasons whatsoever:-

a. To reject any or all of the tenders.

b. To split up the work amongst two or more tenderers as per NIT

c. To award the work in part if specified in NIT

d. In case of either of the contingencies stated in (b) and (c) above, the time for completion as stipulated in the tender shall be applicable.

1.15.2 Conditional tenders, unsolicited tenders, tenders which are incomplete or not in the form specified or defective or have been materially altered or not in accordance with the tender conditions, specifications etc., are liable to be rejected.

1.15.3 Tenders are liable to be rejected in case of unsatisfactory performance of the tenderer with BHEL, or tenderer under suspension (hold/banning /delisted) by any unit / region / division of BHEL or tenderers who do not comply with the latest guidelines of Ministry/Commissions of Govt of India. BHEL reserves the right to reject a bidder in case it is observed that they are overloaded and may not be in a position to execute this job as per the required schedule. The decision of BHEL will be final in this regard.

1.15.4 If a tenderer who is a proprietor expires after the submission of his tender or after the acceptance of his tender, BHEL may at their discretion, cancel such tender. If a partner of a firm expires after the submission of tender or after the acceptance of the tender, BHEL may then cancel such tender at their discretion, unless the firm retains its character.

1.15.5 BHEL will not be bound by any Power of Attorney granted by changes in the composition of the firm made subsequent to the execution of the contract. They may, however, recognise such

- power of Attorney and changes after obtaining proper legal advice, the cost of which will be chargeable to the contractor concerned.
- 1.15.6 If the tenderer deliberately gives wrong information in his tender, BHEL reserves the right to reject such tender at any stage or to cancel the contract if awarded and forfeit the Earnest Money/Security Deposit/any other money due.
- 1.15.7 Canvassing in any form in connection with the tenders submitted by the Tenderer shall make his offer liable to rejection.
- 1.15.8 In case the Proprietor, Partner or Director of the Company/Firm submitting the Tender, has any relative or relation employed in BHEL, the authority inviting the Tender shall be informed of the fact as per specified format, along with the Offer. Failing to do so, BHEL may, at its sole discretion, reject the tender or cancel the contract and forfeit the Earnest Money/Security Deposit.
- 1.15.9 The successful tenderer should not sub-contract part or complete work detailed in the tender specification undertaken by him without written permission of BHEL's Construction Manager/Site Incharge. The tenderer is solely responsible to BHEL for the work awarded to him.
- 1.15.10 The Tender submitted by a techno commercially qualified tenderer shall become the property of BHEL who shall be under no obligation to return the same to the bidder. However unopened price bids and late tenders shall be returned to the bidders
- 1.15.11 Unsolicited discount received after the due date and time of Bid Submission shall not be considered for evaluation. However, if the party who has submitted the unsolicited discount/rebate becomes the L-1 party, then the awarded price i.e contract value shall be worked out after considering the discount so offered.
- 1.15.12 BHEL shall not be liable for any expenses incurred by the bidder in the preparation of the tender irrespective of whether the tender is accepted or not.

CHAPTER-2

2.1 DEFINITION: The following terms shall have the meaning hereby assigned to them except where the context otherwise requires.

- i) BHEL shall mean Bharat Heavy Electricals Limited (of the respective Power Sector Region inviting the Tender), a company registered under Indian Companies Act 1956, with its Registered Office at BHEL HOUSE, SIRI FORT, NEW DELHI – 110 049, or its Power Sector Regional Offices or its Authorised Officers or its Site Engineers or other employees authorised to deal with any matters with which these persons are concerned on its behalf.
- ii) “EXECUTIVE DIRECTOR” or ‘GROUP GENERAL MANAGER’ or “GENERAL MANAGER (Incharge)” or “GENERAL MANAGER” shall mean the Officer in Administrative charge of the respective Power Sector Region.
- iii) “COMPETENT AUTHORITY” shall mean Executive Director or Group General Manager or General Manager (Incharge) or General Manager or BHEL Officers who are empowered to act on behalf of the Executive Director or General Manager (Incharge) or General Manager of BHEL.
- iv) “ENGINEER” or “ENGINEER IN CHARGE” shall mean an Officer of BHEL as may be duly appointed and authorized by BHEL to act as “Engineer” on his behalf for the purpose of the Contract, to perform the duty set forth in this General Conditions of Contract and other Contract documents. The term also includes ‘CONSTRUCTION MANAGER’ or ‘SITE INCHARGE’ as well as Officers at Site or at the Headquarters of the respective Power Sector Regions.
- v) “SITE” shall mean the places or place at which the plants/equipments are to be erected and services are to be performed as per the specification of this Tender.
- vi) “CLIENT OF BHEL” or “CUSTOMER” shall mean the project authorities with whom BHEL has entered into a contract for supply of equipments or provision of services.
- vii) “CONTRACTOR” shall mean the successful Bidder/Tenderer who is awarded the Contract and shall include the Contractor’s successors, heirs, executors, administrators and permitted assigns.
- viii) “CONTRACT” or “CONTRACT DOCUMENT” shall mean and include the Agreement of Work Order, the accepted appendices of Rates, Schedules, Quantities if any, General Conditions of Contract, Special Conditions of Contract, Technical conditions and scope of work, Instructions to the Tenderers, Drawings, Technical Specifications, the Special Specifications if any, the Tender documents, subsequent amendments mutually agreed upon and the Letter of Intent/Acceptance issued by BHEL. Any conditions or terms stipulated by the contractor in the tender documents or subsequent letters shall not form part of the contract unless, specifically accepted in writing by BHEL in the Letter of Intent/Award and incorporated in the agreement.
- ix) “GENERAL CONDITIONS OF CONTRACT” shall mean the ‘Instructions to Tenderers’ and ‘General Conditions of Contract’ pertaining to the work for which above tenders have been called for.
- x) “TENDER SPECIFICATION” or “TENDER” or “TENDER DOCUMENTS” shall mean General Conditions, Common Conditions, Special Conditions, Technical conditions and scope of works, Price Bid, Rate Schedule, Technical Specifications, Appendices, Annexures, Corrigendums, Amendments, Forms, procedures, Site information, etc and drawings/documents pertaining to the work for which the tenderers are required to submit their offers. Individual specification number will be assigned to each Tender Specification.

- xi) "LETTER OF INTENT" shall mean the intimation by a Letter/Fax/email to the tenderer that the tender has been accepted in accordance with provisions contained in the letter. The responsibility of the contractor commences from the date of issue of this letter and all terms and conditions of the contract are applicable from this date.
- xii) "COMPLETION TIME" shall mean the period by 'date/month' specified in the 'Letter of Intent/Award' or date mutually agreed upon for handing over of the intended scope of work, the erected equipment/plant which are found acceptable by the Engineer, being of required standard and conforming to the specifications of the Contract.
- xiii) "PLANT" shall mean and connote the entire assembly of the plant and equipments covered by the contract.
- xiv) "EQUIPMENT" shall mean equipment, machineries, materials, structural, electricals and other components of the plant covered by the contract.
- xv) "TESTS" shall mean and include such test or tests to be carried out on the part of the contractor as are prescribed in the contract or considered necessary by BHEL, in order to ascertain the quality, workmanship, performance and efficiency of the contractor or part thereof.
- xvi) "APPROVED", "DIRECTED" or "INSTRUCTED" shall mean approved, directed or instructed by BHEL.
- xvii) "WORK or CONTRACT WORK" shall mean and include supply of all categories of labour, specified consumables, tools and tackles and Plants required for complete and satisfactory site transportation, handling, stacking, storing, erecting, testing and commissioning of the equipments to the entire satisfaction of BHEL.
- xviii) "SINGULAR AND PLURALS ETC" words carrying singular number shall also include plural and vice versa, where the context so requires. Words imparting the masculine Gender shall be taken to include the feminine Gender and words imparting persons shall include any Company or Associations or Body of Individuals, whether incorporated or not.
- xix) "HEADING" – The heading in these General Conditions are solely for the purpose of facilitating reference and shall not be deemed to be part thereof or be taken as instructions thereof or of the contract.
- xx) "MONTH" shall mean calendar month unless otherwise specified in the Tender.
- xxi) Day' or 'Days' unless herein otherwise expressly defined shall mean calendar day or days of twenty four (24) hours each. A week shall mean continuous period of seven (7) days.
- xxii) "COMMISSIONING" shall mean the synchronisation testing and achieving functional operation of the Equipment with associated system after all initial adjustments, trials, cleaning, re- assembly required at site if any, have been completed and Equipment with associated system is ready for taking into service.
- xxiii) "WRITING" shall include any manuscript type written or hand written or printed statement or electronically transmitted messages, under the signature or seal or transmittal of BHEL.
- xxiv) "TEMPORARY WORK" shall mean all temporary works for every kind required in or for the execution, completion, maintenance of the work.
- xxv) 'CONTRACT PRICE' or 'CONTRACT VALUE' shall mean the sum mentioned in the LOI/LOA/Contract Agreement subject to such additions thereto or deductions there from as may be made under provisions hereinafter contained.
- xxvi) "COMMENCEMENT DATE" or "START DATE" shall mean the commencement/start of work at Site as per terms defined in the Tenderl.
- xxvii) "SHORT CLOSING" or "FORE CLOSING" of Contract shall mean the premature closing of Contract, for reasons not attributable to the contractor and mutually agreed between BHEL and the contractor.
- xxviii) "TERMINATION" of Contract shall mean the pre mature closing of contract due to reasons as mentioned in the contract

- xxix) "DE MOBILISATION" shall mean the temporary winding up of Site establishment by Contractor leading to suspension of works temporarily for reasons not attributable to the contractor.
- xxx) "RE MOBILISATION" shall mean the resumption of work with all resources required for the work after demobilization.
- 2.2 LAW GOVERNING THE CONTRACT AND COURT JURISDICTION :** Please refer Clause No. 7 , Page 14 of Annexure – I of NIT.
- 2.3 ISSUE OF NOTICE**
- 2.3.1 Service of notice on contractor**
Any notice to be given to the Contractor under the terms of the contract shall be served by sending the same **by Registered Post / Speed Post** to or leaving the same at the Contractor's last known address of the principal place of business (or in the event of the contractor being a company, to or at its Registered Office). In case of change of address, the notice shall be served at changed address as notified in writing by the Contractor to BHEL. Such posting or leaving of the notice shall be deemed to be good service of such notice and the time mentioned to the condition for doing any act after notice shall be reckoned from the date so mentioned in such notice.
- 2.3.2 Service of notice on BHEL**
Any notice to be given to BHEL in-charge/Region under the terms of the Contract shall be served by sending the same by post to or leaving the same at BHEL address or changed address as notified in writing by BHEL to the Contractor.
- 2.4 USE OF LAND**
No land belonging to BHEL or their Customer under temporary possession of BHEL shall be occupied by the contractor without written permission of BHEL.
- 2.5 COMMENCEMENT OF WORK**
- 2.5.1 The contractor shall commence the work as per the time indicated in the Letter of Intent from BHEL and shall proceed with the same with due expedition without delay.
- 2.5.2 If the contractor fails to start the work within stipulated time as per LOI or as intimated by BHEL, then BHEL at its sole discretion will have the right to cancel the contract. The Earnest Money and/or Security Deposit with BHEL will stand forfeited without any further reference to him without prejudice to any and all of BHEL's other rights and remedies in this regard.
- 2.5.3 All the work shall be carried out under the direction and to the satisfaction of BHEL.

2.6 MEASUREMENT OF WORK AND MODE OF PAYMENT:

- 2.6.1 All payments due to the contractors shall be made by e mode only.
- 2.6.2 For progress running bill payments: - The Contractor shall present detailed measurement sheets in triplicate, duly indicating all relevant details based on technical documents and connected drawings for work done during the month/period under various categories in line with terms of payment as per contract. The basis of arriving at the quantities, weights shall be relevant documents and drawings released by BHEL. These measurement sheets shall be prepared jointly with BHEL Engineers and signed by both the parties.
- 2.6.3 These measurement sheets will be checked by BHEL Engineer and quantities and percentage eligible for payment under various groups shall be decided by BHEL Engineer. The abstract of quantities and percentage so arrived at based on the terms of payment shall be entered in Measurement sheets and signed by both the parties.
- 2.6.4 Based on the above quantities, contractor shall prepare the bills in prescribed format and work out the financial value. Payment shall be made by BHEL after effecting the recoveries due from the contractor.
- 2.6.5 All recoveries due from the contractor for the month/period shall be effected in full from the corresponding running bills unless specific approval from the competent authorities is obtained to the contrary.
- 2.6.6 Measurement shall be restricted to that portion of work for which it is required to ascertain the financial liability of BHEL under this contract.
- 2.6.7 The measurement shall be taken jointly by persons duly authorized on the part of BHEL and by the Contractor.
- 2.6.8 The Contractor shall bear the expenditure involved if any, in making the measurements and testing of materials to be used/used in the work. The contractor shall, without extra charges, provide all the assistance with appliances and other things necessary for measurement.
- 2.6.9 If at any time due to any reason whatsoever, it becomes necessary to re-measure the work done in full or in part, the expenses towards such re measurements shall be borne by the contractor unless such re measurements are warranted solely for reasons not attributable to contractor.
- 2.6.10 Passing of bills covered by such measurements does not amount to acceptance of the completion of the work measured. Any left out work has to be completed, if pointed out at a later date by BHEL.
- 2.6.11 Final measurement bill shall be prepared in the final bill format prescribed for the purpose based on the certificate issued by BHEL Engineer that entire works as stipulated in tender specification has been completed in all respects to the entire satisfaction of BHEL. Contractor shall give unqualified "No Claim" Certificate. All the tools and tackles loaned to him should be returned in satisfactory condition to BHEL. The Final Bill shall be prepared and paid within a reasonable time after completion of work.

2.7 RIGHTS OF BHEL

BHEL reserves the following rights in respect of this contract during the original contract period or its extensions if any, as per the provisions of the contract, without entitling the contractor for any compensation.

- 2.7.1 To withdraw any portion of work and/or to restrict/alter quantum of work as indicated in the contract during the progress of work and get it done through other agencies to suit BHEL's commitment to its customer or in case BHEL decides to advance the date of completion due to other emergent reasons/ BHEL's obligation to its customer.
- 2.7.2 To terminate the contract or get any part of the work done through other agency or deploy BHEL's own/hired/otherwise arranged resources , at the risk and cost of the contractor after due notice of a period of two weeks by BHEL, in the event of:-
- i) Contractor's continued poor progress
 - ii) Withdrawal from or abandonment of the work before completion of the work
 - iii) Contractor's inability to progress the work for completion as stipulated in the contract
 - iv) Poor quality of work
 - v) Corrupt act of Contractor
 - vi) Insolvency of the Contractor
 - vii) Persistent disregard to the instructions of BHEL
 - viii) Assignment, transfer, sub-letting of contract without BHEL's written permission
 - ix) Non fulfillment of any contractual obligations
 - x) In the opinion of BHEL, the contractor is overloaded and is not in a position to execute the job as per required schedule
- 2.7.3 To meet the expenses including BHEL overheads on the differential cost at 5%, over and above the Liquidated damages/penalties arising out of "Risk & Cost" as explained above under Sl.No. 2.7.2. BHEL shall recover the amount from any money due from Contractor, or from any money due to the Contractor including Security Deposit, or by forfeiting any T&P or material of the contractor under this contract or any other contract of BHEL or by any other means or any combination thereof
- 2.7.4 To terminate the contract or to restrict the quantum of work and pay for the portion of work executed in case BHEL's contract with their customer are terminated for any reason, as per mutual agreement.
- 2.7.5 To effect recovery from any amounts due to the contractor under this or any other contract or in any other form, the moneys BHEL is statutorily forced to pay to anybody, due to contractor's failure to fulfill any of his obligations. BHEL shall levy overheads of 5% on all such payments along with interest as defined elsewhere in the GCC.
- 2.7.6 While every endeavour will be made by BHEL to this end, they cannot guarantee uninterrupted work due to conditions beyond their control. The Contractor will not be normally entitled for any compensation/extra payment on this account unless otherwise specified elsewhere in the contract.

2.7.7 In case the execution of works comes to a complete halt or reaches a stage wherein worthwhile works cannot be executed and there is no possibility of commencement of work for a period of not less than two months, due to reasons not attributable to the contractor and other than Force Majeure conditions, BHEL may consider permitting the contractor to de mobilize forthwith and re mobilize at an agreed future date. Cost of such demobilization/remobilization shall be mutually agreed. The duration of contract/time extension shall accordingly get modified suitably. In case of any conflict, BHEL decision in this regard shall be final and binding on the contractor.

2.7.8 In the unforeseen event of inordinate delay in receipt of materials, drawings, fronts, etc, due to which inordinate discontinuity of work is anticipated, BHEL at its discretion may consider contractor's request to short close the contract in following cases:

- a) The balance works (including but not limited to Trial Operation, PG Test, etc) are minor vis a vis the scope of work envisaged as per the contract.
- b) There has been no significant work in past 6 months OR no significant work is expected in next 6 months (example in Hydro projects or in projects where work has stopped due to reasons beyond the control of BHEL)
- c) The balance works cannot be done within a reasonable period of time as they are dependent on unit shutdown or on other facilities of customer or any other reasons not attributable to the contractor

At the point of requesting for short closure, contractor shall establish that he has completed all works possible of completion and he is not able to proceed with the balance works due to constraints beyond his control. In such a case, the estimated value of the unexecuted portion of work (or estimated value of services to be provided for carrying out milestone/stage payments like Trial Operation/PG Test, etc) as mutually agreed, shall however be reduced from the final contract value.

2.7.9 **LIQUIDATED DAMAGES/PENALTY** : Please refer Clause No. 10 , Page 15 of Annexure – I of NIT.

2.8 RESPONSIBILITIES OF THE CONTRACTOR IN RESPECT OF LOCAL LAWS, EMPLOYMENT OF WORKERS ETC.

The following are the responsibilities of the contractor in respect of observance of local laws, employment of personnel, payment of taxes etc. The subcontractor shall fully indemnify BHEL against any claims of whatsoever nature arising due to the failure of the contractor in discharging any of his responsibilities hereunder:

2.8.1 As far as possible, Unskilled Workers shall be engaged from the local areas in which the work is being executed.

2.8.2 The contractor at all times during the continuance of this contract shall, in all his dealings with local labour for the time being employed on or in connection with the work, have due regard to all local festivals and religious and other customs.

- 2.8.3 The contractor shall comply with all applicable State and Central Laws, Statutory Rules, Regulations etc. such as Payment of Wages Act, Minimum Wages Act, Workmen Compensation Act, Employer's Liability Act, Industrial Disputes Act, Employers Provident Act, Employees State Insurance Scheme, Contract Labour (Regulation and Abolition) Act 1970, Payment of Bonus & Gratuity Act and other Acts, Rules and Regulations for labour as may be enacted by the Government during the tenure of the Contract and having force or jurisdiction at Site. The Contractor shall also give to the local Governing Body, Police and other relevant Authorities all such notices as may be required by the Law.
- 2.8.4 The contractor shall obtain independent License under the Contract Labour (Regulations and Abolition Act, 1970) as required from the concerned Authorities based on the certificate (Form-V) issued by the Principal Employer/Customer
- 2.8.5 The contractor shall pay all taxes, fees, license charges, deposits, duties, tolls, royalties, commission or other charges which may be leviable on account of his operations in executing the contract.
- 2.8.6 While BHEL would pay the inspection fees and Registration fees of Boiler/Electrical Inspectorate, all other arrangements for site visits periodically by the Inspectorate to site, Inspection certificate etc. will have to be made by contractor. However, BHEL will not make any payment to the Inspectorate in connection with contractor's Welders/Electricians qualification tests etc.
- 2.8.7 Contractor shall be responsible for provision of Health and Sanitary arrangements (more particularly described in Contract Labour Regulation & Abolition Act), Safety precautions etc. as may be required for safe and satisfactory execution of contract.
- 2.8.8 The contractor shall be responsible for proper accommodation including adequate medical facilities for personnel employed by him.
- 2.8.9 The contractor shall be responsible for the proper behavior and observance of all regulations by the staff employed by him.
- 2.8.10 The contractor shall ensure that no damage is caused to any person/property of other parties working at site. If any such damage is caused, it is responsibility of the contractor to make good the losses or compensate for the same.
- 2.8.11 All the properties/equipments/components of BHEL/their Client loaned with or without deposit to the contractor in connection with the contract shall remain properties of BHEL/their Client.
- 2.8.12 The contractor shall use such properties for the purpose of execution of this contract. All such properties/equipments/components shall be deemed to be in good condition when received by the contractor unless he notifies within 48 hours to the contrary. The contractor shall return them in good condition as and when required by BHEL/their Client. In case of non-return, loss, damage, repairs etc, the cost thereof as may be fixed by BHEL Engineer will be recovered from the contractor
- 2.8.13 In case the contractor is required to undertake any work outside the scope of this contract, the rates payable shall be those mutually agreed upon if the item rates are not mentioned in existing contract.
- 2.8.14 Any delay in completion of works/or non achievement of periodical targets due to the reasons attributable to the contractor, the same may have to be compensated by the contractor either by increasing manpower and resources or by working extra hours and/or by working more than one shift. All these are to be carried out by the contractor at no extra cost.
- 2.8.15 The contractor shall arrange, coordinate his work in such a manner as to cause no hindrance to other agencies working in the same premises.

2.8.16 All safety rules and codes applied by the Client/BHEL at site shall be observed by the contractor without exception. The contractor shall be responsible for the safety of the equipment/material and works to be performed by him and shall maintain all light, fencing guards, slings etc. or other protection necessary for the purpose. Contractor shall also take such additional precautions as may be indicated from time to time by the Engineer with a view to prevent pilferage, accidents, fire hazards. Due precautions shall be taken against fire hazards and atmospheric conditions. Suitable number of Clerical staff, watch and ward, store keepers to take care of equipment/materials and construction tools and tackles shall be posted at site by the contractor till the completion of work under this contract.

The contractor shall arrange for such safety devices as are necessary for such type of work and carry out the requisite site tests of handling equipment, lifting tools, tackles etc. as per prescribed standards and practices.

Contractor has to ensure the implementation of Health, Safety and Environment (HSE) requirements as per directions given by BHEL/Customer. The contractor has to assist in HSE audit by BHEL/Customer and submit compliance Report. The contractor has to generate and submit record/reports as per HSE plan/activities as per instruction of BHEL/Customer

2.8.17 The contractor will be directly responsible for payment of wages to his workmen. A pay roll sheet giving all the payments given to the workers and duly signed by the contractor's representative should be furnished to BHEL site for record purpose, if so called for.

2.8.18 In case of any class of work for which there is no such specification as laid down in the contract, such work shall be carried out in accordance with the instructions and requirements of the Engineer.

2.8.19 Also, no idle charges will be admissible in the event of any stoppage caused in the work resulting in contractor's labour and Tools & Plants being rendered idle due to any reason at any time.

2.8.20 The contractor shall take all reasonable care to protect the materials and work till such time the plant/equipment has been taken over by BHEL or their Client whichever is earlier.

2.8.21 The contractor shall not stop the work or abandon the site for whatsoever reason of dispute, excepting force majeure conditions. All such problems/disputes shall be separately discussed and settled without affecting the progress of work. Such stoppage or abandonment shall be treated as breach of contract and dealt with accordingly

2.8.22 The contractor shall keep the area of work clean and shall remove the debris etc. while executing day-to-day work. Upon completion of work, the contractor shall remove from the vicinity of work, all scrap, packing materials, rubbish, unused and other materials and deposit them in places specified by the Engineer. The contractor will also demolish all the hutments, sheds, offices, etc. constructed and used by him and shall clean the debris. In the event of his failure to do so, the same will be arranged to be done by the Engineer and the expenses recovered from the contractor.

2.8.23 The contractor shall execute the work in the most substantial and workman like manner in the stipulated time. Accuracy of work and timely execution shall be the essence of this contract. The contractor shall be responsible to ensure that the quality, assembly and workmanship conform to the dimensions and clearance given in the drawings and/ or as per the instructions of the Engineer.

2.8.24 The Contractor to note that some of BHEL's T&Ps/MMDs may not be insured. The Contractor will take necessary precautions and due care to protect the same while in his custody from any damage/ loss till the same is handed over back to BHEL. In case the damage / loss is due to carelessness/ negligence on the part of the contractor, the Contractor is liable to get them repair/ replaced immediately and in case of his failure to do so within a reasonable time, BHEL will reserve the right to recover the loss from the contractor.

2.9 PROGRESS MONITORING, MONTHLY REVIEW AND PERFORMANCE EVALUATION

2.9.1 A detailed plan/programme for completion of the contractual scope of work as per the time schedule given in the contract shall be jointly agreed between BHEL and Contractor, before commencement of work . The above programme shall be supported by monthwise deployment of resources viz Manpower, T&P, Consumables, etc. Progress will be reviewed periodically (Daily/Weekly/Monthly) vis a vis this jointly agreed programme. The Contractor shall submit periodical progress reports (Daily/Weekly/Monthly) and other reports/information including manpower, consumables, T&P mobilization etc as desired by BHEL.

2.9.2 Monthly progress review between BHEL and Contractor shall be based on the agreed programme as above, availability of inputs/fronts etc, and constraints if any, as per prescribed formats. Manpower, T&P and consumable reports as per prescribed formats shall be submitted by contractor every month. Release of RA Bills shall be contingent upon certification by BHEL Site Engineer of the availability of the above prescribed formats duly filled in and signed.

2.9.3 The burden of proof that the causes leading to any shortfall is not due to any reasons attributable to the contractor is on the contractor himself. The monthly progress review shall record shortfalls attributable to (i) Contractor, (ii) Force Majeure Conditions, and (iii) BHEL

2.9.4 Performance of the Contractor shall be assessed as per prescribed formats and shall form the basis for 'Annual/Overall Performance Evaluation' of the Contractor and also for 'Assessment of Capacity of Bidder' for Tenders where the Contractor is a bidder. BHEL reserves the right to revise the evaluation formats during the course of execution of the works

2.10 TIME OF COMPLETION

2.10.1 The time schedule shall be as prescribed in the Contract. The time for completion shall be reckoned from the date of commencement of work at Site as certified by BHEL Engineers.

2.10.2 The entire work shall be completed by the contractor within the time schedule or within such extended periods of time as may be allowed by BHEL under clause 2.11

2.11 EXTENSION OF TIME FOR COMPLETION

2.11.1 If the completion of work as detailed in the scope of work gets delayed beyond the contract period, the contractor shall request for an extension of the contract and BHEL at its discretion may extend the Contract.

2.11.2 Based on the monthly reviews jointly signed, the works balance at the end of original contract period less the backlog attributable to the contractor shall be quantified, and the number of months of 'Time extension' required for completion of the same shall be jointly worked out. Within this period of 'Time extension', the contractor is bound to complete the portion of backlog attributable to the contractor. Any further 'Time extension' or 'Time extensions' at the end of the previous extension shall be worked out similarly.

2.11.3 However if any 'Time extension' is granted to the contractor to facilitate continuation of work and completion of contract, due to backlog attributable to the contractor alone, then it shall be without prejudice to the rights of BHEL to impose penalty/LD for the delays attributable to the contractor, in addition to any other actions BHEL may wish to take at the risk and cost of contractor.

- 2.11.4 A joint programme shall be drawn for the balance amount of work to be completed during the period of 'Time Extension', along with matching resources (with weightages) to be deployed by the contractor as per specified format. Review of the programme and record of shortfall shall be done every month of the 'Time extension' period in the same manner as is done for the regular contract period.
- 2.11.5 During the period of 'Time extension', contractor shall maintain their resources as per mutually agreed program
- 2.11.6 At the end of total work completion as certified by BHEL Engineer, and upon analysis of the total delay, the portion of time extensions attributable to (i) Contractor, (ii) Force majeure conditions, and (iii) BHEL, shall be worked out and shall be considered to be exhausted in the same order. The total period of time extensions shall be the sum of (i), (ii) and (iii) above and shall be equal to period between the scheduled date of completion and the actual date of completion of contract. LD shall be imposed/levied for the portion of time extensions attributable to contractor and recoverable from the dues payable to the contractor.
- 2.12 OVERRUN COMPENSATION:** Please refer Clause No. 11 , Page 15 of Annexure – I of NIT.
- 2.13 INTEREST BEARING RECOVERABLE ADVANCES**
- 2.13.1 Normally no advance is payable to the contractor. However, advance payment in exceptional circumstances shall be interest bearing and secured through a Bank Guarantee and shall be limited to a maximum of 5% of contract value. This 'Interest Bearing Recoverable Advance' shall be payable in not less than two installments with any of the installment not exceeding 60% of the total eligible advance.
- 2.13.2 In exceptional circumstances, with due justification, Competent Authority of BHEL is empowered to approve proposals for payment of additional interim interest bearing advance against Bank Guarantee, for resource augmentation towards expediting work for project implementation.
- 2.13.3 Bank Guarantee towards 'Interest Bearing Recoverable Advance' shall be atleast 110% of the advance so as to enable recovery of not only principle amount but also the interest portion, if so required.
- 2.13.4 Contractor shall establish the utilization of advance drawn before the release of next installment.
- 2.13.5 Payment and recovery of Interest Bearing Recoverable advance shall be at the sole discretion of BHEL and shall not be a subject matter of arbitration.
- 2.13.6 The rate of interest applicable for the above advances shall be the prime lending rate of State Bank of India prevailing at the time of disbursement of the advance + 2%, and such rate will remain fixed till the total advance amount is recovered
- 2.13.7 Unadjusted amount of advances paid shall not exceed 5% of the total contract value at any point of time. Recovery of advances shall be made progressively from each Running Bill such that the advance amounts paid along with the interest is fully recovered by the time the contractor's billing reaches 80% of contract value.
- 2.13.8 Recovery rate per month shall be the sum of:
- Not less than 10% of Running Bill amount
 - Simple interest up to the date of RA Bill on the outstanding Principle amount/amounts

2.13.9 Contractor to submit Bank Guarantee as per prescribed formats for each of the advance and shall be valid for at least one year or the recovery duration or the balance contract period whichever ever is later. In case the recovery of dues does not get completed within the aforesaid BG period, the contractor shall renew the BG or submit fresh BG for the outstanding amount and the remaining recovery period.

2.13.10 BHEL is entitled to make recovery of the entire outstanding amount in case the contractor fails to comply with the BG requirement

2.14 QUANTITY VARIATION

2.14.1 The quoted rates shall remain firm irrespective of any variations in the individual quantities. No compensation becomes payable in case the variation of the final executed contract value is within the limits of Plus (+) or Minus (-) 15% of awarded contract value.

2.14.2 Compensation due to variation of final executed value in excess of the limits defined in clause above, shall be as follows:

- i) In case the finally executed contract value reduces below the lower limit of Contract Value due to quantity variation specified above, the contractor will be eligible for compensation @ 15% of the difference between the lower limit of the contract value and the actual executed value.
- ii) In case the finally executed contract value increases above the upper limit of Contract Value due to quantity variation specified above, there will be no revision in the rates within the contract period.

2.15 EXTRA WORKS

2.15.1 All rectifications/modifications, revamping, and reworks required for any reasons not due to the fault of the contractor, or needed due to any change in deviation from drawings and design of equipments, operation/maintenance requirements, mismatching, or due to damages in transit, storage and erection/commissioning, and other allied works which are not very specifically indicated in the drawings, but are found essential for satisfactory completion of the work, will be considered as extra works.

2.15.2 Extra works arising on account of the contractor's fault, irrespective of time consumed in rectification of the damage/loss, will have to be carried out by the contractor free of cost. Under such circumstances, any material and consumable required for this purpose will also have to be arranged by the contractor at his cost.

2.15.3 All the extra work should be carried out by a separately identifiable gang, without affecting routine activities. Daily log sheets in the pro-forma prescribed by BHEL should be maintained and shall be signed by the contractor's representative and BHEL engineer. No claim for extra work will be considered/ entertained in the absence of the said supporting documents i.e. daily log sheets. Signing of log sheets by BHEL engineer does not necessarily mean the acceptance of such works as extra works.

2.15.4 BHEL retains the right to award or not to award any of the major repair/ rework/ modification/ rectification/ fabrication works to the contractor, at their discretion without assigning any reason for the same

2.15.5 After eligibility of extra works is established and finally accepted by BHEL engineer/designer, payment will be released on competent authority's approval at the following rate.

MAN-HOUR RATE FOR ELIGIBLE EXTRA WORKS: Single composite average labour man-hour rate, including overtime if any, supervision, use of tools and tackles and other site expenses and incidentals, consumables for carrying out any major rework/ repairs/ rectification/ modification/ fabrication as certified by site as may arise during the course of erection, testing, commissioning or extra works arising out of transit, storage and erection damages, payment, if found due will be at Rs 60/- per man hour.

2.15.6 The above composite labour man hour rate towards extra works shall remain firm and not subject to any variation during execution of the work.

2.15.7 **Extra Works for Civil Packages** shall be regulated as follows

Rates for Extra Works arising due to (1) non availability of BOQ (Rate Schedule), OR (2) change in Specifications of materials/works (3) rectification/modification/dismantling & re erecting etc due to no fault of Contractor, shall be in the order of the following:

- a) Item rates are to be derived from similar nature of items in the BOQ (Rate Schedule) with applicable escalation derived from All India Consumer Price Index for Whole Sale Commodities.
- b) As per CPWD-DSR-2007 (or latest edition) with applicable escalation derived from All India Consumer price Index for Whole Sale Commodities, OR, Notification issued by the office of CPWD for 'Cost Index' in that Region where the project is being executed, whichever is less
- c) Item rates are to be worked out on the basis of prevailing market rates mutually agreed between BHEL and Contractor, plus 15% towards Contractor's overheads and profit.

2.16 SUPPLEMENTARY ITEMS

2.16.1 For NON Civil Works

Supplementary items are items/works required for completion of entire work but not specified in the scope of work. Subject to certification of such items/works as supplementary items by BHEL Engineer, rates shall be derived on the basis of any one of the following on mutual agreement:

- i) Based on percentage breakup/rates indicated for similar/nearby items.
- ii) In case (i) above does not exist, then BHEL/site may derive the percentage breakup/rates to suit the type of work

2.16.2 For Civil Works

i) Rates for Supplementary Works/Additional Works arising out due to additions/alterations in the original scope of works as per contract subject to certification of BHEL Engineer shall be worked out as under:

- a) Item rates which are available in existing BOQ (Rate Schedule) shall be operated with applicable escalation derived from All India Consumer Price Index for Whole Sale Commodities
- b) Items of works which are not available in existing BOQ shall be operated as an 'Extra Works' and rate shall be derived as per clause no 2.15.7
- ii) Execution of Supplementary Works/Additional Works through the Contractor shall be at the sole discretion of BHEL, and shall be considered as part of executed contract value for the purpose of Quantity Variation as per clause 2.14
- iii) BHEL Engineer's decision regarding fixing the rate as above is final and binding on the contractor.
- iv) PVC & ORC will not be applicable for (I) above.

2.17 PRICE VARIATION COMPENSATION : Please refer Clause No. 12 , Page 15 of Annexure – I of NIT.

2.18 INSURANCE

2.18.1 BHEL/their customer shall arrange for insuring the materials/properties of BHEL/customer covering the risks during transit, storage, erection and commissioning.

2.18.2 It is the sole responsibility of the contractor to insure his materials, equipments, workmen, etc. against accidents and injury while at work and to pay compensation, if any, to workmen as per Workmen's compensation Act. The work will be carried out in a protected area and all the rules and regulations of the client /BHEL in the area of project which are in force from time to time will have to be followed by the contractor.

2.18.3 If due to negligence and or non-observation of safety and other precautions by the contractors, any accident/injury occurs to the property / manpower belong to third party, the contractor shall have to pay necessary compensation and other expense, if so decided by the appropriate authorities.

2.18.4 The contractor will take necessary precautions and due care to protect the material, while in his custody from any damage/ loss due to theft or otherwise till the same is taken over by BHEL or customer. For lodging / processing of insurance claim the contractor will submit necessary documents. BHEL will recover the loss including the deductible franchise from the contractor, in case the damage / loss is due to carelessness / negligence on the part of the contractor. In case of any theft of material under contractor's custody , matter shall be reported to police by the contractor immediately and copy of FIR and subsequently police investigation report shall be submitted to BHEL for taking up with insurance. However this will not relieve the contractor of his contractual obligation for the material in his custody.

2.19 STRIKES & LOCKOUT

2.19.1 The contractor will be fully responsible for all disputes and other issues connected with his labour. In the event of the contractor's labour resorting to strike or the Contractor resorting to lockout and if the strike or lockout declared is not settled within a period of one month, BHEL shall have the right to get the work executed through any other agencies and the cost so incurred by BHEL shall be deducted from the Contractor's bills.

2.19.2 For all purposes whatsoever, the employees of the contractor shall not be deemed to be in the employment of BHEL

2.20 FORCE MAJEURE

The following shall amount to Force Majeure:-

2.20.1 Acts of God, act of any Government, War, Sabotage, Riots, Civil commotion, Police action, Revolution, Flood, Fire, Cyclones, Earth quake and Epidemic and other similar causes over which the contractor has no control.

2.20.2 If the contractor suffers delay in the due execution of the contractual obligation due to delays caused by force majeure as defined above, the agreed time of completion of the job covered by this contract or the obligations of the contractor shall be extended by a period of time equal to period of delay, provided that on the occurrence of any such contingency, the contractor immediately reports to BHEL in writing the causes of delay and the contractor shall not be eligible for any compensation.

2.21 ARBITRATION & RECONCILIATION

In case amicable settlement is not reached in the event of any dispute or difference arising out of the execution of the Contract or the respective rights and liabilities of the parties or in relation to interpretation of any provision by the Contractor in any manner touching upon the Contract, such dispute or difference shall (except as to any matters, the decision of which is specifically provided for therein) be referred to the sole arbitration of the arbitrator appointed by BHEL/In charge(Region/Unit).

The award of the Arbitrator shall be binding upon the parties to the dispute

Subject as aforesaid, the provisions of Arbitration and Reconciliation Act 1996 (India) or statutory modifications or re enactments thereof and the rules made there under and for the time being in force shall apply to the arbitration proceedings under this clause. The venue of the arbitration shall be the place from which the contract is issued or such other place as the Arbitrator at his discretion may determine

2.21.2 In case of Contract with Public Sector Enterprise (PSE) or a Government Department, the following shall be applicable :

In the event of any dispute or difference relating to the interpretation and application of the provisions of the Contract, such dispute or difference shall be referred to by either party to the arbitration of one of the arbitrators in the department of public enterprises. The award of the arbitrator shall be binding upon the parties to the dispute, provided, however, any party aggrieved by such award may make further reference for setting aside or revision of the award to the Law Secretary, Department of Legal Affairs, Ministry of Law and Justice, Government of India. Upon such reference the dispute shall be decided by the Law Secretary or the Special Secretary or Additional Secretary when so authorized by the Law Secretary, whose decision shall bind the parties hereto finally and conclusively.

2.21.3 The cost of arbitration shall be borne equally by the parties.

2.21.4 Work under the contract shall be continued during the arbitration proceedings.

2.22 RETENTION AMOUNT

2.22.1 Retention Amount shall be 10% of executed contract value and shall be recovered at the rate of 10% from each Running Bill admitted.

2.22.2 Refund of Retention Amount shall be as follows:

- i) The retention amount shall be retained towards 'Performance Guarantee for Workmanship' and shall become refundable after expiry of Guarantee period, provided all the defects noticed during the guarantee period have been rectified to the satisfaction of BHEL Site Engineer/BHEL Construction Manager, and after deducting all expenses/other amounts due to BHEL under the contract/other contracts entered into by BHEL with them. This retention amount can be released on commencement of the Guarantee period, on submission of equivalent Bank Guarantee.

2.23 PAYMENTS

Payments to Contractors are made in any one of the following forms

2.23.1 **Running Account Bills (RA Bills)**

- i) These are for interim payments when the contracts are in progress. The bills for such interim payments are to be prepared by Contractor in prescribed formats (RA Bill forms).
- ii) Payments shall be made according to the extent of work done as per measurements taken up to the end of the calendar month and in line with the terms of payments described in the Tender documents
- iii) Recoveries on account of electricity, water, statutory deductions, etc are made as per terms of contract

- iv) Full rates for the work done shall be allowed only if the quantum of work has been done as per the specifications stipulated in the contract. If the work is not executed as per the stipulated specifications, BHEL may ask the contractor to re do the work according to the required specifications, without any extra cost. However, where this is not considered necessary 'OR' where the part work is done due to factors like non-availability of material to be supplied by BHEL 'OR' non availability of fronts 'OR' non availability of drawings, fraction payment against full rate, as is considered reasonable, may be allowed with due regard for the work remaining to be done. BHEL decision in this regard will be final and binding on the contractor
- v) In order to facilitate part payment, BHEL Site Engineer at his discretion may further split the contracted rates/percentages to suit site conditions, cash flow requirements according to the progress of work.

2.23.2 Final Bill

Final Bill' is used for final payment on closing of Running Account for works or for single payment after completion of works. 'Final Bill' shall be submitted as per prescribed format after completion of works as per scope and upon material reconciliation, along with the following.

- i) 'No Claim Certificate' by contractor
- ii) Clearance certificates where ever applicable viz Clearance Certificates from Customer, various Statutory Authorities like Labour department, PF Authorities, Commercial Tax Department, etc
- iii) Indemnity bond as per prescribed format

BHEL shall settle the final bills after deducting all liabilities of Contractor to BHEL

2.24 PERFORMANCE GUARANTEE FOR WORKMANSHIP

2.24.1 Even though the work will be carried out under the supervision of BHEL Engineers the Contractor will be responsible for the quality of the workmanship and shall guarantee the work done for a period of twelve months from the date of commencement of guarantee period for good workmanship and shall rectify free of cost all defects due to faulty erection detected during the guarantee period. In the event of the Contractor failing to repair the defective works within the time specified by the Engineer, BHEL may proceed to undertake the repairs of such defective works at the Contractor's risk and cost, without prejudice to any other rights and recover the same from the Guarantee money.

2.24.2 BHEL shall release the guarantee money subject to the following

- i) Contractor has submitted 'Final Bill'
- ii) Guarantee period as per contract has expired or against submission of Bank Guarantee for equivalent amount.
- iii) Contractor has furnished 'No Claim Certificate' in specified format
- iv) BHEL Site Engineer/Construction Manager has furnished the 'No Demand Certificate' in specified format
- v) Contractor has carried out the works required to be carried out by him during the period of Guarantee and all expenses incurred by BHEL on carrying out such works is included for adjustment from the Guarantee money refundable.

2.25 CLOSING OF CONTRACTS

The Contract shall be considered completed and closed upon completion of all contractual obligations and settlement of Final Bill or completion of Guarantee period whichever is later. Upon closing of Contract, BHEL shall issue a completion certificate as per standard format, based on specific request of Contractor.

2.26 REVERSE AUCTION:

BHEL reserves the right to go for Reverse Auction for Price Bid Opening by BHEL appointed service provider, instead of opening the submitted sealed price bid in the conventional way. The Business Rules for Reverse Auction shall be as per BHEL guidelines issued from time to time.

2.27 SUSPENSION OF BUSINESS DEALINGS

BHEL reserves the right to take action against Contractors who either fail to perform or Tenderers/Contractor who indulge in malpractices, by suspending business dealings with them in line with BHEL guidelines issued from time to time.

2.28 OTHER ISSUES

- 2.28.1 Value of Non judicial Stamp Paper for Bank Guarantees and for Contract Agreement shall be not less than Rs 100/- unless otherwise required under relevant statutes.
- 2.28.2 In case of any conflict between the General Conditions of Contract and Special Conditions of Contract, provisions contained in the Special Conditions of Contract shall prevail.
- 2.28.3 Unless otherwise specified in NIT, offers from consortium/JVs shall not be considered.
- 2.28.4 BHEL may not insist for signing of Contract Agreements in respect of low value and short time period contracts.

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Chapter - I : General Intent of Specifications

1.0	INTENT OF THE SPECIFICATION
1.1	The intent of this erection specification is to provide services for execution of the project according to most modern and proven techniques and codes. The omission of specific reference to any method, equipment or material necessary for the proper and efficient services towards installation of the plant shall not relieve the contractor of the responsibility of providing such services / facilities to complete the work or portion of work awarded to him. The quoted / accepted rates / price shall deem to be inclusive of all such contingencies.
1.2	The work shall conform to dimensions and tolerances given in various drawings and documents that will be provided during erection. If any portion of works is found to be defective in workmanship and not conforming to drawings / documents or other stipulations, the contractor shall dismantle and re-do the work duly replacing the defective materials at their own cost, failing which recoveries, as determined by BHEL, shall be effected from contractor's bills.
1.3	It is not the intent of this specification to specify herein all the details of erection and commissioning. However, the system shall conform in all respects to high standards of quality and workmanship for performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his judgments is not in full accordance herewith.
1.4	The omission of specific reference to any fabrication / erection or other method, equipment or material necessary for proper and efficient working of the plant shall not relieve the tenderer of the responsibility of providing such facilities to complete the work at quoted rates. Any mismatch/ defect found due to mistake in fabrication / erection shall have to be rectified by the vendor free of cost. Inspection by BHEL/Customer does not relieve vendor of his responsibility of executing quality erection.
1.5	The work covered under this specification is of highly sophisticated nature, requiring the best quality workmanship, supervision, engineering and construction management. The contractor should ensure proper planning and successful and timely completion of the work to meet the overall project schedule. The contractor must deploy adequate quantity of tools & plants, modern / latest construction aids etc. He must also deploy adequate trained, qualified and experienced supervisory staff and skilled personnel.

SPECIAL CONDITIONS OF CONTRACT (SCC)

Chapter - I : General Intent of Specifications

1.6	Contractor shall erect and commission all the equipments and auxiliaries as per the sequence & methodology prescribed by BHEL depending upon the technical requirements. Availability of materials and fronts will decide this. BHEL Engineer's decision regarding correctness of the work and method of working shall be final and binding on the contractor. No claims for extra payment from the contractor will be entertained on the ground of deviation from the methods / sequence adopted in erection of similar sets elsewhere.
1.7	Following shall be the minimum responsibility of contractor and have to be provided within finally accepted rates / prices:
1.7.1	Provision as required of all types of labour, supervisors, engineers, watch and ward, tools & tackles, calibrated MMEs (Monitoring and Measuring Equipment) as specified and otherwise required for the work, consumables for erection, testing and commissioning including material handling.
1.7.2	Achieving Proper out-turn / Turn-over as per BHEL plan and commitment.
1.7.3	Completion of work as per BHEL Schedule.
1.7.4	Good quality and accurate workmanship for proper performance of the equipment
1.7.5	Repair and rectification
1.7.6	Preservation / Re-conservation of all components during storage / erection / commissioning till handing over.

SPECIAL CONDITIONS OF CONTRACT (SCC)

Chapter - II : General Services to be rendered by the Bidder

2.0	GENERAL SERVICES TO BE RENDERED BY THE BIDDER
2.1	Services for construction, fabrication, equipment erection, testing as well as trial run & commissioning of various equipment and accessories under the contract shall include but not be limited to the following:
2.2	Issuing materials from store/open yard from time to time for erection as per the construction programme. The Contractor shall be the custodian of all the materials issued till the plant/equipment is officially taken over by the owner / BHEL after complete erection and successful trial run & commissioning.
2.3	Transport of material to their respective places of erection and erection of the complete plant & equipment as supplied under this specification.
2.4	Trial run and commissioning of individual equipment / sub-systems to the satisfaction of Owner/BHEL.
2.5	Deployment of all skilled and unskilled manpower required for erection, supervision of erection, watch & ward, commissioning and other services to be rendered under this specification.
2.6	Deployment of all erection tools & tackle, construction machinery, transportation vehicles and all other implements in adequate number and size, appropriate for the erection work to be handled under scope of this specification except otherwise specified.
2.7	Supply of all consumables, eg welding electrodes, gases, grinding/cutting wheels, cleaning agents, diesel oil, lubricant etc as well as materials required for temporary supports, scaffolding etc as necessary for such erection work, unless specified other wise.
2.8	Providing support services for the contractor's erection staff eg construction of site offices, temporary stores, residential accommodation and transport to work site for erection personnel, watch and ward for security and safety of the materials under the Contractor's custody etc. as required.
2.9	Maintaining proper documentation of all the site activities undertaken by the Contractor as per the proforma mutually agreed with BHEL, Submission of monthly progress reports and any such document as and when desired by BHEL/owner, taking approval of all statutory authorities i.e Boiler Inspector, Factory Inspector, Inspector of Explosives etc , as applicable for respective portions of work fall under the jurisdiction of such statutes of laws.
2.10	Any other service, although not specifically called for but required for a contract of the size and nature indicated in the specification.

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Chapter - III : General Technical Requirements (Codes and Standards)

3.0	GENERAL TECHNICAL REQUIREMENTS (CODES AND STANDARDS)
3.1	Except where otherwise specified, the plant/equipment shall comply with the appropriate Indian Standard or an agreed internationally accepted Standard Specification as mentioned elsewhere in contract specifications, each incorporating the latest revisions at the time of tendering. Where no internationally accepted standard is applicable, the Bidder shall give all particulars and details as necessary, to enable BHEL to identify all of the plant/equipment in the same detail as would be possible had there been a Standard Specification.
3.2	Where the Bidder proposes alternative codes or standards he shall include in his tender one copy (in English) of each Standard Specification to which materials offered shall comply. In such case, the adopted alternative standard shall be equivalent or superior to the standards mentioned in the specification.
3.3	In the event of any conflict between the codes and standards referred above, and the requirements of this specification, the requirements which are more stringent shall govern.
3.4	Tools used during erection and commissioning shall not be accepted except with the specific approval of the Engineer.

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Chapter - IV : Obligations of Contractor

4.0	OBLIGATIONS OF CONTRACTOR
4.1	CONSUMABLES & OTHER ITEMS
4.1.1	The contractor shall provide within finally accepted price / rates, all consumables (except those indicated in BHEL scope) like welding electrodes (including alloy steel and stainless steel), filler wires, TIG filler wires, gases (inert, welding, cutting), soldering material, dye penetrants, radiography films, etc. Other erection consumables such as tapes, jointing compound, grease, mobile oil, M-seal, Araldite, petrol, CTC / other cleaning agents, grinding and cutting wheels are to be provided by the contractor. Steel, packers, shims, wooden planks, scaffolding materials hardware items etc required for temporary works such as supports, scaffoldings are to be arranged by the contractor. Sealing compounds, gaskets, gland packing, wooden/concrete sleepers, for temporary work, required for completion of work except those which are specifically supplied by manufacturing unit are also to be arranged by the contractor.
4.1.2	All the shims, gaskets and packing, which are required for erection and alignment of equipments shall be supplied by contractor free of cost.
4.1.3	It shall be the responsibility of the contractor to plan the activities and store sufficient quantity of consumables. Non-availability of any consumable materials or equivalent suggested by BHEL cannot be considered as reason for not attaining the required progress or for additional claim.
4.1.4	Void.
4.1.5	It shall be the responsibility of the contractor to obtain prior approval of BHEL, regarding suppliers, type of electrodes etc before procurement of welding electrodes. On receipt of electrodes at site these shall be subjected to inspection and approval by BHEL. The contractor shall inform BHEL details regarding type of electrodes, batch number, date of expiry etc and produce test certificate for each lot / batch with correlation of batch / lot number with respective test certificate. No electrode without a valid test certificate will be used.

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Chapter - IV : Obligations of Contractor

4.1.6	BHEL reserves the right to reject the use of any consumable including electrodes, gases, lubricants / special consumables if it is not found to be of the required standard / make / purity or when shelf life has expired. Contractor shall ensure display of shelf life on consumable wherever required and records maintained.
4.1.7	Storage of all consumables including welding electrodes shall be done as per requirement / instruction of the Engineer by the contractor at his cost.
4.1.8	In case of improper arrangement for procurement of any consumable, BHEL reserves the right to procure the same from any source and recover the cost from the Contractor's first subsequent bill at market value plus the departmental charges of BHEL from time to time. Postponement of such recovery is normally not permitted. The decision of Engineer in this regard shall be final and binding on the Contractor.
4.1.9	All lubricants and chemicals required for pre-commissioning, commissioning, testing, preservation and lubricants for trial runs of the equipment shall be supplied by BHEL / BHEL's client. All services including labour and T&P will be provided by the contractor for handling, filling, emptying, refilling etc. The consumption of lubricants / chemicals shall be properly accounted for. Surplus material if any shall be properly stacked/tagged and returned to BHEL/ CUSTOMER stores at no extra cost to BHEL. BHEL reserves the right to recover costs for wastage by the contractor.
4.1.10	Transportation of oil drums from stores, filling of oil for flushing, first filling, subsequent changeover if any, topping/making up till the unit is fully commissioned and handed over to customer is included in scope of this contract. The contractor shall have to return all the empty drums to BHEL / BHEL's client store at no extra cost. Any loss / damage to above drums shall be to contractor's account.
4.1.11	All charges on account of Octroi, terminal or sales tax and other duties on materials obtained from any source for carrying out the works in the scope of the contractor shall be borne by the contractor.
4.2	TOOLS AND PLANTS / MONITORING AND MEASURING EQUIPMENT (MMEs)
4.2.1	T&Ps and MMEs to be provided by Contractor
4.2.1.1	All T&Ps and MMEs excepting those specifically indicated in BHEL scope are to be provided by the Contractor. Contractor has to make his own arrangement at his cost for completing the formalities (including arrangement of Road permits, if any) if required with Sales Tax/VAT authorities, for bringing their materials, plants and equipments at site for the execution of work under this contract.

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4.2.1.2	All suitable cranes for erection of equipments, pipe lines, structural, unloading & loading and material handling, lifting and transport equipments for material handling at stores/yard/siding of BHEL/Customer are included in contractor's scope. BHEL's cranes will not be available for this purpose unless otherwise specifically permitted as per contract conditions
4.2.1.3	All T&Ps to be deployed by the contractor shall have the approval of BHEL Engineer with regard to brand, quality and specification.
4.2.1.4	Indicative list of Major T&Ps in the scope of Contractor are given in the Technical Conditions of Contract. Bidders to note that these are only indicative and as such all other T&P necessary for timely and satisfactory completion of work in scope shall be mobilized by Contractor
4.2.1.5	Timely deployment of adequate T&Ps is the responsibility of the contractor. The contractor shall be prepared to augment the T&P at short notice to match the planned programme and to achieve the milestones.
4.2.1.6	Contractor shall maintain and operate his tools and plants in such a way that major breakdowns are avoided. In the event of major breakdown, contractor shall make alternative arrangements expeditiously so that the progress of work is not hampered.
4.2.1.7	In the event of contractor failing to arrange the required tools, plants, machinery, equipment, material or non-availability of the same owing to breakdown, BHEL will make alternative arrangement at the risk and cost of the contractor. Decision of BHEL shall be final and binding on the contractor
4.2.1.8	The T&P to be arranged by the contractor shall be in proper working condition and their operation shall not lead to unsafe condition. The movements of cranes, and other equipment should be such that no damage / breakage occurs to foundations, other equipments, material, property and men. All arrangements for the movement of the T&P etc shall be the contractor's responsibility
4.2.1.9	Use of welding generators/ rectifiers only shall be permitted for welding. Use of welding transformers will be subject to specific approval of BHEL engineer.
4.2.1.10	The contractor at his cost shall carry out periodical testing of his construction equipments. Test certificates shall be furnished to BHEL.
4.2.1.11	Contractor shall ensure deployment of serviced and healthy T&Ps including cranes, lifting tackles, wire ropes, manila ropes, winches and slings etc. History card and maintenance records for major T&Ps will be maintained by the contractor and will be made available to BHEL Engineer for inspection as and when required. Fitness certificate / Test Certificates of T&P shall have to be submitted before it is put in use. Identification for such T&Ps will be done as per BHEL Engineer's advice.

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Chapter - IV: Obligations of Contractor

	BHEL reserves the right to permit only new slings up to 20 mm and lifting tackles up to 3 MT capacities.
4.2.1.12	Contractor shall ensure deployment of reliable and calibrated MMEs (Inspection measuring and Monitoring equipment). The MMEs shall have test / calibration certificates from authorized / Government approved / accredited agencies traceable to National / International standards. Each MME shall have a label indicating calibration status i.e. date of calibration, calibration agency and due date for calibration. A list of such instruments deployed by contractor at site with its calibration status is to be submitted to BHEL Engineer for control.
4.2.1.13	Re-testing / re-calibration shall also be arranged at regular intervals during the period of use as advised by BHEL Engineer within the contract price. The contractor will also have alternate arrangements for such MME so that work does not suffer when the particular instrument is sent for calibration. If any MMEs not found fit for use, BHEL shall have the right to stop the use of such item. It will be necessary for the contractor to deploy proper item. Any readings taken by the defective instrument will be recalled and repeat the readings taken by that instrument with a proper one. In case he fails to do so, BHEL may deploy MMEs and retake the readings at contractor's cost.
4.2.1.14	BHEL shall have lien on all T&P, MMEs and other equipment of the contractor brought to the site for the purpose of erection, testing and commissioning. BHEL shall continue to hold the lien on all such items throughout the period of contract / extended period. The contractor and / or his sub-contractors, without the prior written approval of the Engineer, shall remove no material brought to the site.
4.2.1.15	The month wise T&P deployment plan to execute the work is to be submitted as per relevant format as per the instruction of BHEL. It shall be the contractor's responsibility to deploy the required T&P, for timely and successful completion of the job, to any extent.
4.2.2	Obligations in respect of T&Ps and MMEs if provided by BHEL
4.2.2.1	T&P / MMEs being provided by BHEL to sub- contractor free of hire charges shall be shared by other subcontractors working for BHEL at site and the allotment done by BHEL Engineer shall be final and binding.
4.2.2.2	BHEL T&P will be issued in basic assembled condition. Additional loose components / sub-assemblies / attachments as and when necessary, will be issued by BHEL. Assembly of such additional loose components/sub-assemblies/ attachments is in contractor's scope.
4.2.2.3	In case of non-availability of the T&Ps to be provided by BHEL due to breakdown, major overhauls, distribution pattern or any other reason, the contractor shall plan /

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	amend / alter his activities to meet erection / commissioning targets in consultation with BHEL.
4.2.2.4	void
4.2.2.5	The contractor shall engage trained and experienced operators for the operation of BHEL's T&Ps. Their skill / performance will be checked by BHEL Engineer before they are allowed to operate the same. However checking of skills by BHEL does not absolve the contractor of his responsibilities for proper and safe handling of equipment, consistent good performance of operators and regular performance evaluation of operators.
4.2.2.6	The day to day operation and maintenance of BHEL's T&Ps (Other than cranes) shall be carried out by contractor as per manufacturer's / BHEL's maintenance schedule at his cost. The contractor shall arrange, at his own cost, trained operators, fuel and other consumables for their operation. BHEL shall arrange all spares needed for upkeep of major T&Ps provided like Huck Bolting Machine*, DG Set, Induction Machine and Hydraulic Test pumps. The contractor has to arrange for fixing of the spares; supervision in specialized cases will be provided by BHEL. For upkeep of all other T&Ps supplied by BHEL, spares shall be arranged by the Contractor. BHEL supplied T&Ps shall be maintained in good working condition during the entire period of use. T&Ps in defective / damaged condition shall be rectified promptly to the full satisfaction of BHEL engineer. Contractor shall maintain records for maintenance of major T&Ps. These shall be made available for Inspection whenever required. In case of any lapses on the part of the contractor, BHEL at its own discretion shall get the servicing / repair of equipment done at the risk and cost of the contractor along with BHEL overheads. Further, if there are breakdowns / damages due to negligence of the contractor, the complete service / repair charges and cost of all the spares damaged with BHEL overheads shall be recovered from contractor's RA bills. *: for operation and maintenance of ESP Huck bolting machine, BHEL shall provide the basic power rig and hose. Balance toolings ie Guns, chuck jaws etc are to be arranged by contractor.
4.2.2.7	void
4.2.2.8	Increasing / shortening of the crane boom to suit work requirements shall have to be arranged by the indenting contractor at his cost including restoration to a state as directed by BHEL. All necessary manpower tools, support, consumables, illumination etc. will have to be arranged by contractor at his cost. If required,

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	contractor has to return the crane with original boom.
4.2.2.9	The area and infrastructure development of the area to be carried out by the customer. However in construction projects of this magnitude it is possible that all the areas / approaches may not be ready. In such cases backfilling of approaches where ever necessary, consolidation of ground and arrangement of sleepers / sand bag filling etc for safe operation / movement of equipment including cranes / trailers etc shall be the responsibility of the contractor at his cost. No compensation on this account shall be payable.
4.2.2.10	In the event of contractor not using and maintaining BHEL T&Ps according to BHEL's instructions. BHEL will have the right to withdraw such item without any notice and no claim in this regard shall be entertained and contractor shall be responsible for delay in execution on this account.
4.2.2.11	The contractor shall furnish regular utilization report of the BHEL T&Ps, as per requirement of BHEL.
4.2.2.12	Any loss / damage to any part of BHEL T&Ps and MMEs shall be to the contractor's account and any expenditure on these accounts by BHEL will be recovered from the contractor's bill in case the contractor fails to make good the loss.
4.2.2.13	It shall be responsibility of the contractor to take delivery of T&Ps and MMEs from stores or place of use by other contractor at project site, transport the same to site and return the same to BHEL store / place as intimated by Engineer in project site in good working conditions after use.
4.2.2.14	The contractor shall return BHEL T&Ps and MMEs issued to him in good working condition as and when desired by BHEL (on completion or reduction of workload). If contractor delays return of T&P and MME, hire charges as applicable shall be levied by BHEL from time, it was requisitioned till the time of actual return. T&Ps and MMEs returned in damaged / unserviceable condition shall be got repaired by BHEL at its own discretion and entire cost of repair with BHEL overheads shall be recovered from the contractor.
4.2.2.15	Replacement cost including BHEL overheads in respect of irreparable / completely damaged / non return of T&Ps and MMEs shall be recovered from the contractor's running / final bills.

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4.2.2.16	Obligations in respect of Cranes if provided by BHEL
a)	BHEL will make available the cranes (as per Technical Conditions of Contract) free of charge to the contractor on sharing basis mainly for the purposes enumerated/indicated therein. BHEL cranes have to be shared with other agencies / contractors of BHEL. The allocation of cranes shall be the discretion of BHEL engineer, which shall be binding on the contractor.
b)	BHEL Cranes may be initially issued in basic assembled condition. Any alteration/addition like boom reduction / extension, assembly of components/sub-assemblies needed for modulating the capacity/reach/other features of cranes and restoration to the state as directed by BHEL shall be the contractor's responsibility.
c)	<p>In case the BHEL cranes are not covered under AMC of BHEL, then the day-to-day upkeep and running maintenance like filling / topping up of lubricants, changing filters, etc including repair of self starter and dynamo of these cranes shall be the responsibility of the contractor. If on checking it is found that the same is not followed, BHEL will exercise its right to get the job/works done at the risk and cost of contractor.</p> <p>In case BHEL cranes are covered under AMC awarded by BHEL, then the day-to-day upkeep and running maintenance as described above are excluded from scope. However any additional helpers if any required during Preventive/Breakdown Maintenance, Assembly/disassembly shall be provided by contractor at no extra cost.</p> <p>BHEL may also provide cranes through crane hiring agencies in which case the day-to-day upkeep and running maintenance shall be excluded from scope of contractor.</p>
d)	Minor consumables like cotton cloth, cotton waste, etc is to be supplied by Contractor. All spares and lubricants/grease is excluded from scope. Contractor to give the requirements of these items well in advance in case the cranes provided by BHEL are BHEL owned cranes.
e)	Unless otherwise specified, trained operators for BHEL owned cranes shall be provided by the contractor. These operators should possess valid license for heavy vehicle.
f)	BHEL cranes will be withdrawn for regular and capital maintenance as per the respective schedule of maintenance. As far as possible such schedules will be intimated to the contractor in advance and may be adjusted depending on the work requirements at site. However no claim whatsoever will be entertained on account

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	of non-availability of cranes.
g)	Where the services of the cranes provided by BHEL are to be shared by other agencies/ contractors of BHEL, the contractor's responsibilities defined above will also be apportioned accordingly to the beneficiary agency. Working arrangements in this regard will be done at site by BHEL engineer and in any case his decision shall be final and binding.
h)	Major breakdowns will be attended to by BHEL. However, in case of breakdowns or damages due to negligence of the contractor, the complete service/repair charges including cost of spares shall be to the account of the contractor, along with BHEL overheads.
4.2.2.17	Void.

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**Chapter – V : Responsibilities of Contractor in respect of Labour,
 Supervisory Staff, etc.**

5.0	RESPONSIBILITIES OF CONTRACTOR IN RESPECT OF LABOUR, SUPERVISORY STAFF, ETC.
5.1	Refer relevant clauses of General Conditions of Contract (GCC) also in this regard
5.2	The contractor shall deploy all the necessary skilled, semiskilled, unskilled labour including highly skilled workmen etc. These workmen should have previous experience on similar job. They shall hold valid certificates wherever necessary. BHEL reserves the right to insist on removal of any employee of the contractor at any time if he is found to be unsuitable and the contractor shall forthwith remove him.
5.3	Contractor shall also comply with the requirements of local authorities/ project authorities calling for police verification of antecedents of the workmen, staff etc.
5.4	It is the responsibility of the contractor to engage his workmen in shifts and or on overtime basis for achieving the targets set by BHEL. This target may be set to suit BHEL's commitments to its customer or to advance date of completion of events or due to other reasons. The decision of BHEL in regard to setting the erection and commissioning targets will be final and binding on the contractor.
5.5	Contractor shall provide at different elevation suitable arrangement for urinal and drinking water facility with necessary plumbing & disposal arrangement including construction of septic tank. These installations shall be maintained in hygienic condition at all times.
5.6	The Contractor in the event of engaging 20 or more workmen, shall obtain Independent license under the Contract labour (Regulation and Abolition) Act 1970 from the concerned authorities based on Form-V issued by the Principal Employer/Customer. In order to issue Form-V by Customer, Contractor shall fulfill all Statutory requirements like Insurance Policy, PF Code/PF Account number etc as per the requirement of BHEL/Customer.
5.7	Contractor shall deduct the necessary amount towards Provident Fund and contribute equal amount as per Government of India laws. This amount will be deposited regularly to the provident Fund Commissioner. BHEL/Customer may insist for submission of the account code duly certified by PF Commissioner.
5.8	Contractor may also be required to comply with provisions of ESI Act in vogue if applicable and submit evidence to BHEL.
5.9	BHEL / customer may insist for witnessing the regular payment to the labour. They may also like to verify the relevant records for compliance with statutory requirements. Contractor shall enable such facilities to BHEL / Customer.

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Chapter – V : Responsibilities of Contractor in respect of Labour, Supervisory Staff, etc.

5.10	Contractor shall deploy only qualified and experienced engineers/ supervisors. They shall have professional approach in executing the work.
5.11	The contractor's supervisory staff shall execute the work in the most professional manner in the stipulated time. Accuracy of work and aesthetic finish are essential part of this contract. They shall be responsible to ensure that the assembly and workmanship conform to dimensions and tolerances given in the drawings / instructions given by BHEL engineer from time to time.
5.12	The supervisory staff employed by the contractor shall ensure proper outturn of work and discipline on the part of the labour put on the job by the contractor. Also in general they should see that the works are carried out in a safe and proper manner and in coordination with other labour and staff employed directly by BHEL or other contractors of BHEL or BHEL's client.
5.13	It is the responsibility of the contractor to arrange gate pass for all his employees, T&P etc for entering the project premises. Necessary coordination with customer officials is the responsibility of the contractor. Contractor to follow all the procedures laid down by the customer for making gate passes. Where permitted, by customer / BHEL, to work beyond normal working hours, the contractor shall arrange necessary work permits for working beyond normal working hours.
5.14	The actual deployment of Labour and Engineer/supervision staff shall be so as to satisfy the erection and commissioning targets set by BHEL. If at any time, it is found that the contractor is not in a position to deploy the required engineers/supervisors/workmen due to any reason, BHEL shall have the option to make alternate arrangements at the contractor's risk and cost. The expenditure incurred along with BHEL overheads thereon shall be recovered from the contractor
5.15	Contractor shall not deploy women labour at night.

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Chapter – VI: Material Handling, Storage & preservation

6.0	MATERIAL HANDLING, STORAGE AND PRESERVATION ETC
6.1	MATERIAL HANDLING AND STORAGE
6.1.1	All the equipments/materials furnished under this contract shall be received from the project stores, sheds / storage yards and transported to pre assembly area / erection site and stored in the storage spaces in a manner so that they are easily retrievable till the contractor erects them. While drawing/lifting material from BHEL / customer stores, the contractor shall ensure that the balance / other materials are stacked back immediately. No claim is admissible on this account
6.1.2	While BHEL will endeavor to store / stack / identify materials properly in their open / close / semi closed / tarpaulins covered storage yard / shed, it shall be contractor's responsibility to assist BHEL in identifying materials well in time for erection. They should take the delivery of the same, following the procedure indicated by BHEL, and transport the material safely to pre-assembly yard / erection site in time, according to program.
6.1.3	The contractor shall take delivery of components, equipment / consumables from storage area after getting the approval of BHEL Engineer on standard indent forms.
6.1.4	The contractor shall identify and deploy necessary Engineers / supervisors / workmen for the above work in sufficient number as may be needed by BHEL, for areas covering their scope.
6.1.5	All the equipment shall be handled very carefully to prevent any damage or loss. No untested wire ropes / slings etc. shall be used for unloading / handling. The equipment shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the stores shall be moved to the actual location at the appropriate time so as to avoid damage of such equipment at site.
6.1.6	Contractor shall ensure that while lifting slings shall be put over the points indicated on the equipment or as indicated in the manufacturer's drawings. Slings / shackles of proper size shall be used for all lifting and rigging purposes. All care shall be taken to safe guard the equipment against any damage. Dragging of piping / valves should be avoided. In case of any damage the cost shall be covered from the contractor.
6.1.7	Approach road conditions from the stores / yards to the erection site may not be equipped and ideal for smooth transportation of the equipment. Contractor

SPECIAL CONDITIONS OF CONTRACT (SCC)

Chapter – VI: Material Handling, Storage & preservation

	may have to be adequately prepared to transport the materials under the above circumstances without any extra cost. . The contractor may familiar himself with soil conditions at site.
6.1.8	Contractor shall be responsible for examining all the plant and materials issued to him and notify the Engineer immediately of any damage, shortage, discrepancy etc before they are moved out of the stores / storage area. The contractor shall be solely responsible for any shortages or damages in transit, handling, storage and erection of the equipment once received by him. As the erection work will be spread in different areas / locations of the project, contractor has to arrange sufficient number of watch / ward personal to avoid any pilferage of material.
6.1.9	The contractor shall maintain an accurate and exhaustive record-detailing out the list of all equipment received by him for the purpose of erection and keep such record open for the inspection of the engineer at any time.
6.1.10	All the material in the custody of contractor and stored in the open or dusty locations must be covered with suitable weather proof / fire retardant covering material wherever applicable and shall be blocked up on raised level above ground. All covering materials including blocks and sleeper shall be arranged by the contractor at his cost.
6.1.11	If the material belonging to the contractor are stored in area other than those earmarked for his operation the engineer will have the right to get it moved to the area earmarked for the contractor at the contractors risk and cost.
6.1.12	The contractor shall be responsible for making suitable indoor storage facilities to store all equipment (drawn by the contractor from BHEL / customer stores), which require indoor storage till the time of their installation. The Engineer will direct the contractor in this regard, which item in his opinion will require indoor storage, and the contractor shall comply with Engineer's decision.
6.1.13	The contractor shall ensure that all surplus / damaged / scrap / unused material, packing wood / containers/ special transporting frames etc are returned to BHEL at a place in project area identified by the Engineer. The contractor will maintain an account for all items received and returned to BHEL. Any shortage in returning such items shall be chargeable to the contractor except allowable wastage for packing wood only.
6.1.14	The contractor shall hand over all parts / materials remaining extra over the normal requirement with proper identification tags to the stores as directed by the concerned BHEL engineer.

SPECIAL CONDITIONS OF CONTRACT (SCC)

Chapter – VI: Material Handling, Storage & preservation

6.1.15	The contractor shall ensure that all the packing materials and protective devices installed on equipment during transit and storage are removed before installation.
6.1.16	It shall be the responsibility of the contractor to keep the work / storage areas in neat, tidy and working conditions. All surplus/unusable packing and other materials shall be removed and deposited at location(s) specified by BHEL within the project premises. If required weighing of the same within the project premises will have to be carried out.
6.2	PRESERVATION OF COMPONENTS
6.2.1	After taking delivery from BHEL / customer's stores, plant materials storage shall be subjected to the following protection besides other provisions indicated in these specifications elsewhere.
6.2.1.1	Items stored outdoors shall be stacked up at least six inches (6") off the ground. Items should not be stored in a low lying area where water logging is a possibility. Contractor should have sufficient numbers of wooden / concrete / steel sleepers for the job.
6.2.1.2	Motors, valves, electrical equipment, control equipment and instruments, and special or precision items requiring special care, etc shall be stored indoors. Motor windings shall be kept dry by use of external heat or space heaters.
6.2.1.3	Bearings and other wearing surfaces of plant materials shall be protected against corrosion and kept clean and should be regularly monitored.
6.2.1.4	Insulation materials shall be stored indoors or otherwise protected against getting wet/ damaged, using suitable measures and should be protected from direct rain.
6.2.2	It shall be the responsibility of the contractor to apply preservatives / touch up paints (primer) on equipment handled and erected by him till such time of final painting. It shall be contractor's responsibility to arrange for required paints (primer), thinners, labour, scaffolding materials, cleaning materials like wire brush, emery sheets, etc, cleaning of surface and provide one coat of preservatives / paints (primer) from time to time as decided by BHEL engineer. The accepted rate shall include this work also. It is to be noted that such painting may have to be done as and when required till such time the final painting is carried out.
6.2.3	The contractor shall effectively protect the finished work from action of weather and from damage or defacement and shall cover the finished parts then and there for their protection.

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Chapter – VI: Material Handling, Storage & preservation

6.2.4	Any failure on the part of contractor to carry out works according to above clauses will entail BHEL to carry out the job from any other party and recover the cost from contractor.
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Chapter – VII: Drawings and documents

7.0	DRAWINGS AND DOCUMENTS
7.1	The detailed drawings, specifications available with BHEL engineers will be made available to the contractor during execution of work at site. The contractor will also ensure availability of all drawings / documents at work place.
7.2	Necessary drawings to carry out the erection work will be furnished to the contractor by BHEL on loan, which shall be returned to BHEL Engineer at site after completion of work. Contractor shall ensure safe storage and quick retrieval of these documents.
7.3	The contractor shall maintain a record of all drawings and documents available with him in a register as per format given by BHEL Engineer. Contractor shall ensure use of pertinent drawings / data / documents and removal of obsolete ones from work place and returning to BHEL.
7.4	The data furnished in various annexure enclosed with this tender specification are only approximate and for guidance. However, the change in the design and in the quantity may occur as is usual in any such large scale of work. The contractors quoted rates shall be inclusive of the above factor
7.5	Should any error or ambiguity be discovered in the specification or information the contractor shall forthwith bring the same to the notice of BHEL before commencement of work. BHEL's interpretation in such cases shall be final and binding on the contractor.
7.6	Deviation from design dimensions should not exceed permissible limit. The contractor shall not correct or alter any dimension / details, without specific approval of BHEL.

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Chapter – VIII: Inspection and Quality

8.0	INSPECTION AND QUALITY
8.1	Inspection, Quality Assurance, Quality Control
8.1.1	Preparation of quality assurance log sheets and protocols with customer/consultants/statutory authority, welding logs, NDE records, testing & calibration records and other quality control and quality assurance documentation as per BHEL engineer's instructions, is within the scope of work/specification. These records shall be submitted to BHEL/customer for approval from time to time.
8.1.2	The protocols between contractor and customer/ BHEL shall be made prior to installation for correctness of foundations, materials, procedures, at each stage of installation, generally as per the requirement of customer/ BHEL. This is necessary to ensure elimination of errors or keeping them within tolerable limits and to avoid accumulation and multiplication of errors.
8.1.3	<p>A daily log book should be maintained by every supervisor/engineer of contractor on the job in duplicate (one for BHEL and one for contractor) for detailing and incorporating alignment/clearance / centering / leveling readings and inspection details of various equipments etc.</p> <p>High pressure welding details like serial number of weld joints, welders name, date of welding, details of repair, heat treatment etc. will be documented in welding log as per BHEL Engineer's instructions.</p> <p>Record of radiography containing details like serial number of weld joints, date of radiography, repairs, if any, re-shots etc shall also be maintained as per BHEL Engineer's instructions.</p> <p>Record of heat treatments performed shall be maintained as prescribed by BHEL</p>
8.1.4	The performance of welders will be reviewed from time to time as per the BHEL standards. Welders' performance record shall be furnished periodically furnished for scrutiny of BHEL's Engineer. Corrective action as informed by BHEL shall be taken in respect of those welders not conforming to these standards. This may include removal/ discontinuance of concerned welder(s). Contractor shall arrange for the alternate welders immediately
8.1.5	All the welders shall carry identity cards as per the proforma prescribed by BHEL/ Customer/Consultant. Only welders duly authorized by BHEL/customer/consultant shall be engaged on the work.

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8.1.6	Contractor shall provide all the Measuring Monitoring Equipments (MMEs) required for completion of the work satisfactorily. These MMEs shall be of brand, quality and accuracy specified by BHEL Engineer and should have necessary calibration and other certificates as per the requirement of BHEL Engineer. Decision of BHEL Engineer regarding acceptance or otherwise of the measuring instruments/gauges/tools for the work under this specification, is final and binding on the contractor. BHEL may give an indicative list of MMEs required for this work and to be made available by the contractor. The list will be reviewed by BHEL and the contractor shall meet any augmentation needed wherever required.
8.1.7	It is the responsibility of the contractor to prove the accuracy of the testing/measuring/calibrating equipments brought by him based on the periodicity of calibration as called for in the BHEL's quality assurance standards/BHEL Engineer's instructions.
8.1.8	Any re-laying or re-termination of cables/re-erection of instruments/ recalibration of instruments etc. required due to contractor's mistake or design requirement and found at any stage inspection, shall be carried out by the contractor at no extra cost.
8.1.9	BHEL have already been accredited with ISO 9001 certification and as such this work is subject to various audits to meet ISO 9001 requirements. One particular aspect which needs special mention is about arrangement of calibration of instruments by the contractor. Contractor shall ensure deployment of reliable and calibrated MMEs (Measuring and Monitoring Equipments). The MMEs shall have test / calibration certificates from authorised / Government approved / Accredited agencies traceable to National / International Standards. Re-testing / re- calibration shall also be arranged at regular intervals during the period of use as advised by BHEL Engineer within the contract price. The contractor will also have alternate arrangements for such MMEs so that work does not suffer when the particular equipment / instrument is sent for calibration. Also if any MMEs not found fit for use, BHEL shall have the right to stop the use of such item and instruct the contractor to deploy proper item and recall ie repeat the readings taken by that instrument, failing which BHEL may deploy MME and retake the readings at Contractor's cost.
8.1.10	Re-work necessitated on account of use of invalid MMEs shall be entirely to the contractor's account. He shall be responsible to take all corrective actions,

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Chapter – VIII: Inspection and Quality

	including resource augmentation if any, as specified by BHEL to make-up for the loss of time.
8.1.11	In the courses of erection, it may become necessary to carry repeated checks of the work with instruments recently calibrated, re-calibrated. BHEL may counter/ finally check the measurements with their own MMEs. Contractor shall render all assistance in conduct of such counter/final measurements.
8.1.12	Total Quality is the watchword of the work and Contractor shall strive to achieve the Quality Standards, procedures laid down by BHEL. He shall follow all the instructions as per BHEL drawings and Quality Standards.
8.2	Stage Inspection By FES/QA Engineers
8.2.1	Apart from day-to-day inspection by BHEL Engineers stationed at Site and Customer's Engineers, stage inspection of equipments under erection and commissioning at various stages shall also be conducted by teams of Engineers from Field Engineering Services of BHEL's Manufacturing Units, Quality Assurance teams from Field Quality Assurance, Unit/Factory Quality Assurance and Commissioning Engineers from Technical Services etc. Contractor shall arrange all labour, tools and tackles etc along with proper access for such stage inspections free of cost.
8.2.2	Any modifications suggested by BHEL FES and QA Engineers' team shall be carried out by contractor.
8.3	Statutory Inspection of Work
8.3.1	<p>The work to be executed under these specifications has to be offered for inspection, at appropriate stages of work completion, to various statutory authorities for compliance with applicable regulations.</p> <p>The work related statutory inspections, though not limited to, are as under:</p> <ol style="list-style-type: none"> 1) Inspectorate of Steam Boilers and Smoke Nuisance 2) Electrical Inspector 3) Factory Inspector, Labour Commissioner, PF Commissioner and other authority connected to this project work <p>The scope includes getting the approvals from the statutory authorities, which includes arranging for inspection visits of statutory authority periodically as per</p>

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	BHEL Engineer's instructions, arranging materials for ground inspection, taking rub outs for the pressure parts to be offered for inspection, submitting co-related inspection reports, documents, radiographs etc and following up the matter with them. Contractor shall also make all arrangements for offering the Products / Systems for inspection at location, as applicable, to the concerned authority.
8.3.2	Contractor should be qualified to execute pressure parts & piping work coming under the purview of IBR, for which he should register himself with CIB of state concerned. contractor also should be aware of the latest IBR regulations and Electricity Act, including the amendments thereof.
8.3.3	Contractor shall comply with 'Qualification Tests for welders engaged in welding of Boilers and Steam Pipes under Construction, Erection and Fabrication at Site in India and in repairing Boilers and steam pipes by welding' in line with Chapter XIII of Indian Boiler Regulations-1950, for testing his welders / men / workers, including all associated fees, procedures, required instruments and equipments and their calibration there of. shall be contractor's responsibility to obtain approval of Statutory Authorities, wherever applicable, for the conducting of any work which comes under the purview of these authorities, at his cost.
8.3.4	The following fees shall be excluded from scope of Contractor: <ol style="list-style-type: none">1. Registration Fee as per Regulation 385 of Chapter IX of Indian Boiler Regulations-19502. Fees for inspection of Boiler at the site of Construction as per Regulation 395 A, sl no 4 of Chapter IX of Indian Boiler Regulations-1950 However all other fees like visit fees charged by the Boiler Inspector and other arrangements for his visit or visits till satisfactory completion of work, shall be included in scope of Contractor
8.4	The Quality Management System of BHEL- HPVP have already been certified and accredited under ISO 9002 standards in this regard. The basic philosophy of the Quality Management System is to define the organizational responsibility, work as per documented procedures, verify the output with respect to acceptance norms, identify the non-conforming product/ procedure and take corrective action for removal of non-conformance specifying the steps for avoiding recurrence of

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	such non-conformities, & maintain the relevant quality records. The non conformities are to be identified through the conduct of periodical audit of implementation of quality systems at various locations/stages of work. Suppliers/vendors of various products/services contributing in the work are also considered as part of the quality management system. .as such the contractor is expected not only to conform to the quality management system of BHEL but also it is desirable that they themselves are accredited under any quality management system standard.
8.5	Field Quality Assurance
8.5.1	Contractor shall carry out all activities conforming to the approved Field Quality Plan (FQP) as revised from time to time. Total quality shall be the watchword of the work and contractor shall strive to achieve the quality standards, procedures laid down by BHEL. He shall follow all the instructions as per BHEL drawings and quality standards. Contractor shall provide the services of quality assurance engineer as per the relevant clauses.

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Chapter-IX:HSE & OHSAS

9.0	<p>OCCUPATIONAL HEALTH, SAFETY & ENVIRONMENT MANAGEMENT/</p> <p>QUALITY ASSURANCE PROGRAMME : BHEL, HPVP is certified for ISO 9001. Quality of work to customer's satisfaction and fulfillment of system requirements are the essence of ISO 9001 certification. BHEL, have HSE certification (ISO 14001 & OHSAS 18001) and therefore Contractor also shall organise/ plan/ perform all their activities to meet with the applicable requirements of these standards.</p>
9.1	<p>HSE (Health, safety & Environment): Contractor will comply with HSE (Health, safety & Environment) requirements of BHEL. HSE requirements in brief, are given below :-</p>
9.1.1	<p>Contractor will nominate one of their qualified and experienced employees as Safety Officer, who will be responsible for all HSE related issues of contractors work area. Safety Officer will have authority to stop any activity, in case he observes that the activity is not being carried out in safe manner. He will conduct surprise inspection as well as periodic inspection/drill (at least once in a month) and submit such reports to BHEL. He will conduct periodic meetings with supervisors of different working groups and explain HSE issues and use of PPEs to them. Reports of such meetings will be submitted to BHEL. Contractor will develop suitable work procedures based upon HSE guidelines and OCPs and implement it. Such work procedures will consist of Area of work, T&P Details, Work Procedure, PPE requirements etc. Please refer Schedule VIII of BOCW Rules for number of safety officers, qualification, duties etc.</p> <p>Contractor should highlight the requirement of safety to staff and labour through daily tool box meeting before start of the days job.</p> <p>Contractor to also submit monthly safety reports as per the format/procedure of BHEL.</p>
9.1.2	<p>The contractor shall arrange induction and regular health check of their employees as per schedule VII of BOCW rules by a registered medical practitioner. The contractor shall take special care of the employees affected with occupational diseases under rule 230 and schedule II of BOCW Rules. The employees not meeting the fitness requirement should not be engaged for such job</p>
9.1.3	<p>Following personnel protective equipments (PPEs), in adequate numbers, will be made available at site & their regular use by all concerned will be ensured :-</p>

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Chapter-IX:HSE & OHSAS

	<ul style="list-style-type: none"> - HELMET - SAFETY GOGGLES & WELDING FACE SHIELDS - SAFETY BELTS AND PROTECTIVE NET FOR WORKING AT HEIGHT - SAFETY SHOES - EAR PLUG - ANY OTHER SAFETY EQUIPMENT REQUIRED FOR SAFE COMPLETION OF THE WORK <p>Contractor to also submit monthly reports on above as per the format/procedure of BHEL/ Consultant / customer.</p>
9.1.4	Providing appropriate First Aid facilities for prompt treatment of injuries and illness at work place. Arranging training to contractor workmen/ employees for giving first aid.
9.1.5	Arranging ambulance in case of any emergency situation .
9.1.6	Identification of nearest hospital and health check-up of workmen/employees
9.1.7	Providing filtered drinking water at work place in cool container.
9.1.8	Providing Canteen, Rest Room, Washing facilities to the contracted employees as per provisions of Contract Labour Regulation Act 1970 (Chapter V).
9.1.9	Providing appropriate fire fighting equipment at designated work place and nominate a fire officer/warden adequately trained for his job.
9.1.10	Identification of nearest fire station and display contact telephone nos. / person's name around work places for cases of emergencies .
9.1.11	Providing adequate no. of 24 V sources and ensure that no hand lamps are operating at voltage level above 24 Volts.
9.1.12	Fulfilling safety requirements at all power tapping points.
9.1.13	Red & White caution tape of proper width(1.5 to 2 inch) to be used for cordoning unsafe area such as open trench, excavation area etc.
9.1.14	Providing contractors company logo on cloths /uniform/ proper identity cards with photographs, for correct identification of people working at project site .
9.1.15	High/ Low pressure welders to be identified with separate colour clothings. No welders will be deployed without passing appropriate tests and holding valid welding certificates. Approved welding procedure should be displayed at work place.
9.1.16	Displaying safe handling procedures for all chemicals such as lube oil, acid, alkali, sealing compounds etc , at work place.
9.1.17	All scaffolding/ platforms should be made from materials of appropriate quality/grade so that these are safe for use. It should be certified/declared safe

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	for use by an experienced contractor person, before any scaffolding/platform is used. Please refer IS:3696 part 1&2 and 4014 part 1 & 2
9.1.18	All T&Ps/ MMEs should be of reputed brand/appropriate quality & must have valid test/calibration certificates bearing endorsement from competent authority of BHEL.. Contractor to also submit monthly reports of T&Ps deployed and validity test certificates to BHEL safety Officer as per the format/procedure of BHEL.
9.1.19	Ensure that the regulatory requirement of excessive weight limit (to carry/lift/ move weights beyond prescribed limits) for male and female workers are complied with.
9.1.20	Safety slogan, Safety/ Caution boards , wherever required to be displayed in consultation with BHEL.
9.1.21	Take suitable measures for waste management and environment related laws/legislation as a part of normal construction activities. Compliance with the legal requirements on storage/ disposal of paint drums (including the empty ones), Lubricant containers, Chemical Containers, and transportation and storage of hazardous chemicals will be strictly maintained. Ensure proper cleanliness of work place, housekeeping and waste management (including proper waste disposal) on daily basis.
9.1.22	It is imperative on the part of the contractor to join and effectively contribute in joint measures such as tree plantation, environment protection, contributing towards social upliftment, conversion of packing woods to school furniture, keeping good relation with local populace etc.
9.1.23	The contractor shall carry out periodic air and water quality check and illumination level checking in his area of work place and take suitable control measure.
9.1.24	The Contractor is required to provide proper safety net systems (IS-11057) where ever the hazard of fall from height is present as per instruction of BHEL Engineer. The safety nets shall be fire resistant, duly tested and shall be of ISI Mark and the nets shall be located as per site requirements to arrest or to reduce the consequences of a possible fall of persons working at different heights.
9.1.25	Void..

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9.2.	<p>SAFETY AND CLEANLINESS : The contractor shall take all necessary safety precautions and arrange for appropriate appliances as per discretion of BHEL or its authorised officials (Site Construction Manager) to prevent loss of human lives, injuries, to personnel engaged and damage to property. Before commencing the work, the contractor shall submit a "Safety Plan" to the above authorised BHEL official and obtain approval on the same. The safety plan shall indicate in detail the measures that would be taken by the contractor to ensure safety of men, equipment, materials and environment during execution of the work. This will also include an organization structure, role and responsibilities of the concerned key personnel, the safety practices that will be followed, PPEs deployed, plan for handling critical activities and emergencies.</p>
9.3	<p>If the contractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instructions issued by the authorised BHEL official, BHEL shall have the right to take corrective steps at the risk and cost of the contractor.</p>
9.4	<p>During the course of construction, alternation or repairs, scrap with protruding nail, sharp edge etc and all other debris shall be kept clean from working areas, passage, ways and stairs in and around site.</p>
9.5	<p>Combustible scrap and debris shall be removed at regular intervals during the course of execution. Safe means shall be provided to facilitate such removal. The combustible scrap should be stored in safe place away from the plant materials to avoid fire accidents. The area shall be chosen in consultation with the Engineer and to be cordoned off.</p>
9.6	<p>Rigging equipment for materials handling shall be inspected prior to use in each shift and as necessary during its use to ensure that it is safe. Defective rigging equipment will be removed from service.</p>
9.7	<p>Rigging equipment shall not be loaded in excess of its recommended safe working load. Rigging equipment, when not in use, shall be removed from the original work area so as not to present a hazard to employees.</p>
9.8	<p>Contractor shall notify the engineer, of his intention to bring on to site any equipment or any container, with liquid or gaseous fuel or other substance which may create a hazard. The Engineer shall have the right to prescribe the condition under which such equipment or container may be handled and used during the performance of the works and the contractor shall strictly adhere to such instructions. The Engineer shall have the right to inspect any construction tool and to forbid its use, if in his opinion it is unsafe. No claim due to such prohibition will be entertained.</p>

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9.9	Where it is necessary to provide and/or store petroleum products or petroleum mixture & explosives, the contractor shall be responsible for carrying out such provision / storage in accordance with the rules & regulations laid down in the relevant petroleum act, explosive act and petroleum and carbide of calcium manual, published by the chief inspector of explosives of India. All such storage shall have prior approval if necessary from the chief inspector of explosives or any other statutory authority. The contractor shall be responsible for obtaining the same.
9.10	Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally dragged, struck or permitted to strike each other violently.
9.11	When cylinders are transported by powered vehicle they shall be secured in a vertical position.
9.12	All workmen of the contractor working on construction area shall wear safety shoes, hand gloves, safety helmets and safety belt as applicable. The contractor shall provide to its workforce and ensure the use of following personnel protective equipment as found necessary and as directed by BHEL.
9.12.1	Safety Helmets conforming to IS-2925 : 1984
9.12.2	Safety Belts conforming to IS-3521:1983
9.12.3	Safety Shoes conforming to IS-1989 : 1978
9.12.4	Eye and face protection devices conforming to IS – 1179:1967, IS 5983:1980, IS 8521 Part 1:1977, IS 8521 Part 2: 1994.
9.12.5	Hand and body protection devices conforming to IS 4770:1991 and IS- 6994 : Part 1: 1973, IS – 8619 : 1977
9.12.6	Ear protection IS-9167:1979
9.12.7	Respiratory Protective Devices as per IS-9473:2002, i4746:1999 and 14166:1994
9.13	The contractor shall insure his workmen against all accidents and the policy shall be presented to BHEL Engineer on demand. Other wise, BHEL will arrange the same and the expenditure towards this will be debited to the contractor. In case of a fatal or disabling injury accident to any person at construction site due to lapses by the contractor, the victim and/or his/her dependants shall be compensated by the contractor as per statutory requirements. However, if considered necessary BHEL shall have the right to impose appropriate financial penalty on contractor and recover the same from payments due to the contractor for suitably compensating the victim and/or his/her dependence before imposing any such penalty. Appropriate enquiry shall be held by BHEL giving opportunity to the contractor for presenting his case. Above safety conditions are not exhaustive but gives an idea for the contractor and contractor shall adhere to all safety precaution given by the Engineer at site.

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9.14	The contractor shall arrange at his cost adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. at various levels for safe and proper working operations during night hours at the work spot as well as at the pre-assembly area.
9.15	The contractor shall be responsible for provision of all the safety notices and safety equipment as enjoined on him by the application of relevant statutory regulation / provisions and/or as called upon by BHEL from time to time. He shall be held responsible for any violation of statutory regulations (local, state or central) and BHEL instruction that may endanger safety of men, equipment and material.
9.16	The contractor shall provide temporary fencing wherever required as a safety measure against accident and damage to properties. Suitable caution notices shall be displayed where access to any part is found to be unsafe and hazardous.
9.17	Contractor shall ensure safety of all the workmen, material and equipment either belonging to him or to others working at site. He shall observe safety rules and codes applied by BHEL without exception.
9.18	It will be the responsibility of the contractor to ensure safe lifting of the equipment, taking due precaution to avoid any accident and damage to other equipment and personnel. All requisite tests and inspection of handling equipment, tools & tackle shall be periodically done by the contractor by engaging only the COMPETENT PERSONS as per law. Defective equipment or uncertified shall be removed from service. Any equipment shall not be loaded in excess of its recommended safe working load.
9.19	The contractor shall provide necessary first aid facilities as per schedule III. In addition, ambulance facilities, OHC and CMO as per schedule IV, V, X and XI of BOCW Rules as applicable for all his employees, representatives and workmen at site and BHEL shall have no obligation in this regard. The first aid boxes should be placed at various elevations so as to make them available within the reach and at the quickest possible time. The contractor should conduct periodical first –aid classes to keep his supervisor and Engineers properly trained for attending to any emergency.
9.20	Training
9.20.1	The contractor shall arrange induction safety training for all employees before assigning work. In addition, awareness programme, mock drill at regular intervals and daily tool box meetings shall be arranged. Monthly report of the above to be given to BHEL safety Officer as per prescribed BHEL formats.
9.20.2	All the contractor’s supervisory personnel and sufficient number of workers shall be trained for fire protection systems. Enough number of such trained personnel must be available during the tenure of contract. Contractor should nominate his

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	supervisor to coordinate and implement the safety measures.
9.21	Contractor shall provide enough fire protecting equipment of the types and numbers at his office, stores, temporary structure in labour colony etc. Such fire protection equipment shall be easy and kept open at all times. The fire extinguishers shall be properly refilled and kept ready which should be certified at periodic intervals. The date of changing should be marked on the Cylinders. All other fire safety measures as laid down in the “codes for fire safety at construction site” issued by safety coordinator of BHEL shall be followed. Non-compliance of the above requirement under fire protection shall in no way relieve the contractor of any of his responsibility and liabilities to fire accident occurring either to his materials or equipment or those of others. Emergency contacts nos must be displayed at prominent locations.
9.22	The contractor shall at his cost, remove from vicinity of work at least once each day all combustible waste, scrap, painting materials, rubbish, unused or other materials and deposit them in places specified by BHEL to keep the work site clear and tidy. Use of undercoated canvas paper, corrugated paper, fabricated carton, plastic or other flammable materials shall be restricted to the minimum and promptly removed.
9.23	The contractor shall not use any hand lamp energized by Electric power with supply voltage of more than 24 volts in confined spaces like inside water boxes, turbine casings, condensers etc.
9.24	All portable electric tools used by the contractor shall have safe plugging system to source of power and be appropriately earthed. Only electricians licensed by appropriate statutory authority shall be employed by the contractor to carry out all types of electrical works. Details of earth resource and their test date to be given to BHEL safety officer as per the prescribed formats of BHEL.
9.25	In case of any delay in completion of a job due to mishaps attributable to lapses by the contractor, BHEL shall have the right to recover cost of such delay from the payments due to the contractor, after notifying the contractor suitably.
9.26	Valve protection caps shall be kept in place and secured.
9.27	The contractor shall be responsible for the safe storage and handling of his radioactive sources as per BARC rules and regulations.
9.28	Tarpaulin being inflammable should not be used (instead, only non infusible covering materials shall be used) as protective cover while preheating, welding,

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	stress relieving etc. at site.
9.29	If the contractor fails to improve the standards of safety in its operation to the satisfaction of BHEL after being given reasonable opportunity to do so and/or if the contractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instruction regarding safety issued by BHEL, BHEL shall have the right to take corrective steps at the risk and cost of the contractor after giving a notice of not less than 7 days indicating the steps that would be taken by BHEL.
9.30	If the contractor succeeds in carrying out its job in time with out any fatal or disabling injury accident and without any damage to property BHEL may, at its sole discretion, favorably consider to reward the contractor suitably for the performance.
9.31	The contractor shall carefully follow the safety requirement of BHEL/ the purchaser with the regard to voltages used in critical areas.
9.32	The contractor shall use only properly insulated and armored cables which conform to the requirement of Indian Electricity Act and Rules for all wiring, electrical applications at site. BHEL reserves the right to replace any unsafe electrical installations, wiring, cabling etc. at the cost of the contractor. All electrical appliances used in the work shall be in good working condition and shall be properly earthed. No maintenance work shall be carried out on live equipment. The contractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installations. Area wise Electrical safety inspection is to be carried out on monthly basis as per "Electrical Safety Inspection checklist" and the report is to be submitted to BHEL safety officer.
9.33	The contractor shall arrange adequate number of persons specifically for clearing any debris and for house keeping of the erection area including restacking of components in the erection areas. Housekeeping to be carried out as per BHEL's checklist and report is to be submitted to BHEL safety officer.
9.34	In case of any damage to property due to lapses by the contractor, BHEL shall have the right to recover the cost of such damages from the contractor after holding an appropriate enquiry.
9.35	The contractor shall submit report of all accidents, fires and property damage etc to the Engineer immediately after such occurrence, but in any case not later then 24 hours of the occurrence. Such reports shall be furnished in the manner prescribed by BHEL. In addition periodic reports on safety shall also be submitted by the contractor to BHEL from time to time as prescribed by the Engineer. Compiled monthly reports of all kinds of accidents, fires and property damage to be submitted to BHEL safety officer as per prescribed formats

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9.36	Before commencing the work, the contractor shall appoint/nominate a responsible person to supervise implementation of all safety measures and liaison with his counterpart of BHEL.
9.37	Suitable scaffolds shall be provided for workman for all works that cannot safely be done from the ground, or from solid construction except in the case of short duration of work which can be done safely from ladders. When a ladder is used, it shall be of rigid construction made of steel. The steps shall have a minimum width of 45 cm and a maximum rise of 30 cm. Suitable handholds of good quality wood or steel shall be provided and the ladder shall be given an inclination not steeper than $\frac{1}{4}$ horizontal and 1 vertical.
9.38	Scaffolding or staging more than 3.6 m above the ground floor, swung or suspended from an overhead support or erected with stationery support shall have a guard rail properly bolted, braced or otherwise secured, at least 90 cm above the floor or platform of such scaffolding or staging and extending along the entire length of the out side and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from savor, from swaying, from the building or structure.
9.39	Working platforms, gangways and stairways shall be so constructed that they do not sag unduly or unequally and if the height of the platform gangways provided is more than 3.6 m above ground level or floor level, they shall be closely boarded and shall have adequate width which shall not be less than 750 mm and be suitably fenced as described above.
9.40	Every opening in the floor or a building or in a working platform shall be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be 90 cm.
9.41	Wherever there are open excavation in ground, they shall be fenced off by suitable railing and danger signals installed at night so as to prevent persons slipping into the excavations.
9.42	Safe means of access shall be provided to all working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 m in the length while the width between side rails in rung ladder shall in no case be less than app. 29.2 cm for ladder upto and including 3 m in length. For longer ladders this width shall be increased at least $\frac{1}{4}$ " for each additional foot of length.
9.43	A sketch of the ladders and scaffolds proposed to be used shall be prepared and approval of the Engineer obtained prior to Construction.
9.44	All personnel of the Contractor working within the plant site shall be provided with safety helmets. All welders shall wear welding goggles while doing welding work and all metal worker shall be provided with safety gloves. Persons employed on metal cutting and grinding shall wear safety glasses.
9.45	Adequate precautions shall be taken to prevent danger for electrical equipment. No materials on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or the public.

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9.46	All trenches, four feet or more in depth, shall at all times be supplied with at least one ladder for each 30 m in length or fraction thereof. The ladder shall be extended from bottom of the trench to at least 90 cm above the surface of the ground. Sides of the trenches which are 1.50 m or more in depth shall be stepped back to give suitable slope or securely held by timer bracing, so as to avoid the danger of sides collapsing. The excavated materials shall not be placed within 1.5 m of the edges of the trench or half of the depth of the trench whichever is more. Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be done.
9.47.1	The contractor shall take permission of BHEL prior to risky jobs such as working at height, hot work, liftig activities, etc through permits. No job should be started without permits.
9.47.2	The Contactor shall take all measures at the sites of the work to protect all persons from accidents and shall be bound to bear the expenses of defense of every suit, action or other proceeding at law that may be brought by any persons for injury sustained or death owing to neglect of the above precautions and to pay any such persons such compensation or which may with the consent of the Contractor be paid to compromise any claim by any such person should such claim proceeding be filed against BHEL, the Contractor hereby agrees to indemnify BHEL against the same.
9.48	Before any demolition work is commenced and also during the process of the work the following shall be ensured:
9.48.1	All roads and open areas adjacent to the work site shall either be closed or suitably protected.
9.48.2	No electric cable or apparatus which is liable to be a source of danger nor a cable or an apparatus used by the operator shall remain electrically charged.
9.48.3	All practical steps shall be taken to prevent danger to persons employed from the risks of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render them unsafe.
9.49	All necessary personnel safety equipment as considered adequate by the Engineer should be kept available for the use of the persons employed in the Site and maintained in a condition suitable for immediate use and the Contactor should take adequate steps to ensure proper use of equipment by those concerned.
9.49.1	Workers employed on mixing asphalted materials, cement and lime mortars shall be provided with protective foot wear and protective goggles.
9.49.2	Those engaged in white washing and mixing or stacking of cement bags or any materials which is injurious to the eyes shall be provided with protective goggles.
9.49.3	Those engaged in welding works shall be provided with welder's protective eyesight lids
9.49.4	Stone breakers shall be provided with protective goggles and protective clothing and seated sufficient to safe intervals.

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9.49.5	Where workers are employed in sewers and manholes, which are in use, the Contractor shall ensure that the manhole covers are opened and ventilated at least for an hour before the workers are allowed to get into manhole, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to the public.
9.49.6	The Contractor shall not employ men below the age of 18 years and women on the work of painting with products containing lead in any form. Wherever men above the age of 18 are employed on the work of lead painting, the following precautions should be taken.
9.49.6.1	No paint containing lead or lead products shall be used except in the form of paste or ready made paint.
9.49.6.2	Suitable face masks should be supplied for use by the workers where paints are applied in the form of spray or a surface having lead paint dry rubbed and scraped.
9.49.6.3	Overalls shall be supplied by the Contractor to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.
9.50	When the work is being done near any place where there is risk of drowning all necessary equipment should be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provision should be made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.
9.51	Motors, gearing, transmission, electric wiring and other dangerous parts of hoisting appliances should be provided with efficient safe guards. Hoisting appliance should be provided with such means as will reduce to the minimum the risk of any part of a suspended load becoming accidentally displaced. When workers employed on electrical installations which are already energized, insulating mats, wearing apparel, such as gloves, sleeves and boots as may be necessary should be provided. The worker should not wear any rings, watches and carry keys or other materials which are good conductor of electricity.
9.52	All scaffolds, ladders and other safety devices mentioned or described herein shall be maintained in safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use. Adequate washing facilities should be provided at or near the places of work.

SPECIAL CONDITIONS OF CONTRACT (SCC)

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9.53	The contractor shall maintain and ensure necessary safety measures as required for inspection and tests HV test, Pneumatic test, Hydraulic test, Spring test, Bend test etc as applicable, to enable. inspection Agency for performing Inspection. If any test equipment is found not complying with proper safety requirements then the Inspection Agency may withhold inspection, till such time the desired safety requirements are met.
9.54	The Contractor shall notify BHEL of his intention to bring to site any equipment or material which may create hazard. BHEL shall have the right to prescribe the conditions under which such equipment or materials may be handled and the contractor shall adhere to such instructions. BHEL may prohibit the use of any construction machinery, which according to him is unsafe. No claim for compensation due to such prohibition will be entertained by BHEL.
9.55	All safety precautions shall be taken for welding and cutting operations as per IS-818. All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.
9.56	All gas cylinders shall be stored in upright position. Suitable trolley shall be used. There shall be flash-back arrestors conforming to IS-11006 at both cylinder and burner ends. Damaged tube and regulators must be immediately replaced. No of cylinders shall not exceed the specified quantity as per OCP
9.57	These safety provisions should be brought to the notice of all concerned by display on a notice board at a prominent, place at work spot. The persons responsible for compliance of the safety code shall be named therein by the Contractor
9.58	To ensure effective enforcement of the rules and regulations relating to safety precautions the arrangement made by the contract shall be open to inspection by the Engineer of the Engineer's Representative.
9.59	Keeping the work area clean/ free from debris, removed scaffoldings, scraps, insulation/sheeting wastage /cut pieces, temporary structures, packing woods etc. will be in the scope of the contractor. Such cleanings has to be done by contractor within quoted rate, on daily basis by an identified group. If such activity is not carried out by contractor / BHEL is not satisfied, then BHEL may get it done by other agency and actual cost alongwith BHEL overheads will be deducted from contractor's bill. Such decisions of BHEL shall be binding on the contractor.

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9.60	Notwithstanding the above clauses there is nothing to exit the Contractor from the operations of any other Act or Rule in force in area of work in this respect. Provided always that all safety measures apart from those specifically provided in this agreement which are brought to the notice of the Contractor from time to time by the Engineer shall be complied by the Contractor. Provided further that all consequences, damages, or losses arising by reason of any safety code shall be met with by the Contractor.																																										
9.61	<p><u>NON COMPLIANCE:-</u></p> <p>NONCONFORMITY OF SAFETY RULES AND SAFETY APPLIANCES WILL BE VIEWED SERIOUSLY AND BHEL HAS RIGHT TO IMPOSE FINES ON THE CONTRACTOR AS UNDER <u>for every instance of violation noticed:</u></p> <table border="1"><thead><tr><th>SN</th><th>Violation of Safety Norms</th><th>Fine (in Rs)</th></tr></thead><tbody><tr><td>1</td><td>Not Wearing Safety Helmet</td><td>50/- *</td></tr><tr><td>2</td><td>Not wearing Safety Belt or not anchoring life line</td><td>100/-*</td></tr><tr><td>3</td><td>Not wearing safety shoe</td><td>100/-*</td></tr><tr><td>4</td><td>Not keeping gas cylinders vertically</td><td>100/-</td></tr><tr><td>5</td><td>Not using flash back arrestors</td><td>50/-</td></tr><tr><td>6</td><td>Not wearing gloves</td><td>50/- *</td></tr><tr><td>7</td><td>Grinding Without Goggles</td><td>50/- *</td></tr><tr><td>8</td><td>Not using 24 V Supply For Internal Work</td><td>500/-</td></tr><tr><td>9</td><td>Electrical Plugs Not used for hand Machine</td><td>100/-</td></tr><tr><td>10</td><td>Not Slinging property</td><td>200/-</td></tr><tr><td>11</td><td>Using Damaged Sling</td><td>200/-</td></tr><tr><td>12</td><td>Lifting Cylinders Without Cage</td><td>500/-</td></tr><tr><td>13</td><td>Not Using Proper Welding Cable With Lot of JointsAnd Not Insulated Property.</td><td>200/-</td></tr></tbody></table>	SN	Violation of Safety Norms	Fine (in Rs)	1	Not Wearing Safety Helmet	50/- *	2	Not wearing Safety Belt or not anchoring life line	100/-*	3	Not wearing safety shoe	100/-*	4	Not keeping gas cylinders vertically	100/-	5	Not using flash back arrestors	50/-	6	Not wearing gloves	50/- *	7	Grinding Without Goggles	50/- *	8	Not using 24 V Supply For Internal Work	500/-	9	Electrical Plugs Not used for hand Machine	100/-	10	Not Slinging property	200/-	11	Using Damaged Sling	200/-	12	Lifting Cylinders Without Cage	500/-	13	Not Using Proper Welding Cable With Lot of JointsAnd Not Insulated Property.	200/-
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	14	Not Removing Small Scrap From Platforms	200/-
	15	Gas Cutting Without Taking Not Using Sheet Below Gas Cutting	200/-
	16	Not Maintaining Electric Operated Dangerously	500/-
	17	Improper Earthing Of Electrical T&P	500/-
	18	No or improper barricading	500/-
	19	Activity carried out without Safety work permit (Height work, Lifting activity, Hot work-each person/case)	1000/-
	20	Accident Resulting in Partial Loss in Earning Capacity	25,000/- per victim
	21	Fatal Accident/Accidents Resulting in total loss in Earning Capacity	1,00,000/- per victim #
<p>Legend: -*: per head, #: or as deducted by Customer whichever is higher.</p> <p>Any other non-conformity noticed not listed above will also be fined as deemed fit by BHEL. The decision of BHEL engineer is final on the above. The amount will be deducted from running bills of the contractor. The amount collected above will be utilized for giving award to the employees who could avoid accident by following safety rules. Also the amount will be spent for purchasing the safety appliances and supporting the safety activity at site.</p>			
9.61	<p>CITATION:-If safety record of the contractor in execution of the awarded job is to the satisfaction of safety department of BHEL, issue of an appropriate certificate to recognize the safety performance of the contractor may be considered by BHEL after completion of the job</p>		

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9.62	<p><u>MEMORANDUM OF UNDERSTANDING</u></p> <p>After Award Of Work, Contractors Are Required To Enter Into A Memorandum Of Understanding As Given Below:</p> <p style="text-align: center;"><u>Memorandum of Understanding</u></p> <ul style="list-style-type: none">➤ BHEL, Power Sector _____ Region is committed to Health, Safety and Environment Policy (EHS Policy).➤ M/s _____ do hereby also commit to the same EHS Policy while executing the Contract Number _____➤ M/s _____ shall ensure that safe work practices not limited to the above are followed by all construction workers and supervisors. Spirit and content therein shall be reached to all workers and supervisors for compliance.➤ BHEL will be carrying out EHS audits twice a year and M/s _____ shall ensure to close any non-conformity observed / reported within fifteen days. <p>Signed by authorized representative of M/s -----</p> <p>Name</p> <p>Place & Date</p>
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SPECIAL CONDITIONS OF CONTRACT (SCC)

Chapter-X: RA Bill Payments

10.0	RA Bill Payments
10.1	The contractor shall submit his monthly RA bills with all the details required by BHEL-HPVP on specified date every month covering progress of work in all respects and areas for the previous calendar month.
10.2	Mode of payment and measurement of work completed shall be as per relevant clauses of General Conditions of Contract
10.3	Release of payment in each running bill will be restricted to 90% of the value of work admitted as per stages of progressive pro rata payments.
10.4	The 10% thus remaining shall be treated as 'Retention Amount' and shall be released as per terms specified in the General Conditions of Contract.
10.5	The payment for running bills will normally be released from BHE_HPVP Head Office at Visakhapatnam within 30 days of submission of running bill complete in all respects with all documents. It is the responsibility of the contractor to make his own arrangements for making timely payments towards labour wages, statutory payments, outstanding dues etc and other dues in the meanwhile.
10.6	BHEL shall release payment through Electronic Fund Transfer (EFT)/RTGS from Head Office. In order to implement this system, Contractor to furnish details pertaining to his Bank Accounts where proceeds will be transferred through BHEL's banker, as per prescribed formats: Note: BHEL may also choose to release payment by other alternative modes as Applicable
10.7	Void

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Chapter-XI : Performance Monitoring

11.0	Performance Monitoring
11.1	Performance of the contractor is monitored through various reports/reviews and shall be jointly evaluated every month for unit wise identified packages as per prescribed formats. Based on the net weighted scores obtained, Contractors shall be rated 'Good' or 'Satisfactory' or 'Unsatisfactory'.
11.2	In case of any dispute on performance rating and the contractor refuses to sign on the performance rating given by BHEL package Incharge, the same shall be reviewed by BHEL site Incharge/Construction Manager and his decision shall be final.
11.3	Void.
11.4	Performance of the contractor will be taken into consideration for assessing the capacity of the bidder to execute future jobs under tender, as detailed in the Notice Inviting Tender. Risk of non evaluation or non availability of the Monthly performance evaluation reports is to be borne by the Bidder.
11.5	In case of 'Unsatisfactory performance' for a continuous period of three or more months for a package or packages, BHEL has the right to get the balance works executed at the risk and cost of the contractor.
11.6	In case of 'Unsatisfactory performance' in a financial year, BHEL reserves the right to put on hold such Contractors for a period of six months for similar package or similar packages

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Chapter-XII: Suspension of Business Dealings

12.0	Suspension of Business dealings
12.1	BHEL reserves the right to take action against contractors who fail to perform or indulge in malpractices, by suspending business dealings with them.
12.2	Suspension could be in the form of 'Hold', 'De-listing' or 'Banning' a contractor.
12.3	<p>A bidder may be put on HOLD for a period of 6 months, for future tenders for specific works on the basis of one or more of the following reasons:</p> <ul style="list-style-type: none">a) Bidder does not honour his own offer or any of its conditions within the validity period.b) Bidder fails to respond against three consecutive enquires of BHEL.c) After placement of order, Bidder fails to execute a contract.d) Bidder fails to settle sundry debt account, for which he is legitimately liable, within one year of its occurrence.e) Bidder's performance rating falls below 60% in specific category (more fully described in chapter 'Performance Monitoring')f) Bidder works are under strike/ lockout for a long period.
12.4	<p>A Bidder may be de-listed from the list of registered Bidders of the region for a period of 1 year on the basis of one or more of the following reasons:-</p> <ul style="list-style-type: none">a) Bidder tampers with tendering procedure affecting ordering process or commits any misconduct which is contrary to business ethics.b) Bidder has substituted, damaged, failed to return, short returned or unauthorizedly disposed off materials/ documents/ drawings/ tools etc of BHEL.c) Bidder no longer has the technical staff, equipment, financial resources etc. required to execute the orders/ contracts.
12.5	<p>A Bidder can be banned from doing any business with all Units of BHEL for a period of 3 years on the basis of one or more of the following reasons:</p> <ul style="list-style-type: none">a) Bidder is found to be responsible for submitting fake/ false/ forged documents, certificates, or information prejudicial to BHEL's interest.b) In spite of warnings, the Bidder persistently violates or circumvents the provisions of labour laws/ regulations/ rules and other statutory requirements.c) Bidder is found to be involved in cartel formation

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Chapter-XII: Suspension of Business Dealings

	<p>d) The Bidder has indulged in malpractices or misconduct such as bribery, corruption and fraud, pilferage etc which are contrary to business ethics.</p> <p>e) The Bidder is found guilty by any court of law for criminal activity/ offences involving moral turpitude in relation to business dealings.</p> <p>f) The Bidder is declared bankrupt, insolvent, has wound up or been dissolved; i.e ceases to exist for all practical purposes.</p> <p>g) Bidder is found to have obtained Official Company information/ documentation by questionable means.</p> <p>h) Communication is received from the administrative Ministry of BHEL to ban the Bidder from business dealings.</p>
12.6	Contracts already entered with a contractor before the date of issue of order of 'HOLD' or 'DE-LISTING' shall not be affected.
12.7	All existing contracts with a 'BANNED' contractor shall normally be short closed.
12.8	Once the order for suspension is passed, existing offers/new offers of the contractor shall not be entertained.
12.9	The above guidelines are not exhaustive but enunciate broad principles governing action against contractors



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ENGINEERING STANDARD

FABRICATION, ASSEMBLY AND ERECTION OF PIPING

FORM NUMBER 02-0000-0021 F1 REV 0

0	SEP. '99	ISSUED FOR IMPLEMENTATION			
REV.	DATE	PURPOSE	PREPARED	REVIEWED	APPROVED



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**ENGINEERING STANDARD
FABRICATION, ASSEMBLY AND
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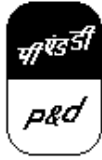
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1.0 SCOPE

- 1.1 This specification covers the requirements of fabrication, assembly and erection of Carbon Steel, Alloy Steel and Stainless Steel pipes and fittings. These requirements conform to ASME Code of pressure piping Process piping ASME B 31.3 - 1999. This standard is meant for easy reference by the Inspector to all requirements of fabrication, assembly and erection of pipes at one place and should not be used as purchase requirements for an enquiry or an order.
- 1.2 For pipes to be used for steam services, the requirements of Indian Boiler Regulations shall apply in addition to all non-conflicting requirements of this specification.
- 1.3 Recommendations contained in this document do not in any way release a welding contractor from his responsibility with regard to correct choice of welding materials and procedures, neither do they constitute any commitment on the part of PDIL with regard to payment of any expenses incurred.

2.0 REFERENCE STANDARDS

- ASME B 31.3 -- Code for pressure piping - Process Piping
- ASME BPV Code -- Specification for Welding Rods, Electrodes and Filler
Sec.II Part C Metals
- AWS A 5.1 -- Carbon Steel Electrodes for Shielded Metal Arc Welding
- AWS A 5.4 -- Stainless Steel Electrodes for Shielded Metal Arc Welding
- AWS A 5.5 -- Low Alloy Steel Covered Arc Welding Electrodes
- AWS A 5.11 -- Nickel and Nickel Alloy Welding Electrodes for Shielded
Metal Arch Welding
- ASME BPV Code -- Welding Qualification
Sec.IX

3.0 WELDING

3.1 Welding Responsibility

Each employer is responsible for the welding done by the personnel of his organization and, except as provided in paras 3.2.2 and 3.2.3 shall conduct the tests required to qualify welding procedures and to qualify and as necessary requalify welders and welding operators.

3.2 Welding Qualifications

3.2.1 Qualification Requirements



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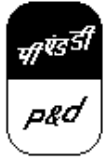
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- (a) Qualification of the welding procedures to be used and of the performance of welders and welding operators shall conform to the requirements of the BPV Code, Section IX except as modified herein.
- (b) Where the base metal will not withstand the 180 ° guided bend required by Section IX, a qualifying welded specimen is required to undergo the same degree of bending as the base metal, within 5°.
- (c) The requirements for preheating in para 4.0 and for heat treatment in para 5.0 as well as such requirements in the engineering design, shall apply in qualifying welding procedures.
- (d) When impact testing is required by this Standard or the engineering design, those requirements shall be met in qualifying welding procedures.
- (e) To reduce the number of welding procedure qualifications required, P-Numbers or S-Numbers and Group Numbers are assigned in the BPV Code, Section IX, to groupings of metals generally based on composition, weldability and mechanical properties, insofar as practicable. The P-Numbers or S-Numbers for most metals are listed in Table A-1 of ASME B 31.3. See Section IX, QW/QB-422, for Group Numbers for respective P-Numbers and S-Numbers. Use of Section IX, QW-420.2 is required for this Standard.

3.2.2 Procedure Qualification by Others

Each employer is responsible for qualifying any welding procedure that personnel of the organization will use. Subject to the specific approval of the Inspector, welding procedures qualified by others may be used, provided that the following conditions are met.

- (a) The Inspector shall be satisfied that :
- 1) the proposed welding procedure specification (WPS) has been prepared, qualified and executed by a responsible, recognized organization with expertise in the field of welding; and
 - 2) the employer has not made any change in the welding procedure.
- (b) The base material P-Number is either 1, 3, 4 Gr.No.1 (1¼ Cr max.), or 8; and impact testing is not required.
- (c) The base metals to be joined are of the same P-Number, except that P-Nos. 1, 3 and 4 Gr.No.1 may be welded to each other as permitted by Section IX.
- (d) The material to be welded is not more than 19 mm in thickness. Postweld heat treatment shall not be required.
- (e) The design pressure does not exceed the ASME B 16.5, Class 300 rating for the material at design temperature; and the design temperature is in the range -29°C to 399°C, inclusive.



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(f) The welding process is SMAW (Shielded Metal Arc Welding) or GTAW (Gas Tungsten Arc Welding) or a combination thereof.

(g) Welding electrodes for the SMAW process are selected from the following classifications.

<u>AWS A 5.1</u>	<u>AWS A 5.4</u>	<u>AWS A 5.5</u>
E6010	E308-15, -16	E7010 - A1
E6011	E308L-15, -16	E7018 - A1
E7015	E309-15, -16	E8016 - B1
E7016	E310-15, -16	E8018 - B1
E7018	E-16-8-2-15, -16	E8015 - B2L
	E316-15, -16	E8016 - B2
	E316L-15, -16	E8018 - B2
	E347-15, -16	E8018 - B2L

Recommended electrodes and bare wires for welding of certain selected pipe materials are shown in Table 1.

The figures in Table 4A & 4B are referring to the selection of welding material in Table 1 and the letters in Table 4A and 4B are referring to the selection of preheat and postweld heat temperature in Table 2 and 3 respectively. The suitability of these electrodes and wires (or materials which may be selected as alternatives) and the suitability of preheat and postweld heat temperatures shall be demonstrated in appropriate Welding Procedure Qualifications as described in ASME Section IX.

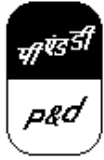
(h) By signature, the employer accepts responsibility for both the WPS and the procedure qualification record (PQR).

(i) The employer has at least one currently employed welder or welding operator who, while in his employ has satisfactorily passed a performance qualification test using the procedure and the P-Number material specified in the WPS. The performance bend test required by Section IX. QW-302 shall be used for this purpose. Qualification by radiography is not acceptable.

The responsibility of the welding contractor shall include the provision of all materials, facilities and man powers for the procedure and performance qualification tests.

3.2.3 Performance Qualification by Others

To avoid duplication of effort, an employer may accept a performance qualification made for another employer, provided that the Inspector specifically approves. Acceptance is limited to qualification on piping using the same or equivalent procedure wherein the essential variables are within the limits in Section IX. The employer shall obtain a copy from the previous employer of the performance



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qualification test record, showing the name of the employer, name of the welder or welding operator, procedure identification, date of successful qualification and the date that the individual last used the procedure on pressure piping.

3.2.4 Qualification Records

The employer shall maintain a self-certified record, available to the owner (and the owner's agent) and the Inspector, of the procedures used and the welders and welding operators employed, showing the date and results of procedure and performance qualifications and the identification symbol assigned to each welder and welding operator.

3.3 Welding Materials

3.3.1 Filler Metal

Filler metal shall conform to the requirements of Section IX. A filler metal not yet incorporated in Section IX may be used with the owner's approval if a procedure qualification test is first successfully made.

3.3.2 Weld Backing Material

Permanent backing rings are not permitted except for use in refractor lined pipes.

When backing rings are used, they shall conform to the following :

(a) *Ferrous Metal Backing Rings*

These shall be of weldable quality. Sulfur content shall not exceed 0.05%.

- (b) If two abutting surfaces are to be welded to a third member used as a backing ring and one or two of the three members are ferritic and the other member or members are austenitic, the satisfactory use of such materials shall be demonstrated by welding procedure qualified as required by para 3.2.

Backing rings may be of the continuous machined or split-band type. Some commonly used types are shown in Fig.3.3.2.

(c) *Nonferrous and Nonmetallic Backing Rings*

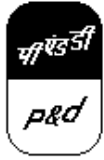
Backing rings of nonferrous or nonmetallic material may be used, provided the designer approves their use and the welding procedure using them is qualified as required by para 3.2.

3.3.3 Consumable Inserts

Consumable inserts are not permitted.

3.4 Preparation for Welding

3.4.1 Cleaning



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Internal and external surfaces to be thermally cut or welded shall be clean and free paint, oil, rust, scale and other material that would be detrimental to either the weld or the base metal when heat is applied.

Where root passes are made by GTAW (Gas Tungsten Arc Welding) or GMAW (Gas Metal Arc Welding) processes, the internal pipe surface shall be cleared before welding by means of grinding, brushing or equivalent for at least 10 mm from the end of the pipe.

3.4.2 End Preparation

(a) *General*

- 1) End preparation is acceptable only if the surface is reasonably smooth and true and slag from oxygen or arc cutting is cleaned from thermally cut surfaces. Discoloration remaining on a thermally cut surface is not considered detrimental oxidation.
- 2) End preparation for groove welds specified in ASME B 16.25 or any other which meets the WPS, is acceptable. [For convenience, the basic bevel angles of ASME B 16.25 and some additional J-bevel angles are shown in Fig.3.4.2 sketches (a) and (b)].
- 3) The root opening is nom. 1.5 mm and shall not normally exceed 3 mm for root passes made by GTAW process and 4 mm for root passes made by GMAW or SMAW (Shielded Metal Arc Welding) process.

(b) *Circumferential Welds*

- 1) If component ends are trimmed as shown in Fig.3.3.2 sketch (a) or (b) to fit backing rings or consumable inserts or as shown in Fig.3.4.3 sketch (a) or (b) to correct internal misalignment, such trimming shall not reduce the finished wall thickness below the required minimum wall thickness t_m .
- 2) Component ends may be bored to allow for a completely recessed backing ring, provided the remaining net thickness of the finished ends is not less than t_m .
- 3) It is permissible to size pipe ends of the same nominal size to improve alignment if wall thickness requirements are maintained.
- 4) Where necessary, weld metal may be deposited inside or outside of the component to permit alignment to provide for machining to ensure satisfactory seating of rings or inserts.
- 5) When a girth or miter groove weld joins components of unequal wall thickness and one is more than $1\frac{1}{2}$ times the thickness of the other end preparation and geometry shall be in accordance with acceptable designs for unequal wall thickness in ASME B 16.25.



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3.4.3 Alignment

(a) *Circumferential Welds*

- 1) Inside surfaces of components at ends to be joined in girth or miter groove welds shall be aligned within the dimensional limits in the WPS and the engineering design.

Misalignment of pipe ends for butt welds shall not exceed 1.6 mm at any point on the bore of the pipe as shown in Fig. 3.4.3.

Alignment of girth butt joints may be achieved either by tack welding or by the use of welded yokes or pipe clamps.

- 2) If the external surfaces of the components are not aligned, the weld shall be tapered between them.

(b) *Longitudinal Welds*

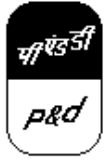
Alignment of longitudinal groove welds (not made in accordance with ASME standard shall conform to the requirements of para 3.4.3(a).

(c) *Branch Connection Welds*

- 1) Branch connections which abut the outside surface of the run pipe shall be contoured for groove welds which meet the WPS requirements [see Fig.3.4.4 sketches (a) and (b)].
- 2) Branch connections which are inserted through a run opening shall be inserted at least as far as the inside surface of the run pipe at all points [see Fig.3.4.4 sketch (c)] and shall otherwise conform to para 3.4.3(c)(1).
- 3) Run openings for branch connections shall not deviate from the required contour more than the dimension m in Fig.3.4.4. In no case shall deviations of the shape of the opening cause the root spacing tolerance limits in the WPS to be exceeded. Weld metal may be added and refinished if necessary for compliance.
- 4) *Spacing*
The root opening of the joint shall be within the tolerance limits in the WPS.

3.5 Welding Requirements

3.5.1 General



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(a) Welds, including addition of weld metal for alignment [paras 3.4.2 (b)(4) and 3.4.3 (c)(3)], shall be made in accordance with a qualified procedure and by qualified welders or welding operators.

(b) Each qualified welder and welding operator shall be assigned an identification symbol. Unless otherwise specified in the engineering design, each pressure containing weld or adjacent area shall be marked with the identification symbol of the welder or welding operator. In lieu of marking the weld, appropriate records shall be filed.

(c) Tack welds at the root of the joint shall be made with filler metal equivalent to that used in the root pass. Tack welds shall be made by a qualified welder or welding operator. Tack welds shall be fused with the root pass weld, except that those which have cracked shall be removed.

For pipe wall thickness above 8 mm bridge tacking (above the root) is preferred. Bridge tacks shall be removed completely before filler passes are added.

(d) Peening is prohibited on the root pass and final pass of a weld.

(e) No welding shall be done if there is impingement on the weld area of rain, snow, sleet or excessive wind, or if the weld area is frosted or wet.

(f) Root passes of all welds in inspection class 2 (see clause 5) and all welds in which either of the metals to be joined is austenitic steel shall be made using the GTAW process with inert backing gas. The inert gas shall preferably be Argon, although gas consisting of 85% N₂ + 15% H₂ may be used if argon is not available.

For pipes ≤ 2 inch nom. size, use GTAW for entire welding.

(g) *Welding End Valves*

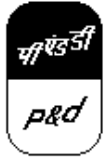
The welding sequence and procedure and any heat treatment for a welding end valve shall be such as to preserve the seat tightness of the valve.

3.5.2 Fillet and Socket Welds

Fillet welds (including socket welds) may vary from convex to concave. The size of a fillet weld is determined as shown in Fig.3.5.2A.

(a) Typical weld details for slip-on and socket welding flanges are shown in Fig.3.5.2B; minimum welding dimensions for other socket welding components are shown in Fig.3.5.2C.

(b) If slip-on flanges are single welded, the weld shall be at the hub.



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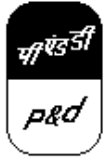
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3.5.3 Seal Welds

Seal welding shall be done by a qualified welder. Seal welds shall cover all exposed threads except those for seal welded thermowell connections.

3.5.4 Welded Branch Connections

- (a) Figures 3.5.4A through 3.5.4E show acceptable details of branch connections with and without added reinforcement, in which the branch pipe is connected directly to the run pipe. The illustrations are typical and are not intended to exclude acceptable types of construction not shown.
- (b) Figure 3.5.4D shows basic types of weld attachments used in the fabrication of branch connections. The location and minimum size of attachment welds shall conform to the requirements herein. Welds shall be calculated in accordance with para 304.3.3 of ASME B 31.3 but shall be not less than the sizes shown in Fig. 3.5.4D.
- (c) The nomenclature and symbols used herein and in Fig.3.5.4D are :
- t_c = lesser of $0.7T_b$ or 6 mm
 T_b = nominal thickness of branch
 T_h = nominal thickness of header
 T_r = nominal thickness of reinforcing pad or saddle
 $t_{min.}$ = lesser of T_b or T_r
- (d) Branch connections, including branch connection fittings which abut the outside of the run or which are inserted in an opening in the run shall be attached by fully penetrated groove welds. The welds shall be finished with cover fillet welds having a throat dimension not less than t_c see Fig.3.5.4D sketches (1) and (2).
- (e) A reinforcing pad or saddle shall be attached to the branch pipe by either:
- 1) a fully penetrated groove weld finished with a cover fillet weld having a throat dimension not less than t_c ; or
 - 2) a fillet weld having a throat dimension not less than $0.7t_{min.}$. See Fig.3.5.4D sketch (5).
- (f) The outer edge of a reinforcing pad or saddle shall be attached to the run pipe by a fillet weld having a throat dimension not less than $0.5T_r$. See Fig. 3.5.4D sketches (3), (4) and (5).
- (g) Reinforcing pads and saddles shall have a good fit with the parts to which they are attached. A vent hole shall be provided at the side (not at the crotch)



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of any pad or saddle to reveal leakage in the weld between branch and run and to allow venting during welding and heat treatment. A pad or saddle may be made in more than one piece if joints between pieces have strength equivalent to pad or saddle parent metal and if each piece has a vent hole.

- (h) Examination and any necessary repairs of the completed weld between branch and run shall be made before adding a pad or saddle.

3.5.5 Fabricated Laps

Figure 3.5.5 shows typical fabricated laps. Fabrication shall be in accordance with the applicable requirements of para 3.5.4.

3.5.6 Welding for Severe Cyclic Conditions

A welding procedure shall be employed which provides a smooth, regular, fully penetrated inner surface.

3.6 Weld Repair

A weld defect to be repaired shall be removed to sound metal. Repair welds shall be made using a welding procedure qualified in accordance with para 3.2.1 recognizing that the cavity to be repaired may differ in contour and dimensions from the original joint. Repair welds shall be made by welders or welding operators qualified in accordance with para 3.2.1. Preheating and heat treatment shall be as required for the original welding. See also para 3.3.3 of ES 6005.

4.0 PREHEATING

4.1 General

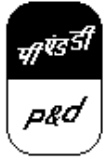
Preheating is used, along with heat treatment, to minimize the detrimental effects of high temperature and severe thermal gradients inherent in welding. The necessity for preheating and the temperature to be used shall be specified in the engineering design and demonstrated by procedure qualification. The requirements and recommendations herein apply to all types of welding including tack welds, repair welds and seal welds of threaded joints.

4.1.1 Requirements and Recommendations

Required and recommended minimum preheat temperatures for materials of various P-Numbers are given in Table 2. If the ambient temperature is below 10°C the recommendations in Table 2 become requirements. Preheating of all materials may be carried out by any controllable means. The thickness intended in Table 2 is that of the thicker component measured at the joint.

4.1.2 Unlisted Materials

Preheat requirements for an unlisted material shall be specified in the WPS.



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4.1.3 Temperature Verification

- (a) Preheat temperature shall be checked by use of temperature indicating crayons, thermocouple pyrometers or other suitable means to ensure that the temperature specified in the WPS is obtained prior to and maintained during welding.
- (b) Thermocouples may be temporarily attached directly to pressure containing parts using the capacitor discharge method of welding without welding procedure and performance qualifications. After thermocouples are removed, the areas shall be visually examined for evidence of defects to be repaired.

4.1.4 Preheat Zone

The preheat zone shall extend at least 25 mm beyond each edge of the weld.

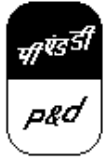
4.2 Specific Requirements

4.2.1 Dissimilar Materials

When materials having different preheat requirements are welded together, it is recommended that the higher temperature shown in Table 2 be used.

4.2.2 Interrupted Welding

If welding is interrupted the rate of cooling shall be controlled or other means shall be used to prevent detrimental effects in the piping. The preheat specified in the WPS shall be applied before welding is resumed.



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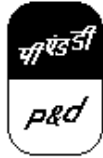
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**TABLE-1
WELDING MATERIALS**

WELDING MATERIALS					
NO.	MATERIAL	COATED ELECTRODES		BARE WIRES	
		ASME SFA	CLASSIFICATION	ASME SFA	CLASSIFICATION
1	C.S	5.1	E7018	5.18	ER70S-2
2	C.Mo.	5.5	E7018	5.18	ER70S-1B
3	1 ¼ Cr.Mo	5.5	E8018-B2	--	ER515
4	2 ¼ Cr.Mo	5.5	E8018-B3	--	ER521
5	5Cr.Mo	5.4	E502-16 or -15	5.9	ER502
6	9Cr.Mo	5.4	E505-16 or -15	--	ER505
7	12Cr	5.4	E410-16 or -15	5.9	ER410
8	3 ½ Ni	5.5	To match base metal	--	--
9	18Cr.8Ni (308,308L)	5.4	E308-16 or -15 E308L-16 or 15	5.9	ER308 ER308L
10	18Cr 10Ni Cb (347)	5.4	E347-16 or -15	5.9	ER347
11	18Cr 10Ni Mo (316 316L)	5.4	E316-16 or -15 E316L-16 or 15	5.9	ER316 ER316L
12	25Cr 12Ni (309) Inconel	5.4 5.11	E309-16 or -15 ENiCrFe-3	5.9 5.14	ER309 ERNiCr-3
13	Inconel	5.11	EniCrFe-3 (Inconel 182)	5.14	ERNiCr-3 (Inconel 82)

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14	Monel	5.11	ENiCu-2 (Monel 190)	5.14	ERNiCu-7 (Monel 60)
15	Nickel	5.11	ENi-I (Nickel 141)	5.14	ERNi-3 (Nickel 61)
16	25Cr 20Ni (310)	5.4	E310-16 OR -15	5.9	ER310

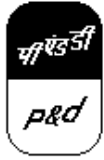
Table 1 shall be used as indication only.

TABLE-2**PREHEAT TEMPERATURES**

Heat Treatment Symbol (Note-1)	Base Metal P-No. or S-No.	Base Metal Group	Nominal Wall Thickness, mm	Specified Min. Tensile Strength, Base Metal Mpa (ksi)	Min. Temperature, °C
A	1	Carbon steel	< 25	≤ 490 (71)	10
			≥ 25	All	80
			All	> 490 (71)	80
B	3	Alloy steels Cr ≤ ½ %	< 13	≤ 490 (71)	10
			≥ 13	All	80
			All	> 490 (71)	80
C	4	Alloy steels ½ % < Cr ≤ 2%	All	All	150
D	5A,5B,5C	Alloy steels 2¼ % ≤ Cr ≤ 10%	All	All	177
E	6	High alloy steels martensitic	All	All	150 (Note 2)
F	7	High alloy steels ferritic	All	All	10
	8	High alloy steels austenitic	All	All	10
G	9A,9B	Nickel alloy steels	All	All	93
H	10	Cr-Cu steel	All	All	150-204
J	10I	27 Cr steel	All	All	150 (Note 3)
K	11A SG1	8 Ni, 9Ni steel	All	All	10

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L	11A SG2	5 Ni steel	All	All	10
M	21 - 52		All	All	10

Notes:

- (1) P - Number or S - Number from ASME BPV Code, Section IX, QW/QB - 422
- (2) Maximum interpass temperature 316°C.
- (3) Maintain interpass temperature between 177°C - 232°C.

TABLE - 3**REQUIREMENT FOR HEAT TREATMENT**

Heat Treatment Symbol (Note-1)	Base Metal P-No. or S-No.	Base Metal Group	Thickness mm	Specified Min. Tensile Strength, Base Metal Mpa (ksi)	Metal. Temperature Range °C	Holding Time (Note 2)	Brinell Hardness (Note-9) Max.
A	1	Carbon steel	≤ 19 > 19	All All	None 595 - 650	2.4 min./mm Minimum 1 hr.	--
B	3	Alloy steels Cr ≤ ½ %	≤ 19 > 19 All	≤ 490 (71) All > 490 (71)	None 595 - 720 595 - 720		-- 225 225
C	4 (Note-8)	Alloy steels ½ % < Cr ≤ 2%	≤ 13 > 13 All	≤ 490 (71) All > 490 (71)	None 705 - 745 705 - 745	2.4 min./mm Minimum 2 hr.	-- 225 225
D	5A,5B,5C (Note-8)	Alloy steels ≤ 3% Cr and ≤ 0.15% C	≤ 13 > 13 All	All All All	None 705 - 760 705 - 760		-- 241 241
E	6	High alloy steels martensitic A 240 Gr.429	All All	All All	732 - 788 621 - 663		241 241
F	7	High alloy steels ferritic	All	All	None	--	--
	8	High alloy steels austenitic	All	All	None	--	--
G	9A,9B	Nickel alloy steels	≤ 19 > 19	All All	None 595 - 635	2.4 min./mm Minimum 1 hr.	--

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H	10	Cr-Cu steel	All	All	760 - 816 (Note-3)	1.2 min./mm Minimum ½ hr.	--
I	10H	Duplex stainless steel	All	All	(Note-5)		--
J	10I	27 Cr steel	All	All	663 - 704 (Note-4)	2.4 min./mm Minimum 1 hr.	--
K	11A SG1	8 Ni, 9Ni steel	≤ 51 > 51	All	None 552 - 585 (Note-6)		--
L	11A SG2	5 Ni steel	> 51	All	552 - 585 (Note-6)		--
N	62	Zr 60705	All	All	538 - 593 (Note-7)	Note-7 Minimum 1 hr.	--

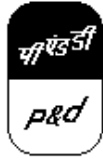
Table 3 (Contd.)

Notes :

- (1) P - Number or S - Number from ASME BPV Code, Section IX, QW/QB - 422
- (2) Holding Time in min/mm (minutes per mm thickness).
- (3) Cool as rapidly as possible after the hold period.
- (4) Cooling rate to 649°C shall be less than 56°C/hr thereafter, the cooling rate shall be fast enough to prevent embrittlement.
- (5) Postweld heat treatment is neither required nor prohibited, but any heat treatment applied shall be as required in the material specification.
- (6) Cooling rate shall be not greater than 167°C/hr upto 316°C.
- (7) Heat treatment shall be carried out within 14 days after welding. Hold time shall be increased by ½ hr. for each 25 mm over 25 mm thickness. Cool to 427°C at a rate < 278°C/hr. per 25 mm nominal thickness, 278°C/hr. max. Cool in still air from 427°C.
- (8) Heat treatment temperatures listed in this table for some P.No.4 and P.No.5 materials may be higher than the minimum tempering temperatures specified in the ASTM specifications for the base material. For higher strength normalised and tempered materials there is consequently a possibility of reducing tensile properties of the base material, particularly if long holding times at higher temperatures are used.
- (9) See para 331.1.7 of ASME B 31.3, reproduced below

Hardness tests of production welds and of hot bent and hot formed piping are intended to verify satisfactory heat treatment. The hardness limit applies to the weld and to the heat affected zone (HAZ) tested as close as practicable to the edge of the weld.

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- (a) Where a hardness limit is specified in Table 3 at least 10% of welds, hot bends and hot formed components in each furnace heat treated batch and 100% of those locally heat treated shall be tested.
- (b) When dissimilar metals are joined by welding the hardness limits specified for the base and welding materials in Table 3 shall be met for each material.

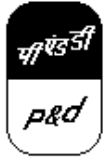
Welding Materials and Heat Treatment for Welding of Dissimilar Steels

TABLE 4A

Ferrous Material														
Materials	P No	310	316 316L	321 347	304 304L	3 ½ Ni	13Cr 405	13Cr 410	9Cr 1 Mo	5Cr ½Mo	2½Cr 1Mo	1½Cr ½Mo	C-Mo	C.S
C.S.	P-1	12A	12A	12A	12A	1G	1B	1E	1D	1D	1D	1C	1B	1A
C.Mo	P-3	12B	12B	12B	12B	2G	2B	2E	2D	2D	2D	2C	2B	
1 ½ Cr-½Mo	P-4	12C	12C	12C	12D	3C	3C	3E	3D	3D	3D	3C		
2 ½ Cr-1Mo	P-5	12D	12D	12D	12D	4D	4D	4E	4D	4D	4D			
5 Cr-½Mo	P-5	12D	12D	12D	12D	5D	5D	5E	5D	5D				
9 Cr-1Mo	P-5	12D	12D	12D	12D	6D	6D	6D	6D					
13 Cr, Type 410	P-6	12E	12E	12E	12E	7E	7E	7E						
13 Cr, Type 405	P-7	12F	12F	12F	12F	7G	12F							
3 ½ Nickel	P-9E	12G	12G	12G	12G	8G 13A,G								
18 Cr-8Ni Type 304, 304L	P-8	9F	9F	9F	9F									
18 Cr 10 Ni Type 347, 321	P-8	10F	10F	10F										
16 Cr 12Ni Type 316, 316L	P-8	11F	11F											
25 Cr 20Ni	P-8	16F												

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Type 310

TABLE 4B

Nickel Base Alloys					
Material	P.No.	Nickel	Monel	Inconel	Incoloy
C.S.	P-1	13F	14F	13F	13F
Stainless	P-8	13F	13F	13F	13F
Incoloy	P-45	13F	13F	13F	13F
Inconel	P-42	13F	13F	13F	
Monel	P-42	15F	14F		
Nickel	P-41	15F			

The figure in each block refers to the electrode or bare wire in Table1, while the letter refers to the preheat and post weld heat treatment shown in Table-2 and 3.

5.0 HEAT TREATMENT

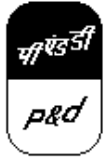
Heat treatment is used to avert or relieve the detrimental effects of high temperature and severe temperature gradients inherent in welding and to relieve residual stresses created by bending and forming. These are basic practices which are suitable for most welding, bending and forming operations, but not necessarily appropriate for all service conditions.

5.1 General

5.1.1 Heat Treatment Requirements

- (a) Heat treatment shall be in accordance with the material groupings and thickness ranges in Table 3 except as provided in paras 5.2.1 and 5.2.2.
- (b) Heat treatment to be used after production welding shall be specified in the WPS and shall be used in qualifying the welding procedure.
- (c) The engineering design shall specify the examination and/or other production quality control (not less than the requirements of this Standard) to ensure that the final welds are of adequate quality.
- (d) Heat treatment for bending and forming shall be in accordance with para 6.4.
- (e) Post -weld heat treatment of Cr.Mo. steels shall be carried out using either electric or gas fired furnaces. For local heat treatment heating by torches is not permitted. Electric heating shall be used.

5.1.2 Governing Thickness



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When components are joined by welding, the thickness to be used in applying the heat treatment provisions of Table 5.1.1 shall be that of the thicker component measured at the joint except as follows :

- (a) In the case of branch connections, metal (other than weld metal) added as reinforcement, whether an integral part of a branch fitting or attached as a reinforcing pad or saddle, shall not be considered in determining heat treatment requirements. Heat treatment is required, however, when the thickness through the weld in any plane through the branch is greater than twice the minimum material thickness requiring heat treatment, even though the thickness of the components at the joint is less than the minimum thickness. Thickness through the weld for the details shown in Fig.3.5.4D shall be computed using the following formulas :

$$\text{sketch (1)} = T_b + t_c$$

$$\text{sketch (2)} = T_h + t_c$$

$$\text{sketch (3)} = \text{greater of } T_b + t_c \text{ or } T_r + t_c$$

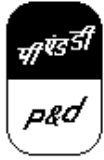
$$\text{sketch (4)} = T_h + T_r + t_c$$

$$\text{sketch (5)} = T_b + t_c$$

- (b) In the case of fillet welds at slip-on and socket welding flanges and piping connections NPS 2" and smaller for seal welding of threaded joints in piping NPS 2" and smaller and for attachment of external nonpressure parts such as lugs or other pipe supporting elements in all pipe sizes, heat treatment is required when the thickness through the weld in any plane is more than twice the minimum material thickness requiring heat treatment (even though the thickness of the components at the joint is less than that minimum thickness except as follows :

- 1) not required for P-No.1 materials when weld throat thickness is 16 mm or less regardless of base metal thickness;
- 2) not required for P-No.3,4,5 or 10A materials when weld throat thickness is 13 mm or less, regardless of base metal thickness, provided that not less than the recommended preheat is applied and the specified minimum tensile strength of the base metal is less than 490 Mpa (71 ksi);
- 3) not required for ferritic materials when welds are made with filler metal which does not air harden. Austenitic welding materials may be used for welds to ferritic materials when the effects of service conditions, such as differential thermal expansion due to elevated temperature or corrosion, will not adversely affect the weldment.

5.1.3 Heating and Cooling



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The heating method shall provide the required metal temperature, metal temperature uniformity and temperature control and may include an enclosed furnace, local flame heating, electric resistance, electric induction or exothermic chemical reaction. The cooling method shall provide the required or desired cooling rate and may include cooling in a furnace, in air, by application of local heat or insulation or by other suitable means.

5.1.4 Temperature Verification

Heat treatment temperature shall be checked by thermocouple pyrometers or other suitable methods to ensure that the WPS requirements are met. See para 4.1.3(b) for attachment of thermocouples by the capacitor discharge method of welding.

5.1.5 Hardness Tests

Hardness tests of production welds and of hot bent and hot formed piping are intended to verify satisfactory heat treatment. The hardness limit applies to the weld and to the heat affected zone (HAZ) tested as close as practicable to the edge of the weld.

Hardness testing shall be carried out using a portable Brinnell hardness tester using a standard 10 mm ball.

- (a) Where a hardness limit is specified in Table 3 at least 10% of welds, hot bends and hot formed components in each furnace heat treated batch and 100% of those locally heat treated shall be tested.
- (b) When dissimilar metals are joined by welding, the hardness limits specified for the base and welding materials in Table 3 shall be met for each material.

It should be noted that hardness test is not a substitute for notch testing.

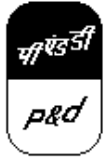
5.2 Specific Requirements

Where warranted by experience or knowledge of service conditions, alternative methods of heat treatment or exceptions to the basic heat treatment provisions of para 5.1 may be adopted as provided in paras 5.2.1 and 5.2.2.

5.2.1 Alternative Heat Treatment

Normalizing or normalizing and tempering or annealing may be applied in lieu of the required heat treatment after welding, bending or forming, provided that the mechanical properties of any affected weld and base metal meet specification requirements after such treatment and that the substitution is approved by the designer.

5.2.2 Exceptions to Basic Requirements



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As indicated in para 5.0 the basic practices therein may require modification to suit service conditions in some cases. In such cases, the designer may specify more stringent requirements in the engineering design, including heat treatment and hardness limitations for lesser thickness or may specify less stringent heat treatment and hardness requirements, including none.

When provisions less stringent than those in para 5.0 are specified, the designer must demonstrate to the owner's satisfaction the adequacy of those provisions by comparable service experience considering service temperature and its effects, frequency and intensity of thermal cycling, flexibility stress levels, probability of brittle failure and other pertinent factors. In addition, appropriate tests shall be conducted, including WPS qualification tests.

5.2.3 Dissimilar Materials

- (a) Heat treatment of welded joints between dissimilar ferritic metals or between ferritic metals using dissimilar ferritic filler metal shall be at the higher of the temperature ranges in Table 3 for the materials in the joint.
- (b) Heat treatment of welded joints including both ferritic and austenitic components and filler metals shall be as required for the ferritic material or materials unless otherwise specified in the engineering design.
- (c) Recommended welding material and recommended heat treatment procedures to be employed when welding various combinations are shown in Table-4A and Table-4B.
- (d) It should be noted that a high alloy electrode is recommended in all cases where low alloy steel is welded to austenitic steel.

5.2.4 Delayed Heat Treatment

If a weldment is allowed to cool prior to heat treatment, the rate of cooling shall be controlled or other means shall be used to prevent detrimental effects in the piping.

5.2.5 Partial Heat Treatment

When an entire piping assembly to be heat treated cannot be fitted into the furnace, it is permissible to heat treat in more than one heat, provided there is at least 300 mm overlap between successive heats and that parts of the assembly outside the furnace are protected from harmful temperature gradients.

5.2.6 Local Heat Treatment

When heat treatment is applied locally, a circumferential band of the run pipe and of the branch where applicable, shall be heated until the specified temperature range exists over the entire pipe section(s), gradually diminishing beyond a band which includes the weldment or the bent or formed section and at least 25 mm beyond the ends thereof.



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6.0 BENDING AND FORMING

6.1 General

Pipe may be bent and components may be formed by any hot or cold method which is suitable for the material the fluid service and the severity of the bending or forming process. The finished surface shall be free of cracks and substantially free from buckling. Thickness after bending or forming shall be not less than that required by the design.

6.2 Bending

6.2.1 Bending Flattening

Flattening of a bend, the difference between maximum and minimum diameters at any cross section, shall not exceed 8% of nominal outside diameter for internal pressure and 3% for external pressure. Removal of metal shall not be used to achieve these requirements.

6.2.2 Bending Temperature

- (a) Cold bending of ferritic materials shall be done at a temperature below the transformation range.
- (b) Hot bending shall be done at a temperature above the transformation range and in any case within a temperature range consistent with the material and the intended service.

6.3 Forming

The temperature range for forming shall be consistent with material, intended service and specified heat treatment.

6.4 Required Heat Treatment

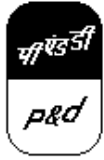
Heat treatment shall be performed in accordance with para 6.1.1 when required by the following :

6.4.1 Hot Bending and Forming

After hot bending and forming, heat treatment is required for P-Nos.3,4,5,6 and 10A materials in all thicknesses. Durations and temperatures shall be in accordance with para 5.0.

6.4.2 Cold Bending and Forming

After cold bending and forming, heat treatment is required (for all thicknesses and with temperature and duration as given in Table 5.1.1) when any of the following conditions exist :



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- (a) for P-Nos. 1 through 6 materials, where the maximum calculated fiber elongation after bending or forming exceeds 50% of specified basic minimum elongation (in the direction of severest forming) for the applicable specification, grade and thickness. This requirement may be waived if it can be demonstrated that the selection of pipe and the choice of bending or forming process provide assurance that in the finished condition the most severely strained material retains at least 10% elongation.
- (b) for any material requiring impact testing, where the maximum calculated fiber elongation after bending or forming will exceed 5%.
- (c) when specified in the engineering design.

7.0 ASSEMBLY AND ERECTION

7.1 General

7.1.1 Alignment

(a) Piping Distortions

Any distortion of piping to bring it into alignment for joint assembly which introduces a detrimental strain in equipment or piping components is prohibited.

(b) Cold Spring

Before assembling any joints to be cold sprung, guides, supports and anchors shall be examined for errors which might interfere with desired movement or lead to undesired movement. The gap or overlap of piping prior to assembly shall be checked against the drawing and corrected if necessary. Heating shall not be used to help in closing the gap because it defeats the purpose of cold springing.

(c) Flanged Joints

Before bolting up, flange faces shall be aligned to the design plane within 1 mm in 200 mm measured across any diameter; flange bolt holes shall be aligned within 3 mm maximum offset.

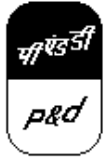
7.2 Flanged Joints

7.2.1 Preparation for Assembly

Any damage to the gasket seating surface which would prevent gasket seating shall be repaired or the flange shall be replaced.

7.2.2 Boltling Torque

- (a) In assembling flanged joints, the gasket shall be uniformly compressed to the proper design loading.



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- (b) Special care shall be used in assembling flanged joints in which the flanges have widely differing mechanical properties. Tightening to a predetermined torque is recommended.

7.2.3 Bolt Length

Bolts should extend completely through their nuts. Any which fail to do so are considered acceptably engaged if the lack of complete engagement is not more than one thread.

7.2.4 Gaskets

No more than one gasket shall be used between contact faces in assembling a flanged joint.

7.3 Threaded Joints

7.3.1 Thread Compound or Lubricant

Any compound or lubricant used on threads shall be suitable for the service conditions and shall not react unfavourably with either the service fluid or the piping material.

7.3.2 Joints for Seal Welding

A threaded joint to be seal welded shall be made up without thread compound. A joint containing thread compound which leaks during leak testing may be seal welded in accordance with para 3.5.3, provided all compound is removed from exposed threads.

7.3.3 Straight Threaded Joints

Typical joints using straight threads, with sealing at a surface other than the threads, are shown in Fig.7.3.3 sketches (a), (b) and (c). Care shall be taken to avoid distorting the seat when incorporating such joints into piping assemblies by welding.

7.4 Tubing Joints

7.4.1 Flared Tubing Joints

The sealing surface of the flare shall be examined for imperfections before assembly and any flare having imperfections shall be rejected.

7.4.2 Flareless and Compression Tubing Joints

Where the manufacturer's instructions call for a specified number of turns of the nut, these shall be counted from the point at which the nut becomes finger tight.

7.5 Caulked Joints

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Caulked joints shall be installed and assembled in accordance with the manufacturer's instructions, as modified by the engineering design. Care shall be taken to ensure adequate engagement of joint members.

7.6 Expanded Joints and Special Joints

7.6.1 General

Expanded joints and special joints shall be installed and assembled in accordance with the manufacturer's instructions, as modified by the engineering design. Care shall be taken to ensure adequate engagement of joint members.

7.6.2 Packed Joints

Where a packed joint is used to absorb thermal expansion, proper clearance shall be provided at the bottom of the socket to permit this movement.

7.7 Cleaning of Piping

Following are some general considerations which may be evaluated in determining the need for cleaning of piping :

- (a) Requirements of the service, including possible contaminants and corrosion products during fabrication, assembly, storage, erection and testing.
- (b) For low temperature service, removal of moisture, oil, grease and other contaminants to prevent sticking of valves or blockage of piping and small cavities; and
- (c) For strong oxidizer fluid service (e.g. oxygen or fluorine), special cleaning and inspection. Reference may be made to the Compressed Gas Association's Pamphlet G-4.1 Cleaning Equipment for Oxygen Service.

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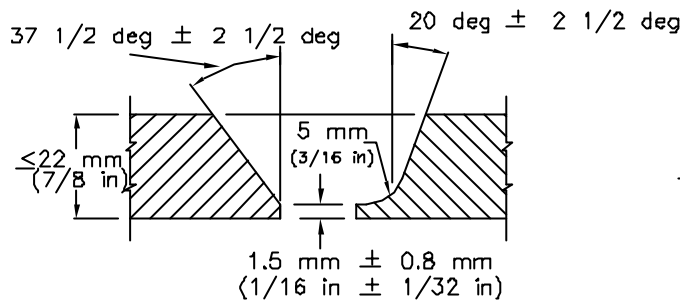
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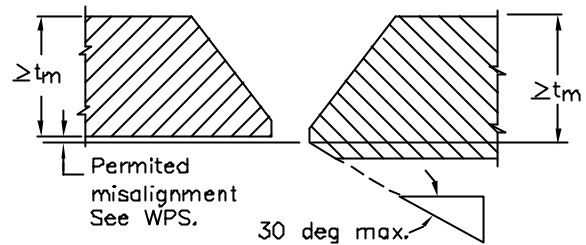
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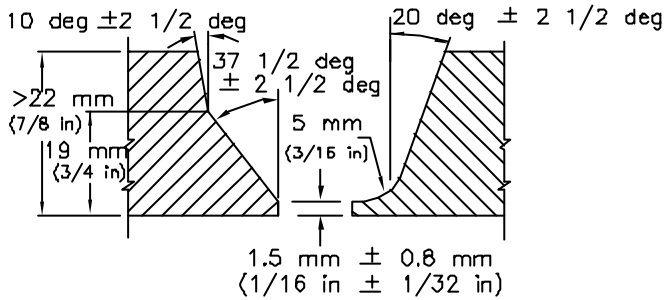
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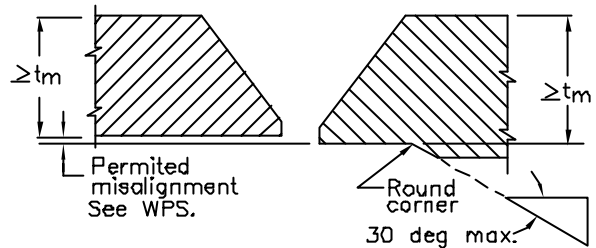
(a) Wall Thickness 6 mm to 22 mm , inclusive (3/16 in. to 7/8 in.)



(a) Thicker Pipe Taper-Bored to Align



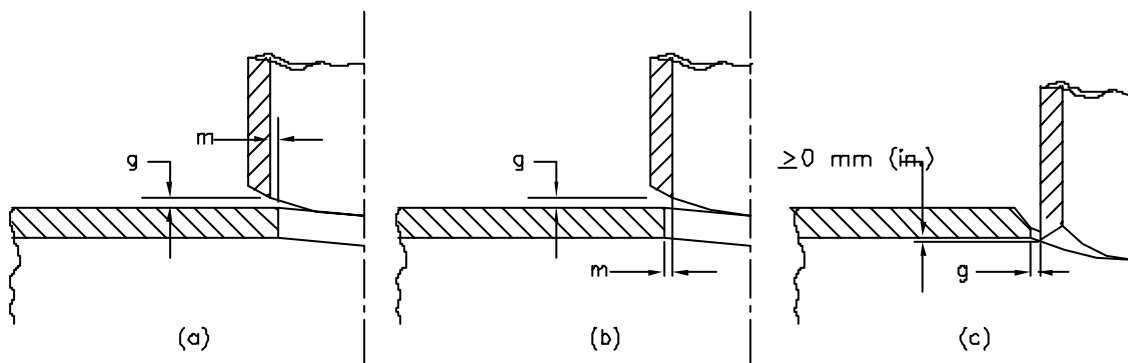
(b) Wall Thickness over 22 mm (7/8 in.)



(b) Thicker Pipe Bored for Alignment

FIG. 3.4.2 TYPICAL BUTT WELD END PREPARATION

FIG. 3.4.3 TRIMMING AND PERMITTED MISALIGNMENT



g = root gap per welding specification
m = the lesser of 3.2 mm (1/8 in.) or 0.5 T_b

FIG. 3.4.4 PREPARATION FOR BRANCH CONNECTIONS

	ISSUED FOR IMPLEMENTATION	ENGG. COMM.		
DATE	PURPOSE	PREPARED	REVIEWED	APPROVED

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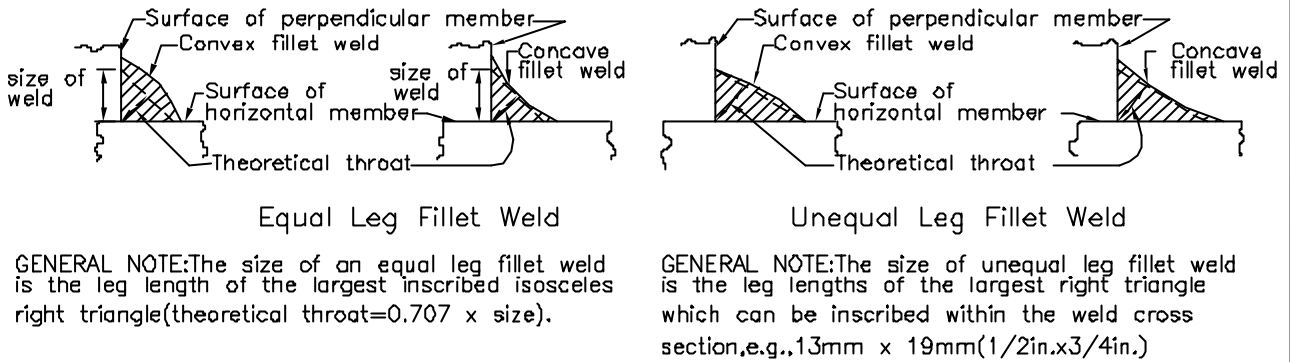


FIG. 3.5.2A FILLET WELD SIZE

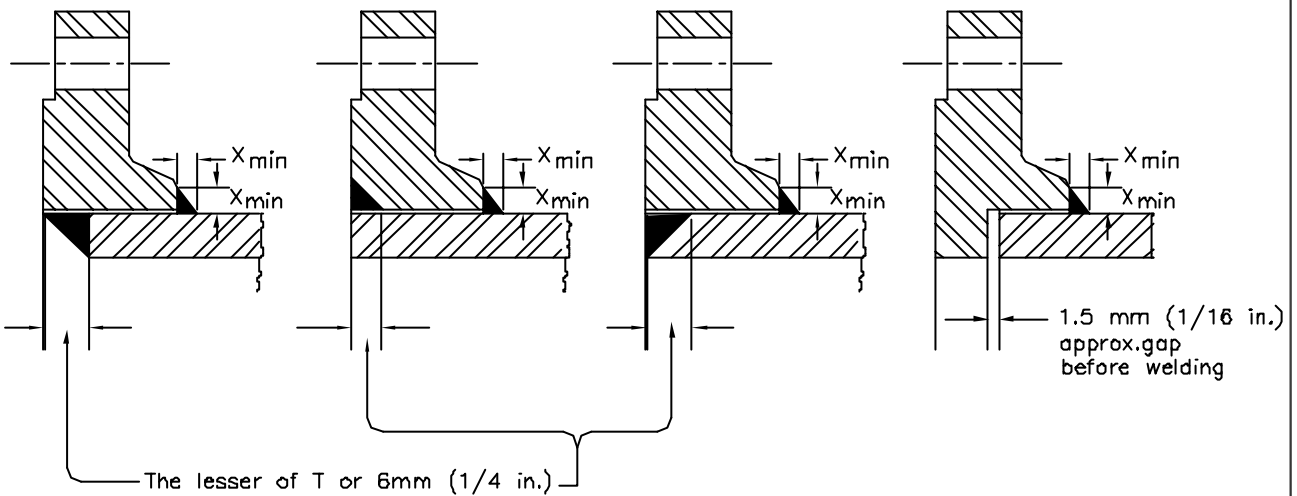


FIG. 3.5.2B TYPICAL DETAILS FOR DOUBLE-WELDED SLIP-ON AND
SOCKET WELDING FLANGE ATTACHMENT WELDS

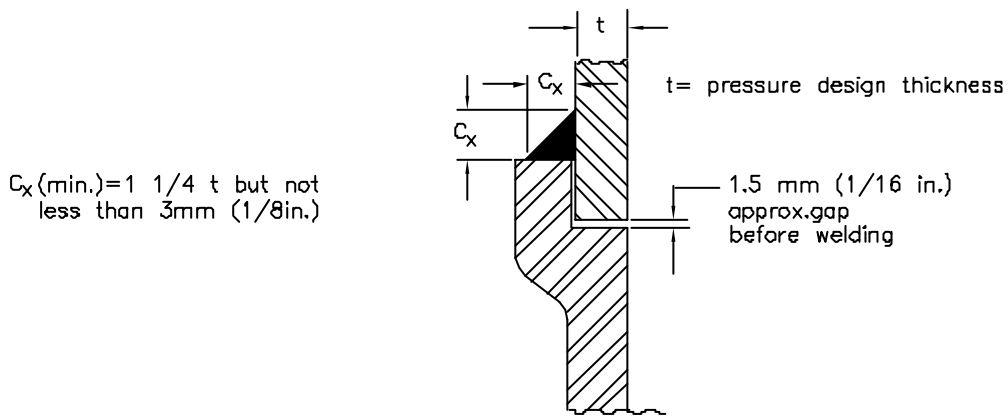


FIG. 3.5.2C MINIMUM WELDING DIMENSIONS FOR SOCKET WELDING COMPONENTS
OTHER THAN FLANGES

	ISSUED FOR IMPLEMENTATION	ENGG. COMM.		
DATE	PURPOSE	PREPARED	REVIEWED	APPROVED

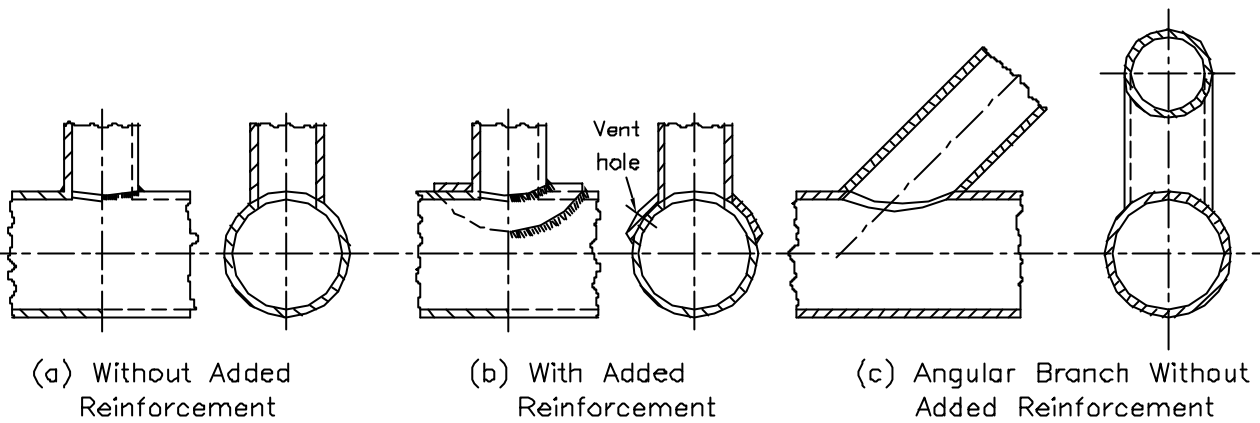
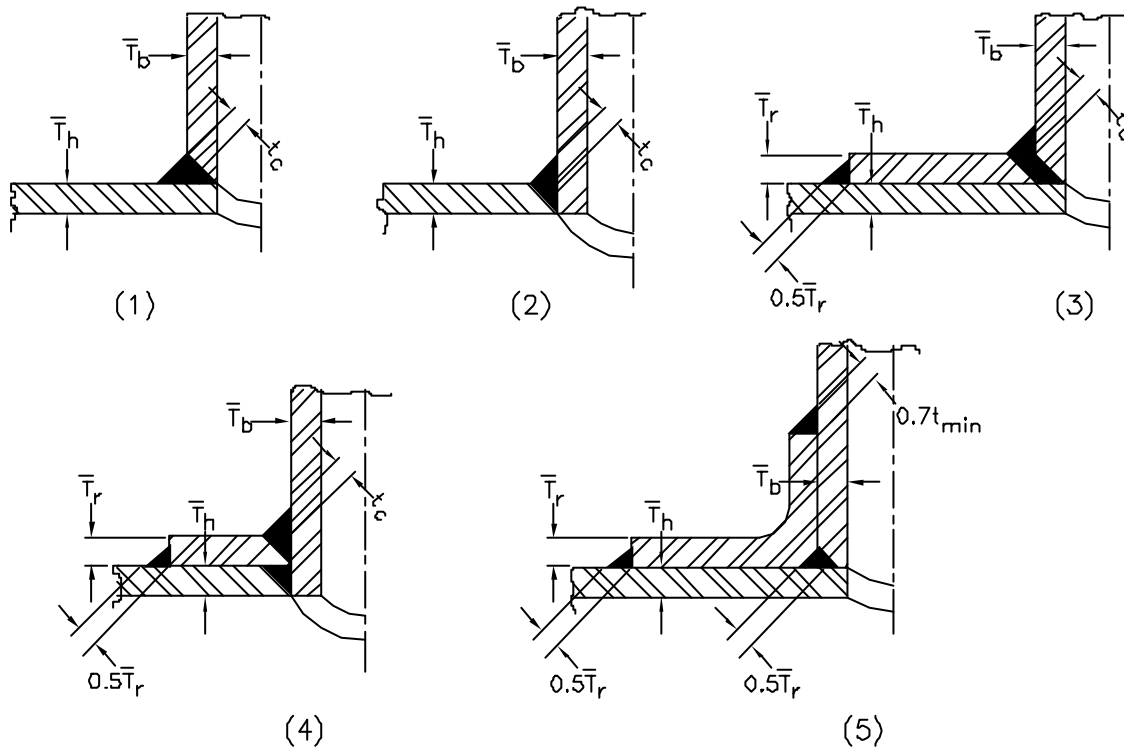


FIG. 3.5.4A,B,C. TYPICAL WELDED BRANCH CONNECTIONS



GENERAL NOTE: These sketches show minimum acceptable welds. Welds may be larger than those shown here.

FIG. 3.5.4D ACCEPTABLE DETAILS FOR BRANCH ATTACHMENT WELDS

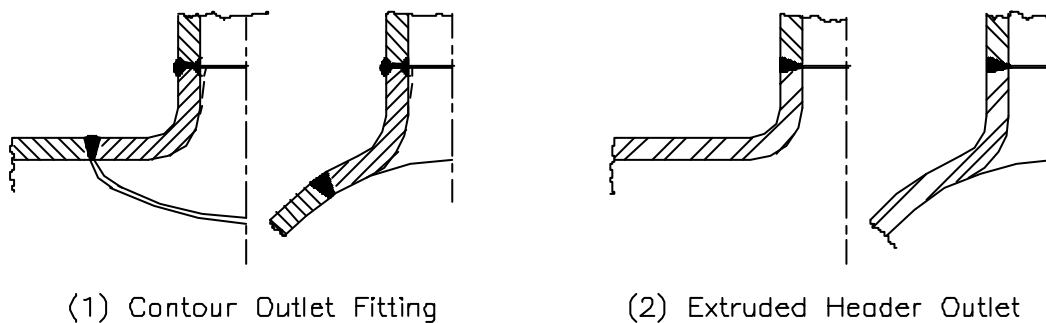
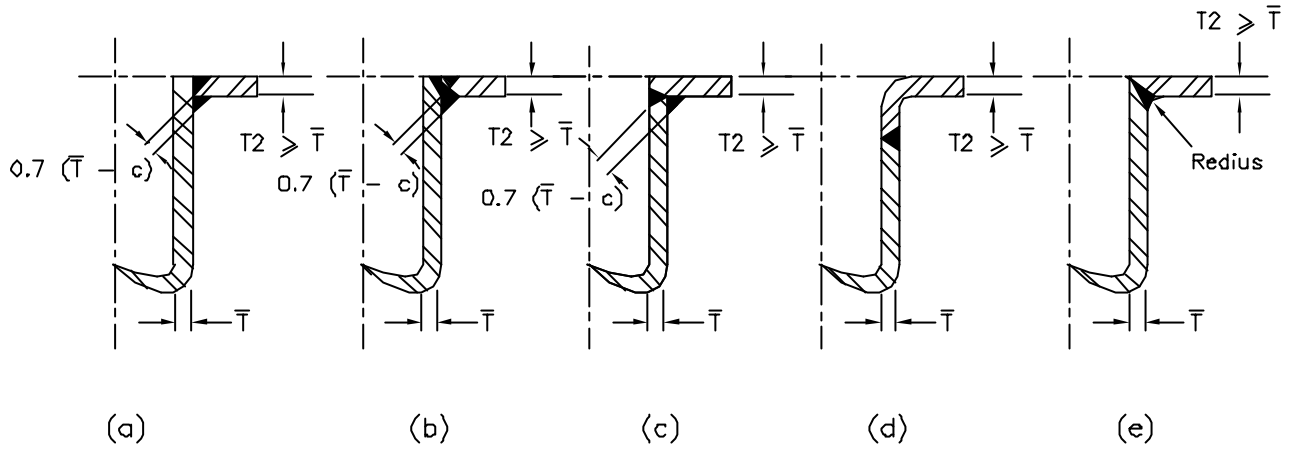


FIG. 3.5.4E ACCEPTABLE DETAILS FOR BRANCH ATTACHMENT SUITABLE FOR 100% RADIOGRAPHY

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DATE	PURPOSE	PREPARED	REVIEWED	APPROVED



GENERAL NOTE:Laps shall be machined (front and back)or trued after welding. Plate flanges per para. 304.5 or lap joint flanges per ASME B16.5 may be used.Welds may be machined to radius,as in sketch (e),if necessary to match ASME B16.5 lap joint flanges.

FIG. 3.5.5 TYPICAL FABRICATED LAPS

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ENGINEERING STANDARD

INSPECTION, EXAMINATION OF WELDING OF PIPING

FORM NUMBER 02-0000-0021 F1 REV 0

0	30/09/99	ISSUED FOR IMPLEMENTATION			
DR	DAY	TODAY	STANDARD	MECHES	SUBP-05WP
				PREPARED	REVIEWED
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**ENGINEERING STANDARD
INSPECTION, EXAMINATION
OF WELDING OF PIPING**

ES : 6005

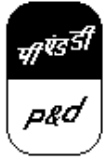
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1.0 SCOPE

This specification covers requirements of Inspection, Examination and Testing of welding of Carbon Steel, Alloy Steel and stainless steel pipes and fittings. These requirements conform to ASME Code of pressure piping - Process Piping ASME B 31.3 - 1999. This standard is meant for easy reference by the Inspector to all requirements of inspection, examination and testing of welding of pipes at one place and should not be used as purchase requirements for an enquiry or an order.

2.0 INSPECTION

2.1 General

This Standard distinguishes between examination (see para 3.0) and inspection. Inspection applies to functions performed for the owner by the owner's Inspector. References in this standard to the "Inspector" are to the owner's Inspector.

2.2 Responsibility for Inspection

It is the Owner's responsibility, exercised through the Owner's Inspector to verify that all required examinations and testing have been completed and to inspect the piping to the extent necessary to be satisfied that it conforms to all applicable examination requirements of the Code/Standard and of the engineering design.

2.3 Rights of the Owner's Inspector

The Owner's Inspector shall have access to any place where work concerned with the piping installation is being performed. This includes manufacture, fabrication, heat treatment, assembly, erection, examination and testing of the piping. They shall have the right to audit any examination, to inspect the piping using any examination method specified by the engineering design and to review all certifications and records necessary to satisfy the Owner's responsibility stated in para 2.2.

2.4 The qualifications of the Owner's Inspector shall be at the discretion of the Owner.

3.0 EXAMINATION

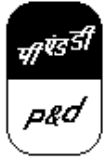
3.1 General

Examination applies to quality control functions performed by the manufacturer (for components only), fabricator or erector. Reference in this Standard to an examiner is to a person who performs quality control examinations.

3.2 Responsibility for Examination

Inspection does not relieve the manufacturer, the fabricator or the erector of the responsibility for :

- (a) providing materials, components and workmanship in accordance with the requirements of the specification and of the engineering design.



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- (b) performing all required examinations; and
- (c) preparing suitable records of examinations and tests for the Inspector's use.

3.3 Examination Requirements

3.3.1 General

Prior to initial operation each piping installation, including components and workmanship shall be examined in accordance with the applicable requirements of para 3.0. The type and extent of any additional examination required by the engineering design and the acceptance criteria to be applied shall be specified. Joints not included in examinations required by para 3.4 or by the engineering design are accepted if they pass leak test/pressure test as per ES 6006.

- (a) For P-Nos. 3, 4 and 5 materials, examination shall be performed after completion of any heat treatment.
- (b) For a welded branch connection the examination of and any necessary repairs to the pressure containing weld shall be completed before any reinforcing pad or saddle is added.

3.3.2 Acceptance Criteria

Acceptance criteria shall be as stated in the engineering design and shall at least meet the applicable requirements stated below, in para 6.6.2 for ultrasonic examination of welds.

Table 3.3.2 states acceptance criteria (limits on imperfections) for welds. See Fig. 3.3.2 for typical weld imperfections.

3.3.3 Defective Components and workmanship

An examined item with one or more defects (imperfections of a type or magnitude exceeding the acceptance criteria of this Standard) shall be repaired or replaced; and the new work shall be reexamined by the same methods, to the same extent and by the same acceptance criteria as required for the original work.

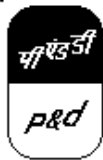
3.3.4 Progressive Sampling for Examination

When required spot or random examination reveals a defect :

- (a) two additional samples of the same kind (if welded or bonded joints, by the same welder, bonder, or operator) shall be given the same type of examination; and
- (b) if the items examined as required by (a) above are acceptable, the defective item shall be repaired or replaced and reexamined as specified in para 3.3.3 and all items represented by these two additional samples shall be accepted; but

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- (c) if any of the items examined as required by (a) above reveals a defect, two further samples of the same kind shall be examined for each defective item found by that sampling; and
- (d) if all the items examined as required by (c) above are acceptable, the defective item(s) shall be repaired or replaced and reexamined as specified in para 3.3.3 and all items represented by the additional sampling shall be accepted; but
- (e) if any of the items examined as required by (c) above reveals a defect, all items represented by the progressive sampling shall be either;
 - 1) repaired or replaced and reexamined as required; or
 - 2) fully examined and repaired or replaced as necessary and reexamined as necessary to meet the requirements of this Standard.

3.4 Extent of Required Examination

3.4.1 Examination Normally Required

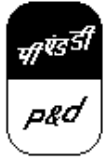
(Category of fluid services requiring the extent of examination as mentioned in para 3.4.1 to 3.4.4 have been defined in ASME B 31.3 and ES 6013)

Piping in **Normal Fluid Service** shall be examined to the extent specified herein or to any greater extent specified in the engineering design. Acceptance criteria are as stated in para 3.3.2 and in Table 3.3.2 for Normal Fluid Service unless otherwise specified.

(a) Visual Examination

At least the following shall be examined in accordance with para 6.2 ;

- 1) sufficient materials and components, selected at random, to satisfy the examiner that they conform to specifications and are free from defects;
- 2) at least 5% of fabrication. For welds, each welder's and welding operator's work shall be represented.
- 3) 100% of fabrication for longitudinal welds, except those in components made in accordance with a listed specification. See para 3.5.1(a) for examination of longitudinal welds required to have a joint factor E_j of 0.90.
- 4) random examination of the assembly of threaded, bolted and other joints to satisfy the examiner that they conform to the applicable requirements of assembly and erection as per para 7.0 of ES 6004. When pneumatic testing is to be performed, all threaded, bolted and other mechanical joints shall be examined.



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- 5) random examination during erection of piping, including checking of alignment, supports and cold spring;
- 6) examination of erected piping for evidence of defects that would require repair or replacement and for other evident deviations from the intent of the design.

(b) Other Examination

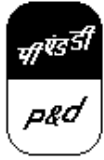
- 1) Not less than 5% of circumferential butt and miter groove welds shall be examined fully by random radiography in accordance with para. 6.5 or by random ultrasonic examination in accordance with para 6.6. The welds to be examined shall be selected to ensure that the work product of each welder or welding operator doing the production welding is included. They shall also be selected to maximize coverage of intersections with longitudinal joints. When a circumferential weld with an intersecting longitudinal weld(s) is examined, at least the adjacent 38 mm (1½ in.) of each intersecting weld shall be examined. In-process examination in accordance with para 6.7 may be substituted for all or part of the radiographic or ultrasonic examination on a weld-for-weld basis if specified in the engineering design or specifically authorized by the Inspector.
- 2) Not less than 5% of all brazed joints shall be examined by in-process examination in accordance with para 6.7, the joints to be examined being selected to ensure that the work of each brazer making the production joints is included.

(c) Certificates and Records

The examiner shall be assured, by examination of certifications, records, and other evidence that the materials and components are of the specified grades and that they have received required heat treatment, examination and testing. The examiner shall provide the Inspector with a certification that all the quality control requirements of the Code and of the engineering design have been carried out.

3.4.2 Examination -- Category D Fluid Service

Piping and piping elements for Category D Fluid Service as designated in the engineering design shall be visually examined in accordance with para 6.2 to the extent necessary to satisfy the examiner that components, materials and workmanship conform to the requirements of ASME B 31.3 Code, this standard and the engineering design. Acceptance criteria are as stated in para. 3.3.2 and in Table 3.3.2 for Category D fluid service, unless otherwise specified.



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3.4.3 Examination -- Severe Cyclic Conditions

Piping to be used under severe cyclic conditions shall be examined to the extent specified herein or to any greater extent specified in the engineering design. Acceptance criteria are as stated in para. 3.3.2 and in Table 3.3.2, for severe cyclic conditions, unless otherwise specified.

(a) *Visual Examination*

The requirements of para 3.4.1(a) apply with the following exceptions

- 1) All fabrication shall be examined.
- 2) All threaded, bolted and other joints shall be examined.
- 3) All piping erection shall be examined to verify dimensions and alignment. Supports, guides and points of cold spring shall be checked to ensure that movement of the piping under all conditions of startup, operation and shutdown will be accommodated without undue binding or unanticipated constraint.

(b) *Other Examination*

All circumferential butt and miter groove welds and all fabricated branch connection welds comparable to those shown in Fig.3.5.4E of ES 6004 shall be examined by 100% radiography in accordance with para 6.5 or (if specified in the engineering design) by 100% ultrasonic examination in accordance with para 6.6. Socket welds and branch connection welds which are not radiographed shall be examined by magnetic particle or liquid penetrant methods in accordance with para 6.3 or 6.4.

- (c) In-process examination in accordance with para 6.7, supplemented by appropriate nondestructive examination, may be substituted for the examination required in (b) above on a weld-for-weld basis if specified in the engineering design or specifically authorized by the Inspector.

(d) *Certification and Records*

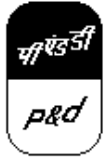
The requirements of para 3.4(c) apply.

3.4.4 Examination - Category M Fluid Service

Piping to be used under Category M Fluid Service shall be examined to the extent specified herein or to any greater extent specified in the engineering design.

(a) *Visual Examination*

- 1) All fabrication shall be examined.
- 2) All threaded, bolted and other mechanical joints shall be examined.



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(b) Other Examination

- 1) The random radiography/ultrasonic examination requirement of para 3.4.1(b)(1) apply except that at least 20% of circumferential butt and mitre welds and of fabricated lap and branch connection welds comparable to those shown in Fig. 3.5.4(E) and 3.5.5 sketches (d) and (e) shall be examined.
- 2) The in-process examination alternative permitted in para 3.4.1 (b)(1) may be specified on a weld-for-weld basis in the engineering design or by the inspector. It shall be supplemented by appropriate non-destructive examination.

3.5 Supplementary Examination

Any of the methods of examination described in para 6.0 may be specified by the engineering design to supplement the examination required by para 3.4. The extent of supplementary examination to be performed and any acceptance criteria that differ from those in para 3.3.2 shall be specified in the engineering design.

3.5.1 Spot Radiography

(a) *Longitudinal Welds*

Spot radiography for longitudinal groove welds required to have a weld joint factor E_j of 0.90 requires examination by radiography in accordance with para 6.5 of at least 300 mm in each 30 m of weld for each welder or welding operator. Acceptance criteria are those stated in Table 3.3.2 for radiography under Normal Fluid Service.

(b) *Circumferential Butt Welds and Other Welds*

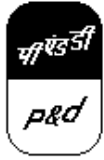
It is recommended that the extent of examination be not less than one shot on one in each 20 welds for each welder or welding operator. Unless otherwise specified, acceptance criteria are as stated in Table 3.3.2 for radiography under Normal Fluid Service for the type of joint examined.

(c) *Progressive Sampling for Examination*

The provisions of para 3.3.4 are applicable

(d) *Welds to Be Examined*

The locations of welds and the points at which they are to be examined by spot radiography shall be selected or approved by the Inspector.



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3.5.2 Hardness Tests

The extent of hardness testing required shall be in accordance with following para except as otherwise specified in the engineering design.

Hardness tests of production welds and of hot bent and hot formed piping are intended to verify satisfactory heat treatment. The hardness limit applies to the weld and to the heat affected zone (HAZ) tested as close as practicable (within 2-3 mm) to the edge of the weld.

- (a) Where a hardness limit is specified in Table 3 at least 10% of welds, hot bends and hot formed components in each furnace heat treated batch and 100% of those locally heat treated shall be tested.
- (b) When dissimilar metals are joined by welding the hardness limits specified for the base and welding materials in Table 3 shall be met for each material.

3.5.3 Examinations to Resolve Uncertainty

Any method may be used to resolve doubtful indications. Acceptance criteria shall be those for the required examination.

4.0 EXAMINATION PERSONNEL

4.1 Personnel Qualification and Certification

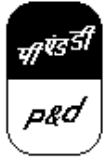
Examiners shall have training and experience commensurate with the needs of the specified examinations. The employer shall certify records of the examiners employed, showing dates and results of personnel qualifications and shall maintain them and make them available to the Inspector.

4.2 Specific Requirement

For in-process examination, the examinations shall be performed by personnel other than those performing the production work.

5.0 EXAMINATION PROCEDURES

Any examination shall be performed in accordance with a written procedure that conforms to one of the methods specified in para 6.0, including special methods (see para 6.1.2). Procedures shall be written as required in the ASME BPV Code, Section V, Article 1, T-150. The employer shall certify records of the examination procedures employed, showing dates and results of procedure qualifications and shall maintain them and make them available to the Inspector.



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6.0 TYPES OF EXAMINATION

6.1 General

6.1.1 Methods

Except as provided in para 6.1.2, any examination required by this Standard, by the engineering design or by the Inspector shall be performed in accordance with one of the methods specified herein.

6.1.2 Special Methods

If a method not specified herein is to be used, it and its acceptance criteria shall be specified in the engineering design in enough detail to permit qualification of the necessary procedures and examiners.

6.1.3 Definitions

The following terms apply to any type of examination

100% Examination : complete examination of all of a specified kind of item in a designated lot of piping.

Random Examination : complete examination of a percentage of a specified kind of item in a designated lot of piping

Spot Examination : a specified partial examination of each of a specified kind of item in a designated lot of piping. e.g. of part of the length of all shop- fabricated welds in a lot of jacketed piping.

Random Spot Examination : a specified partial examination of a percentage of a specified kind of item in a designated lot of piping.

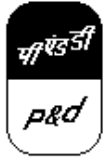
6.2 Visual Examination

6.2.1 Definition

Visual examination is observation of the portion of components, joints and other piping elements that are or can be exposed to view before, during or after manufacture, fabrication, assembly, erection, examination or testing. This examination includes verification of Code and engineering design requirements for materials, components, dimensions, joint preparation, alignment, welding, bonding, brazing, bolting, threading or other joining method, supports, assembly and erection.

6.2.2 Method

Visual examination shall be performed in accordance with the BPV Code, Section V, Article 9. Records of individual visual examinations are not required, except for those of in-process examination as specified in para 6.7.



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6.3 Magnetic Particle Examination

Magnetic particle examination of welds shall be performed in accordance with ASME BPV Code, Section V, Article 7. Magnetic particle examination is not normally required for site welded joints. Liquid penetrant examinations normally preferred.

6.4 Liquid Penetrant Examination

Liquid penetrant examination of welds shall be performed in accordance with ASME BPV Code, Section V, Article 6.

6.5 Radiographic Examination

6.5.1 Method

Radiography of welds shall be performed in accordance with ASME BPV Code, Section V, Article 2.

6.5.2 Extent of Radiography

(a) *100% Radiography*

This applies only to girth and miter groove welds and to fabricated branch connection welds comparable to Fig.3.5.4E, unless otherwise specified in the engineering design.

(b) *Random Radiography*

This applies only to girth and miter groove welds.

(c) *Spot Radiography*

This requires a single exposure radiograph in accordance with para 6.5.1 at a point within a specified extent of welding. For girth, miter and branch groove welds the minimum requirement is :

- 1) for sizes \leq NPS 2½", a single elliptical exposure encompassing the entire weld circumference;
- 2) for sizes $>$ NPS 2½", the lesser of 25% of the inside circumference or 152 mm.

For longitudinal welds the minimum requirement is 152 mm of weld length.

6.6 Ultrasonic Examination

6.6.1 Method

Ultrasonic examination of welds shall be performed in accordance with ASME BPV Code, Section V, Article 5, except that the alternative specified in (a) and (b) below is permitted for basic calibration blocks specified in T-542.2.1 and T-542.8.1.1.

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- (a) When the basic calibration blocks have not received heat treatment in accordance with T-542.1.1(c) and T-542.8.1.1, transfer methods shall be used to correlate the responses from the basic calibration block and the component. Transfer is accomplished by noting the difference between responses received from the same reference reflector in the basic calibration block and in the component and correcting for the difference.
- (b) The reference reflector may be a V-notch (which must subsequently be removed), an angle beam search unit acting as a reflector or any other reflector which will aid in accomplishing the transfer.
- (c) When the transfer method is chosen as an alternative, it shall be used, at the minimum :
- 1) for sizes \leq NPS 2", once in each 10 welded joints examined.
 - 2) for sizes $>$ NPS 2" and \leq NPS 18", once in each 1.5 m of welding examined.
 - 3) for sizes $>$ NPS 18" once for each welded joint examined.
- (d) Each type of material and each size and wall thickness shall be considered separately in applying the transfer method. In addition, the transfer method shall be used at least twice on each type of weld joint.
- (e) The reference level for monitoring discontinuities shall be modified to reflect the transfer correction when the transfer method is used.

6.6.2 Acceptance Criteria

A linear-type discontinuity is unacceptable if the amplitude of the indication exceeds the reference level and its length exceeds :

- (a) 6 mm for $T_w \leq 19$ mm
- (b) $T_w/3$ for $19 \text{ mm} < T_w \leq 57$ mm
- (c) 19 mm for $T_w > 57$ mm

6.7 In-Process Examination

6.7.1 Definition

In-process examination comprises examination of the following, as applicable:

- (a) joint preparation and cleanliness;
- (b) preheating;
- (c) fit-up, joint clearance and internal alignment prior to joining;
- (d) variables specified by the joining procedure, including filler material; and
 - 1) (for welding) position and electrode;
 - 2) (for brazing) position, flux, brazing temperature, proper wetting and capillary action;



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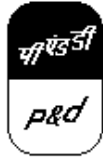
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- (e) (for welding) condition of the root pass after cleaning - external and where accessible, internal - aided by liquid penetrant or magnetic particle examination when specified in the engineering design;
- (f) (for welding) slag removal and weld condition between passes; and
- (g) appearance of the finished joint.

6.7.2 Method

The examination is visual, in accordance with para 6.2, unless additional methods are specified in the engineering design.



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TABLE 3.3.2

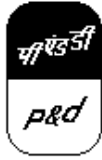
ACCEPTANCE CRITERIA FOR WELDS

Criteria (A to M) for Types of Welds, for Service Conditions and for Required Examination Methods[(Note (1))]

Kind of Implementation	Normal Fluid Service					Severe Cyclic Conditions					Category D Fluid Service								
	Methods		Types of Weld			Methods		Types of Weld			Method	Types of Weld							
	Visual	Radiography	Girth and Miter Groove	Longitudinal Groove [Note (2)]	Fillet [Note (3)]	Branch Connection [Note (4)]	Visual	Radiography	Magnetic Particle	Liquid Penetrant	Girth and Miter Groove	Longitudinal Groove [Note (2)]	Fillet [Note (3)]	Branch Connection [Note (4)]	Visual	Girth and Miter Groove	Longitudinal Groove [Note (2)]	Fillet [Note (3)]	Branch Connection [Note (4)]
Crack	X	X	A	A	A	A	X	X	X	X	A	A	A	A	X	A	A	A	A
Lack of fusion	X	X	A	A	A	A	X	X	--	--	A	A	A	A	X	C	{ A	NA	A
Incomplete penetration	X	X	B	A	NA	B	X	X	--	--	A	A	NA	A	X		{ A	NA	B
Internal porosity	--	X	E	E	NA	E	--	X	--	--	D	D	NA	D	--	--	--	--	--
Slag inclusion, tungsten inclusion or elongated indication	--	X	G	G	NA	G	--	X	--	--	F	F	NA	F	--	--	--	--	--
Undercutting	X	--	H	A	H	H	X	X	--	--	A	A	A	A	X	I	A	H	H
Surface porosity or exposed slag inclusion [Note (5)]	X	--	A	A	A	A	X	--	--	--	A	A	A	A	X	A	A	A	A
Surface finish	--	--	--	--	--	--	X	--	--	--	J	J	J	J	--	--	--	--	--
Concave root surface (suck-up)	X	X	K	K	NA	K	X	X	--	--	K	K	NA	K	X	K	K	NA	K
Reinforcement or internal protrusion	X	--	L	L	L	L	X	--	--	--	L	L	L	L	X	M	M	M	M

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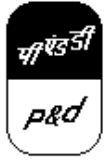
CRITERION VALUE NOTES FOR TABLE 3.3.2

Criterion		Acceptable Value Limits [Note (6)]										
Symbol	Measure											
A	Extent of imperfection	Zero (no evident imperfection)										
B	Depth of incomplete penetration	$\leq 1 \text{ mm}$ and $\leq 0.2 T_w$										
	Cumulative length of incomplete penetration	$\leq 38 \text{ mm}$ in any 150 mm weld length										
C	Depth of lack of fusion and incomplete penetration	$\leq 0.2 T_w$										
	Cumulative length of lack of fusion and incomplete penetration [Note (7)]	$\leq 38 \text{ mm}$ in any 150 mm weld length										
D	Size and distribution of internal porosity	See ASME BPV Code, Section VIII, Division 1, Appendix 4										
E	Size and distribution of internal porosity	For $T_w \leq 6 \text{ mm}$ limit is same as D For $T_w > 6 \text{ mm}$ limit is $1.5 \times D$										
F	Slag inclusion, tungsten inclusion or elongated indication											
	Individual length -- --											
	Individual width -- --	$\leq T_w / 3$										
	Cumulative length -- --	$\leq 2.5 \text{ mm}$ and $< T_w / 3$ $\leq T_w$ in any 12 T_w weld length										
G	Slag inclusion, tungsten inclusion or elongated indication											
	Individual length	$\leq 2 T_w$										
	Individual width	$\leq 3 \text{ mm}$ and $< T_w / 2$										
	Cumulative length	$\leq 4 T_w$ in any 150 mm weld length										
H	Depth of undercut	$\leq 1 \text{ mm}$ and $\leq T_w / 4$										
I	Depth of undercut	$\leq 1.5 \text{ mm}$ and $\leq (T_w / 4 \text{ or } 1 \text{ mm})$										
J	Surface roughness	$\leq 500 \text{ mm Ra}$ per ASME B 46.1										
K	Depth of root surface concavity	Total joint thickness, incl. weld reinf., $\geq T_w$										
L	Height of reinforcement or internal protrusion [Note (8)] in any plane through the weld shall be within limits of the applicable height value in the tabulation at right, except as provided in Note (9). Weld metal shall merge smoothly into the component surfaces	<table border="0"> <tr> <td><u>For T_w mm</u></td> <td><u>Height, mm</u></td> </tr> <tr> <td>≤ 6</td> <td>≤ 1.5</td> </tr> <tr> <td>$> 6, \leq 13$</td> <td>≤ 3</td> </tr> <tr> <td>$> 13, \leq 25$</td> <td>≤ 4</td> </tr> <tr> <td>> 25</td> <td>≤ 5</td> </tr> </table>	<u>For T_w mm</u>	<u>Height, mm</u>	≤ 6	≤ 1.5	$> 6, \leq 13$	≤ 3	$> 13, \leq 25$	≤ 4	> 25	≤ 5
<u>For T_w mm</u>	<u>Height, mm</u>											
≤ 6	≤ 1.5											
$> 6, \leq 13$	≤ 3											
$> 13, \leq 25$	≤ 4											
> 25	≤ 5											
M	Height of reinforcement or internal protrusion [Note (8)] as described in L. Note (9) does not apply	Limit is twice the value applicable for L above.										

X = required examination NA = not applicable -- = not required

FORM NUMBER 02-0000-0021 REV 0

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PDIL

**ENGINEERING STANDARD
INSPECTION, EXAMINATION
OF WELDING OF PIPING**

ES : 6005

ISSUE : SEP. '99

SHEET 16 OF 16

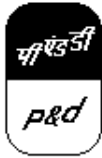
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TABLE 3.3.21 (CONTD.)

NOTES :

- (1) Criteria given are for required examination. More stringent criteria may be specified in the engineering design. See also paras 3.5 and 3.5.3.
- (2) Longitudinal groove weld includes straight and spiral seam. Criteria are not intended to apply to welds made in accordance with a standard listed in Table A-1 or Table 326.1 of Code ASME B 31.3.
- (3) Fillet weld includes socket and seal welds and attachment welds for slip-on flanges, branch reinforcement and supports.
- (4) Branch connection weld includes pressure containing welds in branches and fabricated laps.
- (5) These imperfections are evaluated only for welds ≤ 5 mm in nominal thickness.
- (6) Where two limiting values are separated by "and" the lesser of the values determines acceptance. Where two sets of values are separated by "or" the larger value is acceptable. T_w is the nominal wall thickness of the thinner of two components joined by a butt weld.
- (7) Tightly butted unfused root faces are unacceptable.
- (8) For groove welds, height is the lesser of the measurements made from the surfaces of the adjacent components; both reinforcement and internal protrusion are permitted in a weld. For fillet welds, height is measured from the theoretical throat Fig. 3.5.2A of ES 6004; internal protrusion does not apply.
- (9) For welds in aluminium alloy only, internal protrusion shall not exceed the following values:
 - (a) For thickness ≤ 2 mm : 1.5 mm
 - (b) For thickness > 2 mm and < 6 mm : 2.5 mmFor external reinforcement and for greater thicknesses, see the tabulation for Symbol L.



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ES : 6006

ISSUE : APR. 2000

SHEET 1 OF 6

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ENGINEERING STANDARD

PRESSURE TESTING OF PIPING

FORM NUMBER 02-0000-0021 F1 REV 0

REV.	DATE	PURPOSE	PREPARED	REVIEWED	APPROVED
2	26/04/2000	PARA 7.0 ADDED & OTHER REVISIONS			
1	28/09/1999	FOR IMPLEMENTATION	ENGG.COMM.		
0	FEB.'98	FOR IMPLEMENTATION	MKD. APP.		

**1.0 SCOPE**

All installed piping after completion of the applicable examinations, but prior to initial operation shall be pressure tested to ensure tightness in accordance with the requirements of this specification. However, piping built, in conformance with the ASME Boiler & PV code or Indian Boiler Regulation shall be pressure tested in compliance of such code or regulations.

Piping systems open to atmosphere, such as drains, vents, outlet piping for relief valves discharging to atmosphere and underground sewers shall not require any pressure testing. These lines shall be examined visually to determine that all joints are properly made up.

2.0 GENERAL REQUIREMENTS FOR LEAK/ PRESSURE TESTS

Following requirements apply to both hydraulic as well as pneumatic leak/pressure tests.

2.1 Limitations on Pressure**(a) Stress Exceeding Yield Strength**

If the test pressure would produce a nominal pressure stress or longitudinal stress in excess of yield strength at test temperature, the test pressure may be reduced to the maximum pressure that will not exceed the yield strength at test temperature.

(b) Test Fluid Expansion

If a pressure test is to be maintained for a period of time and the test fluid in the system is subject to thermal expansion, precautions shall be taken to avoid excessive pressure.

(c) Preliminary Pneumatic Test

A preliminary test using air at no more than 170 kPa (25 psi) gauge pressure may be made prior to hydrostatic testing to locate major leaks.

2.2 Other Test Requirements**(a) Examination for Leaks**

Test pressure during leak/pressure test shall be maintained for at least 10 min. and all joints and connections shall be examined for leaks.

(b) Heat Treatment

Leak tests shall be conducted after any heat treatment has been completed.

(c) Low Test Temperature

The possibility of brittle fracture shall be considered when conducting leak tests at metal temperatures near the ductile-brittle transition temperature.

**2.3 Special Provisions for Testing****(d) Piping Subassemblies**

Piping subassemblies may be tested either separately or as assembled piping.

(e) Flanged Joints

A flanged joint at which a blank is inserted to isolate other equipment during a test need not be tested.

(f) Closure Welds

The final weld connecting piping systems or components which have been successfully tested in accordance with this engineering standard need not be leak tested provided the weld is examined in process in accordance with para 344.7 of ASME B 31.3 (para 6.7 of ES:6005) and passes with 100% radiographic examination in accordance with para 344.5 of ASME B 31.3 (Para 6.5 of ES 6005) or 100% ultrasonic examination in accordance with para 344.6 of ASME B 31.3 (Para 6.6 of ES 6005).

2.4 Externally Pressured Piping

Piping subject to external pressure shall be tested at an internal gauge pressure 1.5 times the external differential pressure, but not less than 105 kPa (15 psi).

2.5 Jacketed Piping

(a) The internal line shall be leak tested on the basis of the internal or external design pressure, whichever is critical. This test must be performed before the jacket is completed if it is necessary to provide visual access to joints of the internal line.

(b) The jacket shall be leak tested on the basis of the jacket design pressure unless otherwise specified in the engineering design.

3.0 PREPARATION FOR LEAK/PRESSURE TEST

3.1 All joints, including welds and bends, shall be left uninsulated & exposed for examination during leak testing, except that joints previously tested may be insulated or covered. All joints may be primed and painted only after leak testing.

3.2 Major equipment, such as compressors, pumps, vessels and exchangers shall be isolated from pipe line during hydrostatic test. When necessary for practicability, exchangers and vessels may be included with the connected piping provided the piping test pressure is within the allowable cold pressure limits of the equipment.

3.3 All air present in the system to be tested shall be vented while admitting the test fluid.

All vent valves during filling up as well as during draining must be fully open.



- 3.4 Piping designed for vapour and gas shall be provided with additional temporary supports if necessary, to support the weight of test fluid.
- 3.5 Instruments, expansion joints, filters etc., for which the maximum permissible cold test pressures are lower than the specified hydrostatic test pressure for piping, shall be isolated and excluded from the test.
- 3.6 Lines containing check valves shall have source of test pressure on the up-stream side.
- 3.7 Valves shall not be subjected to a test pressure in excess of manufactures allowable test rating. When permitted, the installed valves shall be kept open.
- 3.8 Relief valves shall be excluded from the test and shall be suitably blanked off.

Orifice plates in horizontal lines shall not be installed till completion of test.

Control valves shall not be field tested. All flanged control valves shall be removed before hydraulic testing of the pipe lines. Welded end control valves shall be welded after hydraulic test, cleaning and blowing.

Indicating pressure gauges mounted locally may be tested with the lines provided the test pressure is not in excess of their scale ratings.

- 3.9 Instrument take-off piping up to the first block valve shall be tested with piping to which it is connected. Testing of remainder of lead line upto instrument can also be done at the same time provided instruments are blocked off from source of pressure and vented to atmosphere.
- 3.10 The test shall be carried out at ambient temperature and the water temperature shall not be less than 7°C.

4.0 **HYDROSTATIC LEAK/ PRESSURE TEST**

4.1 **Test Fluid**

The fluid shall be water unless there is the possibility of damage due to freezing or to adverse effects of water on the piping or the process. In that case another suitable nontoxic liquid may be used. If the liquid is flammable, its flash point shall be at least 49°C and consideration shall be given to the test environment.

4.2 **Test Pressure**

Except as provided in para 4.3, the hydrostatic test pressure at any point in a metallic piping system shall be as follows:

- (a) Not less than 1½ times the design pressure ;
- (b) For design temperature above the test temperature, the minimum test pressure shall be calculated by following equation except that the value of S_T / S shall not exceed 6.5 ;

$$P_T = \frac{1.5PS_T}{S}$$



Where

P_T = minimum test gauge pressure
 P = internal design gauge pressure
 S_T = stress value at test temperature
 S = stress value at design temperature

- (c) If the test pressure as defined above would produce a stress in excess of the yield strength at test temperature, the test pressure may be reduced to the maximum pressure that will not exceed the yield strength at test temperature.

4.3 Hydrostatic Test of Piping With Vessels as a System

- (a) Where the test pressure of piping attached to a vessel is the same as or less than the test pressure for the vessel, the piping may be tested with the vessel at the piping test pressure.
- (b) Where the test pressure of the piping exceeds the vessel test pressure, and it is not considered practicable to isolate the piping from the vessel, the piping and the vessel may be tested together at the vessel test pressure, provided the owner approves and the vessel test pressure is not less than 77% of the piping test pressure calculated in accordance with para 4.2(b).

4.4 Lines at Atmospheric Pressure

All liquid lines at atmospheric pressure ($\leq 1 \text{ Kg./cm}^2\text{g}$) shall be tested hydrostatically at $2 \text{ Kg/cm}^2\text{g}$.

5.0 PNEUMATIC LEAK/ PRESSURE TEST

Piping may be tested pneumatically if these cannot be safely filled with water or where traces of water cannot be tolerated or if these have been previously tested hydrostatically.

5.1 Precautions

Pneumatic testing involves the hazard of released energy stored in compressed gas. Particular care must therefore be taken to minimize the chance of brittle failure during a pneumatic leak test. Test temperature is important in this regard and must be considered when the designer chooses the material of construction.

5.2 Pressure Relief Device

A pressure relief device shall be provided, having a set pressure not higher than the test pressure plus the lesser of 345 kPa (50 psi) or 10% of the test pressure.

5.3 Test Fluid

The gas used as test fluid, if not air, shall be nonflammable and nontoxic.

5.4 Test Pressure

The test pressure shall be 110% of design pressure.

**5.5 Procedure**

5.6 The pressure shall be gradually increased until a gage pressure which is the lesser of one-half the test pressure or 170 kPa (25 psi) is attained, at which time a preliminary check shall be made, including visual examination of joints. Thereafter, the pressure shall be gradually increased in steps until the test pressure is reached, holding the pressure at each step long enough to equalize piping strains. The pressure shall then be reduced to the design pressure before examining for leakage in accordance with para 2.2.

5.7 Lines at Atmospheric Pressure

All gas lines at atmospheric pressure ($\leq 1 \text{ Kg/cm}^2\text{g}$) shall be tested pneumatically at $0.5 \text{ Kg.cm}^2\text{g}$.

6.0 VACUUM SERVICES

Lines in vacuum services shall be hydrostatically tested at a minimum internal pressure of $1.5 \text{ Kg/cm}^2\text{g}$ unless limited to a lower value by design. Where it is not possible to test hydrostatically, the pipe lines shall be tested pneumatically at $1 \text{ Kg/cm}^2\text{g}$.

7.0 SENSITIVE LEAK TEST

The test shall be in accordance with the Gas and Bubble Test method specified in the BPV Code, Section V, Article 10, or by another method demonstrated to have equal sensitivity. Sensitivity of the test shall be not less than $10^{-3} \text{ atm.ml/sec}$ under test conditions.

- a) The test pressure shall be at least the lesser of 105 kPa (15 psi) gage, or 25% or the design pressure.
- b) The pressure shall be gradually increased until a gage pressure the lesser of one-half the test pressure or 170 kPa (25 psi) is attained, at which time a preliminary check shall be made. Then the pressure shall be gradually increased in steps until the test pressure is reached, the pressure being held long enough at each step to equalize piping strains.

8.0 REPAIRS OR ADDITIONS AFTER LEAK TESTING

If repairs or additions are made following the leak test, the affected piping shall be retested, except that for minor repairs or additions the owner may waive retest requirements when precautionary measures are taken to assure sound construction.

9.0 TEST RECORDS

Records shall be made of each piping system during the testing, including :

- a) Date of Test
- b) Identification of the piping tested.
- c) Test Method
- d) Test Pressure and duration
- e) Certification of results by examiner *
- f) Approval by the Inspector

regarding flammability, explosiveness & toxicity.

- d) Maximum allowed storage time for various paint materials shall be clearly indicated on individual containers. Materials which have passed expiry date shall not be used.
- e) Paints in non-original containers and/or in containers without seals, shall not be used.

5.0 COATING SYSTEM SELECTION

Coating Systems for Structures Piping and Equipment

The following Table 1 shall be used as a general guide for the selection of a paint system suitable for a particular plant area application. Paint systems specified on equipment data sheets and the Drawings shall take precedence over the general paint system area applications listed in Table 1

TABLE - 1

Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks
01	Structural Steel work with operating temp. Up to 90 ^o C (Steel structures, Piping support, uninsulated CS piping, flanges, valves, stairways, walkways etc. except grating).	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no.4.60. Touch-up – As per clause no.4.70	Primer: Two coats of two pack zinc rich epoxy polyamide cured Primer. Finish coat: Three coats of two packs. Polyamide Cured Epoxy.	Primer :35 microns For each coat (Total- 70microns). Finish: 40 microns for each coat (Total– 120 microns.	Total dry film thickness of paint system: 190 microns.
02	Uninsulated CS piping, flanges, valves with operating temp. From 90 ^o C to 200 ^o C.	Blast cleaning to near white metal grade Sa-2½, of Swedish Standards SIS-05-5900 (Latest) wash-up – As per clause no. 4.60. Touch-up – As per clause no. 4.70	Primer: One coat of Ethyl Silicate zinc rich with solvent. Finish coat: Two coats of single pack special Synthetic Rubber based heat resistant ready mixed Aluminium Paint.	Primer: 75 microns Finish: 25 microns for each coat Total - 50 microns.	Total dry film thickness of paint system: 125 microns.
	NOTE : Only for valves where it will be impossible to blast cleaning, four to five coats of Heat Resisting, ready mixed Aluminium Paint will be applied on surface without inorganic zinc primer and surface preparation to grade Sa-2 ½ of Swedish Standard SIS-05-5900 (Latest).				
03	Uninsulated CS piping, flanges, valves with operating temp. Over 200 ^o C.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no. 4.60. Touch-up – As per clause no.4.70.	Primer: One coat of Ethyl Silicate zinc rich with solvent. Finish coat: Two coats of Heat Resisting Silicon Aluminium Paint.	Primer: 75 microns Finish: 20 microns for each coat Total - 40 microns.	Total dry film thickness of paint system: 115 microns.

Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks
	NOTE: Only for valves where it will be impossible to blast cleaning, four to five coats of Heat Resisting Silicon Aluminium Paint will be applied on surface without inorganic zinc primer and surface preparation to grade Sa-2 ½ of Swedish Standard SIS-05-5900 (Latest).				
04	Insulated CS piping flanges, valves with operating temp up to 90° C	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no.4.60. Touch-up – As per clause no.4.70	Primer: One coat of high temperature phenolic epoxy Finish Coat : One coat of high temperature phenolic epoxy	Primer :100 microns Finish : 100 micron	Total dry film thickness of paint system: 200 microns.
05	Insulated CS piping, flanges, valves with operating temp. From 90° C to 200° C.	Blast cleaning to near white metal grade Sa-2½, of Swedish Standards SIS-05-5900 (Latest) wash-up – As per clause no. 4.60. Touch-up – As per clause no. 4.70	Primer: One coat of high temperature phenolic epoxy Finish coat : One coat of high temperature phenolic epoxy	Primer: 100 microns Finish: 100 micron	Total dry film thickness of paint system:200 microns
	NOTE : Only for valves where it will be impossible to blast cleaning, four to five coats of Heat Resisting, ready mixed Aluminium Paint will be applied on surface without inorganic zinc primer and surface preparation to grade Sa-2 ½ of Swedish Standard SIS-05-5900 (Latest).				
06	Insulated CS piping, flanges, valves with operating temp. Over 200° C.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no. 4.60. Touch-up – As per clause no.4.70.	Primer: One coat of Ethyl Silicate zinc rich with solvent. Finish coat: One coat of Heat resisting Silicon Aluminium paint.	Primer: 75 microns Finish: 25 micron	Total dry film thickness of paint system: 100 microns.
	NOTE: Only for valves where it will be impossible to blast cleaning, four to five coats of Heat Resisting Silicon Aluminium Paint will be applied on surface without inorganic zinc primer and surface preparation to grade Sa-2 ½ of Swedish Standard SIS-05-5900 (Latest).				
07	Uninsulated CS equipment with operating temp. Up to 90° C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no.4.60. Touch-up – As per clause no.4.70.	Primer: Two coats of two pack zinc rich epoxy polyamide cured Primer. Finish coat : Three coats of two pack Polyamide Cured Epoxy	Primer: 35 micron for each coat. Total – 70 microns. Finish: N.A Finish: 40 microns for each coat Total - 120 microns.	Total dry film thickness of paint system: 190 microns.
08	Uninsulated CS equipment with operating temp. From 91° C to 200° C, to be treated at	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-	Primer: One coat of Ethyl Silicate zinc rich with solvent.	Primer: 75 microns Finish:	Total dry film thickness of paint system: 125 microns.

Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks
	Manufacturer's shop.	5900 (Latest). Wash-up – As per clause no. 4.60. Touch-up – As per clause no. 4.70.	Finish coat: Two coats of single pack special Synthetic Rubber based heat resistant ready mixed Aluminium Paint.	25 microns for each coat Total - 50 microns.	
09	Uninsulated CS equipment with operating temp. Over 200°C , to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no.4.60. Touch-up – As per clause no. 4.70.	Primer: One coat of Ethyl Silicate zinc rich with solvent. Finish coat: Two coats of Heat Resisting Silicon Aluminium Paint.	Primer: 75 microns Finish: 20 microns for each coat Total - 40 microns.	Total dry film thickness of paint system: 115 microns.
10	Insulated CS equipment with operating temp. Up to 90°C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no.4.60. Touch-up – As per clause no.4.70.	Primer: One coat of high temperature phenolic epoxy Finish coat: One coat of high temperature phenolic epoxy	Primer: 100 micron Finish: 100 microns	Total dry film thickness of paint system: 200 microns.
11	Insulated CS equipment with operating temp. From 91°C to 200°C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no. 4.60. Touch-up – As per clause no. 4.70.	Primer: One coat of high temperature phenolic epoxy Finish coat: One coat of high temperature phenolic epoxy	Primer: 100 microns Finish: 100 micron	Total dry film thickness of paint system: 200 microns.
12	Insulated CS equipment with operating temp. Over 200°C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no.4.60. Touch-up – As per clause no. 4.70.	Primer: One coat of Ethyl Silicate zinc rich with solvent. Finish coat: One coat of Heat resisting Silicon Aluminium paint.	Primer: 75 microns Finish: 25 microns	Total dry film thickness of paint system: 100 microns.
13	Stainless steel pipe flanges, valves, equipments with operating temp. Up to 200°C	Lightly Blast cleaned as per grade Sa-1.0, of Swedish Standards SIS-05-5900 (Latest) wash-up – As per clause no. 4.60. Touch-up – As per clause no. 4.70	Primer: One coat of high temperature phenolic epoxy Finish coat: One coat of high temperature phenolic epoxy	Primer: 100 microns Finish: 100 microns	Total dry film thickness of paint system: 200 microns.
14	Surface of structural steel for furnaces, external	Blast cleaning to near white metal grade 2	Primer: One coat of Ethyl Silicate	Primer: 75 microns	Total dry film thickness of

Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks
	surface of furnaces, external surface of flue duct, metal stacks and similar with operating temp. Up to 200°C. (With exclusion of stair ways, walk ways etc.).	½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no. 4.60. Touch-up – As per clause no.4.70.	zinc rich with solvent. Finish coat: Two coats of single pack special Synthetic Rubber based heat resistant ready mixed Aluminium Paint.	Finish: 25 microns for each coat Total - 50 microns.	paint system: 125 microns.
15	For external surfaces of flue ducts, metal stacks, and similar with operating temp. Above 200°C.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no. 4.60. Touch-up – As per clause no. 4.70	Primer: One coat of Ethyl Silicate zinc rich with solvent. Finish coat: Two coats of Heat Resisting Silicon Aluminium Paint.	Primer: 75 microns Finish: 20 microns for each coat Total - 40 microns.	Total dry film thickness of paint system: 115 microns.
	NOTE: Only for zones where it will be impossible to blast cleaning, four to five coats of Heat Resisting Silicone Aluminium Paint will be applied on surface without inorganic zinc primer and surface preparation to grade Sa-2 ½ of Swedish Standard SIS-05-5900 (Latest).				
16	For surfaces of air cooler heads not galvanized with operating temperature up to 90°C, treated at manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no.4.60. Touch-up – As per clause no. 4.70.	Primer: Two coats of two pack zinc rich epoxy polyamide cured Primer. Finish coat: Three coats of two pack. Polyamide Cured Epoxy.	Primer: 35 micron for each coat. Finish: 40 microns for each coat Total - 120 microns.	Total dry film thickness of paint system: 190 microns.
	NOTE: All surfaces shall be galvanized at manufacturer's shop with exception of the end header of air cooled heat exchangers that shall be treated as described above at Manufacturer's shop. In case the same surfaces shall not be treated at shop, they shall be treated at site according to environmental and operating conditions.				
17	For surfaces of air cooler heads not galvanized with operating temperature up to 91°C TO 200°C, treated at manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no.4.60. Touch-up – As per clause no. 4.70.	Primer: One coat of Ethyl Silicate zinc rich with solvent. Finish coat: Two coats of single pack special Synthetic Rubber based heat resistant ready mixed Aluminium Paint.	Primer: 75 microns Finish: 25 microns for each coat Total - 50 microns.	Total dry film thickness of paint system: 125 microns.
	NOTE: All surfaces shall be galvanized at manufacturer's shop with exception of the end header of air cooled heat exchangers that shall be treated as described above at Manufacturer's shop. In case the same surfaces shall not be treated at shop, they shall be treated at site according to environmental and operating conditions.				
18	STORAGE TANKS				
a)	Acid / Alkali CS Storage Tank (External Surface)	Blast cleaning to near white metal grade 2	Primer: Two coats of two pack zinc	Primer: 35 micron for each	Total dry film thickness of

Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks
	including all stair ways)	½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no.4.60. Touch-up – As per clause no. 4.70.	rich epoxy polyamide cured Primer. Finish coat: Three coats of two packs. Polyamide Cured Epoxy.	coat. Total – 70 microns. Finish: 40 microns for each coat Total - 120 microns.	paint system: 190 microns.
b)	CS Storage Tanks, Excluding indicated in Sl. No. (a)	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no.4.60. Touch-up – As per clause no. 4.70.	Primer: One coat of Ethyl Silicate zinc rich with solvent. Finish coat: Two coats of epoxy amine cured tank liner.	Primer: 75 microns Finish: 30 microns for each coat Total - 60 microns.	Total dry film thickness of paint system: 135 microns.
19	Cold Insulated Carbon Steel and low alloy Steel (1-¼ Cr through 9 Cr) Piping and Equipment.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no. 4.60. Touch-up – As per clause no. 4.70.	Primer: One coat of Ethyl Silicate zinc rich with solvent. Finish coat: One coat of Epoxy Coal Tar paint with solvent.	Primer: 75 microns Finish: 40 microns	Total dry film thickness of paint system: 115 microns.
20	Cold Insulated high alloy Steel piping and Equipment	Lightly Blast cleaned as per Sa 1.0 Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no. 4.60. Touch-up – As per clause no. 4.70.	Primer: One coat of high temperature phenolic epoxy Finish coat: One coat of high temperature phenolic epoxy	Primer: 100 microns Finish: 100 microns	Total dry film thickness of paint system: 200 microns
21	Cold insulated Stainless Steel piping and equipments	Lightly Blast cleaned as per Sa 1.0 Swedish Standards SIS-05-5900 (Latest) wash-up – As per clause no. 4.60. Touch-up – As per clause no. 4.70	Primer: One coat of high temperature phenolic epoxy Finish coat: One coat of high temperature phenolic epoxy	Primer: 100 microns Finish: 100 microns for each coat	Total dry film thickness of paint system: 200 microns
22	Surface (CS) with Equipment with temp. Indicating paint from 220°C to 240°C treated at Manufacturer's shop	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	Primer: One coat of Ethyl Silicate zinc rich with solvent. Finish coat : Two	Primer: 75 microns Finish: 25 microns for	Total dry film thickness of paint system: 125 microns.

Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks
		Wash-up – As per clause no. 4.60. Touch-up – As per clause no. 4.70	coats of Silicon Acrylic Paint	each coat Total - 50 microns.	
23	PACKAGE:				
a)	Surface(CS) with operating temperature upto 90°C treated at Manufacturer's shop	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no. 4.60. Touch-up – As per clause no.4.70.	Primer: Two coats of two pack zinc rich epoxy polyamide cured Primer. Finish coat: Three coats of two packs. Polyamide Cured Epoxy.	Primer: 35 micron for each coat. Total – 70 microns. Finish: 40 microns for each coat Total - 120 microns.	Total dry film thickness of paint system: 190 microns.
b)	Surfaces (CS) with operating temperature upto 91°C TO 200°C, treated at manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no. 4.60. Touch-up – As per clause no. 4.70	Primer: One coat of Ethyl Silicate zinc rich with solvent. Finish coat: Two coats of single pack special Synthetic Rubber based heat resistant ready mixed Aluminium Paint.	Primer: 75 microns Finish: 25 microns for each coat Total - 50 microns.	Total dry film thickness of paint system: 125 microns.
c)	Surface (CS) with operating temp. Over 200°C, treated at manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no. 4.60. Touch-up – As per clause no. 4.70.	Primer: One coat of Ethyl Silicate zinc rich with solvent. Finish coat: Two coats of Heat Resisting Silicone Aluminium Paint.	Primer: 75 microns Finish: 20 microns for each coat Total - 40 microns.	Total dry film thickness of paint system: 115 microns.
d)	Package in Carbon Steel and low Alloy Steel (1-¼ Cr through 9 Cr) with cold insulated surface treated at manufacturer's shop	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no.4.60. Touch-up – As per clause no. 4.70.	Primer: One coat of Ethyl Silicate zinc rich with solvent. Finish coat: One coat of Epoxy Coal Tar paint with solvent.	Primer: 75 microns Finish: 40 microns	Total dry film thickness of paint system: 115 microns.
e)	Package in Cold Insulated high alloy Steel.	Lightly Blast cleaned as per Sa 1.0 Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no. 4.60. Touch-up – As per clause no. 4.70.	Primer: One coat of high temperature phenolic epoxy Finish coat: One coat of high temperature phenolic epoxy	Primer: 100 microns Finish: 100 microns	Total dry film thickness of paint system: 200 microns
f)	Package in Cold insulated	Lightly Blast cleaned	Primer: One coat	Primer: 100	Total dry film

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Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks
	Stainless Steel.	as per Sa 1.0 Swedish Standards SIS-05-5900 (Latest) wash-up – As per clause no. 4.60. Touch-up – As per clause no. 4.70	of high temperature phenolic epoxy Finish coat: One coat of high temperature phenolic epoxy	microns Finish: 100 microns	thickness of paint system: 200 microns
24	For external surface of shell, roof of CS tanks, with operating temp. Upto 110°C	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no.4.60. Touch-up – As per clause no. 4.70.	Primer: One coat of Ethyl Silicate zinc rich with solvent. Finish coat: Two coats of single pack special Synthetic Rubber based heat resistant ready mixed Aluminium Paint.	Primer: 75 microns Finish: 25 microns for each coat Total - 50 microns.	Total dry film thickness of paint system: 125 microns.
25	For down external surfaces(CS) below only of the fixed tanks, bottom & shell shall be treated as follows:	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	Primer : None Finish Coat: Two coats of Epoxy Coal Tar Solvent base.	200 microns for each coat Total: 400 microns	Total dry film thickness of paint system : 400 microns
26	CS Equipment and associated piping subject to cyclic, intermittent or regeneration operating condition (e.g. Molecular Sieve Driers) subjected to very severe corrosion with wide operating temperature range.	Blast cleaning to near white metal grade 3, of Swedish Standards SIS-05-5900 (Latest). Wash-up – As per clause no.4.60. Touch-up – As per clause no. 4.70.	Primer: One coat of Thermal spray Aluminium paint and sealed with a Silicon Aluminium seal Finish Coat: One coat of Thermal spray Aluminium paint and sealed with a Silicon Aluminium seal.	Primer: 125 microns Finish: 125 microns	Total dry film thickness of paint system 250 microns.

6.0 MACHINERY, ELECTRICAL AND INSTRUMENT EQUIPMENT:

6.1 Machinery

Steel surfaces shall be treated with complete paint system at Manufacturer's shop. The paint system shall be according to Manufacturer's Std. However, suitable for operating condition and the environmental condition where the machinery will operate. Where necessary machinery shall be restored at site by Contractor with suitable finish.

6.2 Electrical and Instrument Equipment

Steel surfaces shall be treated with complete paint system at Manufacturer's shop. The paint system shall be according to Manufacturer's Std., however suitable for operating condition and the environmental condition where the electrical and instrument equipment will operate. Where necessary Electrical and Instrument Equipment shall be restored at site by Contractor with suitable finish.

7.0 COLOURS:

These shall be as required by specification and in particular for :

Description	Colour	Ra1	Correspond. Asian Paint colors to be defined – See Note-2
- Piping with temperature less than 90°C	GREY	7035	
- Piping, hot surface, flue gas ducts and stacks with temperature above 90°C	SMOOTH	ALUMINIUM	“
- Cooling Water Piping	SEA GREEN		“
- Fire fighting Piping	Red	3002	“
- Structures upto 2 MT	BLACK	9005	“
- Structures above 2 MT	GREY	7010	“
- Stair cases – ladders	BLACK	9005	“
- Walkways	GREY	7010	“
- Handrails assemblies	YELLOW	1004	“
- Equipment	GREY	7035	“
- Hot equipment	SMOOTH	ALUMINIUM	“
- Fire fighting equipment	RED	3002	“
- Valves in general	GREY	7035	“
- Hot valves	SMOOTH	ALUMINIUM	“
- Safety and Fire fighting valves	RED	3002	“
- Valves handwheels	BLACK	9005	
- Electric Rotary Machines	SKY BLUE	5012	
- Electric Static Machines	GREY	7035	
- Machinery (compressors & pumps) with operating temperature less than 90°C	GREY	7035	“
- Machinery (compressors & pumps) with operating temperature above 90°C	SMOOTH	ALUMINIUM	“
FURNACES			
- Casing and connected steel	SMOOTH	ALUMINIUM	“

Description	Colour	Ra1	Correspond. Asian Paint colors to be defined – See Note-2
works			
- Steel work not connected to casing	SMOOTH	ALUMINIUM	“
AIR COOLER			
- High Temperature Surfaces (Temp. > 90°C)	SMOOTH	ALUMINIUM	
- Low Temperature surface (Temp. ≤ 90°C)	GREY	7035	“
- Flare ≤ 90°C	GREY	7035	“
- Flare ≥ 90°C)	SMOOTH	ALUMINIUM	“
TANKS			
- Shell of fixed roof	WHITE	9010	“
- Roof of fixed roof tank	WHITE	9010	
- T-301	SMOOTH	ALUMINIUM	“
- T-303	WHITE	9010	“

NOTE-1: The colours shall be according to IS2379:1990/International STD. RAL or BS, proposed by Contractor or Manufacturer

8.0 PARTICULAR DESCRIPTION

The abrasive to be used shall be chloride-free siliceous sand (marine sand excluded) or metal grit.

Primerized surface shall be faultless and shall not have mud-cracking, dripping over thickness and dry sprays.

Blast cleaning and painting shall not be carried out on wet surfaces.

Blast cleaning shall not be done when surfaces temperatures are less than 3°C above dew point of below 5°C.

No acid washes or other cleaning solutions or solvents shall be used on metal surfaces after they have been blasted.

The surface preparation of all steel surfaces to be coated shall be free of all mill scale, rust corrosion product, oxides, paint, oil or other foreign matter

Only dry sand blasting procedures will be allowed. The compressed air supply used for blasting shall be free of detrimental amounts of water and oil. Adequate separator and traps shall be provided and these shall be kept emptied of water and oil.

All welded areas and appurtenances shall be given special attention for removal of welding flux in crevices. Welding splatter, slivers, laminations and underlying mill scale exposed during sand blasting shall be removed or repaired.

The blast-cleaned or power brushing surfaces shall be coated with primer within four hours of surface preparation.

No primer or intermediate or finishing coating shall be applied without prior notification to the Company.

The application of the products shall be carried out in strict compliance with the paint manufacturer's recommendation.

The Contractor shall provide suitable protection for all adjacent plants or equipment from airborne during spraying and sand blasting.

9.0 INSPECTION AND TESTING

The inspection and testing requirements outlined in this section shall be performed for shop and site applied coating systems.

Preference shall be given to manufacturers and applicators that are quality certified to ISO 9001: 2000.

Documentation of coating material manufacturers and applicators shall include daily inspection reports, equipment reports, and shall clearly identify and trace materials supply and testing performed on coated items and areas.

Inspection and Test Plans (ITPs), and quality control procedures used for application of coating systems shall form part of the Method Statement and shall be submitted for approval by the Principal prior to commencement of work.

The applicator shall appoint a certified inspector of coatings for inspection and testing of coating systems.

Tests of coated areas and items shall form part of the ITPs.

- Surface Preparation in accordance to Swedish Standard SIS-05-5900 (Latest).
- Blast Cleaning profile shall be checked using a suitable profile meter – Acceptable profile shall be 25-30 microns.
- Check of time of top coating and drying in accordance with the direction of the paint manufacturer.
- Check of dry film thickness by suitable non-destructive Instrument such as "MIKROTEST", "DIAMETER" or equivalent.
- Before any coating work is performed on the site, the contractor shall ensure that any works applied by others is acceptable.

Any defect that are discovered, are to be notified in writing to the owner before proceeding with the contract work. To ensure the good execution of painting work following test shall be performed:

- Surface Preparation
- Surface contaminant tests
- Surface profile tests
- Coating thickness tests
- Tests for cure of coatings
- Adhesion tests

- Continuity testing
- Iron contamination
- Chloride contamination
- Dust Contamination

All Inspection and Test Records (ITRs) shall be submitted with the Manufacturer's Data Report (MDR) at the conclusion of the job.

Defective coated areas shall be suitably marked for rectification work to be performed in compliance with this specification.

Access shall be granted for inspection of all paint work, and witnessing of test work. This shall not however relieve the Contractor of their own QA/QC responsibilities.

10.0 ADHESION TEST RESULTS

For all type of primer the Contractor shall guarantee the Classification of Adhesion Test Results as per DIN 53151. The acceptable Rate Adhesion Test Results shall be for sandblasted and primerized surfaces upto GT2.

For primer plus finishing coat(s) the Contractor shall guarantee the Classification of Adhesion Test Results as per DIN 53151. The acceptable Rate Adhesion Test Results shall be for sandblasted and painted surfaces upto GT2.

After test, the surface must be repaired according to the system applied.

11.0 SUBMISSION OF DATA

Contractor shall submit in phase of bid the original technical data sheet and system for all material supplied by him to apply for the permanent works and test report for the paint in compliance to IS101. This material shall be subject to Owner's approval.

12.0 LETTER AND NUMBER INSCRIPTION

Inscriptions letters, as herebelow indicated, shall be made on equipments, piping, storage tanks, machinery etc.

12.1 Geometric forms and dimensions

Letters and numbers dimensions shall be orientatively fixed according to following:

(A – Dimension of side of unitary elements of grid)

- a) Storage Tanks A – 60 mm
- b) Equipments and piping with O.D. above 600 mm A– 40 mm and
- c) Equipments and pipings with O.D. from 300 to 600 mm and for machinery of great dimensions A – 20 mm
- d) Equipments and pipings with O.D. less than 300 mm and for machinery with small dimensions A – 10 mm

12.2 Inscription's Colours

Inscriptions shall be Black ENI 901 (RAL 9005) on light base

Inscriptions shall be White ENI 101 (RAL 9010) on dark base

12.3 Spaces and Interspaces

Spaces between words and assemblage of numbers shall have dimensions equal to 2A

Interspaces between letters or numbers shall have dimensions equal to A.

13.0 **Colour Band for piping ;-**

As a rule minimum width of colour band shall confirm to the following Table:-

Nominal pipe Size	Width L (mm)
3" & below	25
4" NB-6" NB	50
8" NB-12"NB	75
14" OD & above	100

14.0 **LIST OF MANUFACTURERS :**

1. M/s Berger Paints
2. M/s Asian Paints
3. M/s GRAUER & WEIL (I) LTD, (Unit-Bombay Paints)

INSULATION SCHEDULE

Project : PGR Unit,NFL-Vijaipur, S.O: 5593

SL. NO	FROM	FROM	LINE NO.	SIZE INCH	OPERATING		DESIGN		INSULATION THICKNESS	INSULATION MATL
					PR. KG/C M ² G	TEMP °C	PR. KG/C M ² G	TEMP °C		
1	2"-SL-101.15-B24S (NFL-17)	1"-LPS-8042-WCH020 (AP-17)	1"-LPS-251.01-B24S	1"	3.5	250	6	350	70mm	ROCK WOOL
2	4"-SG-118.01-J24 (NFL-5)	3"-HPGA-8027-WCH260 (AP-5)	3"-SG-252.01-J24	3"	190	15	245	390	30	ROCK WOOL
3	N F L LOCAL DRAIN (NFL-18)	1.5"-LPC-8055-WCH020 (AP-18)	1.5"-LPC-251.01-B24S	1.5"	35	250	6	350	25mm	ROCK WOOL
4	2"-AL-122.04-D14 (NFL-7)	1.5"-AM-8052-ZLH050 (AP-7)	1.5"-AL-251.01-D14	1.5"	21	47	36	275	25mm	PUFF
5	3"-SM-105.02-F24S (NFL-12)	1.5"-MPS-8150-WCH100 (AP-12)	1.5"-MPS-251.01-F24S	1.5"	38	380	46	425	70mm	ROCK WOOL
6	3"-SC-105.02-F24S (NFL-8)	3"-MPC-2245-WCH100 (AP-8)	3"-MPC-251.01-F24S	3"	38	380	46	425	70mm	ROCK WOOL
7	CONDENSATE TANK(B-3702)NOZZLE-G(V015)	CONDENSATE TANK(B-3702)NOZZLE-F(V016)	INSTRUMENTATION LINE	50	2	41	5	100	40mm	ROCK WOOL
8	HP SCRUBBER (NOZZLE-J)V-037	HP SCRUBBER (NOZZLE-K)V-039	INSTRUMENTATION LINE	50	124	13	145	65	40mm	ROCK WOOL
9	HP SCRUBBER (NOZZLE-H)V-038	UP TO 37LT 05	INSTRUMENTATION LINE	50	124	13	145	65	40mm	ROCK WOOL
10	HP SCRUBBER (NOZZLE-I)V-040	UP TO 37LT 05	INSTRUMENTATION LINE	50	124	13	145	65	40mm	ROCK WOOL
	SHEET : 3									
11	LOW PRESSURE STEAM (TP17)	FEED HEATER(E-3704)INLET	1"-LPS-8042-WCH020	25	3.5	250	10	350	65mm	ROCK WOOL
12	FEED HEATER(E-3704)OUTLET NOZ-D	LOW PRESSURE CONDENSATE (TP18)	1.5"-LPC-8055-WCH020	40	3.5	250	10	350	25mm	ROCK WOOL
13	FEED HEATER OUTLET	UPTO REDUCER	3"-HPPG-8013-WCH-150	80	124	37	145	350	40mm	ROCK WOOL

SL. NO	FROM	FROM	LINE NO.	SIZE INCH	OPERATING		DESIGN		INSULATION THICKNESS	INSULATION MATL
					PR. KG/C M ² G	TEMP °C	PR. KG/C M ² G	TEMP °C		
14	AFTER REDUCER	UPTO REDUCER	4"-WCH-150	100	124	37	145	350	40mm	ROCK WOOL
15	AFTER REDUCER	PRISM SEPARATOR INLET	3"-HPPG-8014-WCH-150	80	124	37	145	350	40mm	ROCK WOOL
	SHEET : 4									
16	REBOILER(E-3703) NOZ-E	STRIPPER FEED EXCHANGER(E-3701)INLET NOZ-C	1.5"-RW-8045-WCH050& 1.5"-RW-8044-WCH050	40	24	28.3	36	275	65mm	ROCK WOOL
17	STRIPPER FEED EXCHANGER(E-3701) NOZ-C	RECYCLE WATER TO CONDENSATE COOLER (E-3702)	1.5"-RW-8042-WCH050	40	24	28.3	36	275	25mm	ROCK WOOL
18	STRIPPER FEED EXCHANGER(E-3701) NOZ-C	RECYCLE WATER TO CONDENSATE COOLER (E-3702)(8042-	1.5"-RW-8043-WCH050	40	24	115	36	275	25mm	ROCK WOOL
19	STRIPPER FEED EXCHANGER(E-3701) NOZ-B	AMMONIA STRIPPER(F-3702) INLET NOZ-M	1.5"-AW-8047-WCH050	40	24	28.3	36	275	40mm	ROCK WOOL
20	AMMONIA STRIPPER(F-3702)OUTLET NOZ-A	CONDENSER (F-3701) NOZ-C	4"-AV-8110-WCH050	100	23	47	36	275	40mm	ROCK WOOL
21	REBOILER(E-3703)OUTLET NOZ-D	AMMONIA STRIPPER(F-3702)INLET NOZ-G	6"-RW-8161-WCH050	150	23	47	TBD	275	65mm	ROCK WOOL
22	AMMONIA STRIPPER(F-3702) NOZ-R	UPTO SAFETY VALVE 37 PSV 03A/B INLET	TBD-AV-8085-WCH050	80				TBD	40mm	ROCK WOOL
23	AMMONIA STRIPPER(F-3702)OUTLET NOZ-S	REBOILER(E-3703)INLET NOZ-C	3"-RW-8084-WCH050	80	24	28.3	TBD	65	65mm	ROCK WOOL
24	MP STEAM (TP12)	REBOILER(E-3703)INLET NOZ-A	1.5"-MPS-8150-WCH100	40	38	380	46	425	65mm	ROCK WOOL
25	REBOILER(E-3703)SELF DRAIN	MP CONDENSATE RETURN	1.5"-MPC-2244-WCH100	40	37	246	46	425	65mm	ROCK WOOL
26	V423	MP CONDENSATE (PGR B/L) TP8	3"-MPC-2245-WCH100	80	37	246	46	425	65mm	ROCK WOOL
	SHEET - 5									
27	CONDENSATE FROM E-3701(SHEET 4)	INLET CONDENSATE COOLER (E 3702)	1.5"RW-8063-WCH050	40	24	28	36	275	25mm	ROCK WOOL
	SHEET-6									
28	M-3701(37RO-02,03,04,05,06)OUTLET	INLET UPTO M-3706, 3707,3708,3709	3"-HPPG-8020-WCH150	80	124	37	138	350	40mm	ROCK WOOL
29	M-3702(37RO-07,08,09,10)OUTLET	INLET UPTO M-3710, 3711,	3"-HPPG-8021-WCH150	80	124	37	138	350	40mm	ROCK WOOL
30	HP PURGE GAS (TP5)	HP PURGE GAS UPTO CONTROL VALVE (37FY01)	3"-HPGA-8027-WCH260	100	190	15	210	65	30	ROCK WOOL

SL. NO	FROM		LINE NO.	SIZE INCH	OPERATING		DESIGN		INSULATION THICKNESS	INSULATION MATL
	FROM				PR. KG/C M ² G	TEMP °C	PR. KG/C M ² G	TEMP °C		
31	AMMONIA STRIPPER(F-3702)SELFDRAIN	AMMONIA PRODUCT(TP7)	1.5"-AM-8052-ZLH050	40	21	47	25	65	25mm	PUF
32	CONDENSER (B-3701)	AMMONIA STRIPPER(F-3702)SELF DRAIN	3"-AM-8051-ZLH050	80	21	47	30	65	30mm	ROCK WOOL
33			3"-HPGA-8010-WCH150	80					30mm	ROCK WOOL
34	HP PURGE GAS INLET LINE (F-3701) 3"HPGA-8010WCH150	37PSV-002	TBD-HBGA-8028-WCH150	50					30mm	ROCK WOOL

INSULATION SCHEDULE

Project : PGR Unit,NFL-Vijaipur, S.O: 5593

SL.NO.	EQUIPMENT NO.	DESCRIPTION OF EQUIPMENT	QTY.	FLUID HANDLED	DIM ODXLG/HT MM (APPROX)	INSULATION		
						TYPE	THK (MM)	MTL.
1	E-3704	FEED HEATER	1	LP STEAM	168.3x3768	HOT	65mm	Rock wool
2	M-3701 TO M 3711	HOUSING FOR MEMBRANE MODULES (PRISM SEPARATOR)	1	MEMBRANE FEED GAS	219.1x3976	HOT	40mm	Rock wool
3	E-3701	STRIPPER FEED EXCHANGER	1	STRIPPER BOTTOMS	219.1x3634	SHELL-HOT TUBE-HOT	76.2mm 76.2mm	Rock wool
4	F-3702	AMMONIA STRIPPER	1	AMMONIA PRODUCT	355.6x11769	HOT	80mm	Rock wool
5	E-3703	REBOILER	1	STRIPPER BOTTOMS	659x6195	SHELL-HOT TUBE-HOT	80mm 130mm	Rock wool
6	E-3702	CONDENSATE COOLER	1	STRIPPER CONDENSATE	273.05x4991	PP	30mm	Rock wool



PROJECTS & DEVELOPMENT INDIA LIMITED

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**TECHNICAL SPECIFICATION
FOR
THERMAL INSULATION
(GENERAL REQUIREMENT)**

0	15.07.2013	ISSUED	Rupesh	AS	AMAR
P	28.06.2013	ISSUED FOR COMMENT	Rupesh	AS	AMAR
REV	DATE	PURPOSE	PREPD	REVWD	APPD

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THERMAL INSULATION
GENERAL REQUIREMENT**

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6.0 MEASUREMENT

7.0 GUARANTEE

Annexure – I : INSULATION SUPPORTS (CLEATS) TO BE PROVIDED BY EQUIPMENT SUPPLIER.



**TECHNICAL SPECIFICATION
THERMAL INSULATION
GENERAL REQUIREMENT**

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1.0 GENERAL

1.1 SCOPE

This standard covers the requirement for supply and application of materials for thermal insulation of equipment, piping and other items.

1.2 REFERENCE STANDARDS

IS 14164 Code of Practice for Industrial Application and finishing of thermal insulation material at temperature -80°C and up to 750°C .

IS 737 Wrought aluminium and aluminium alloys, sheet, strip

IS 1254 Specification for corrugated aluminum sheet

TS 6701 Thermal Insulation – Hot service

TS 6702 Thermal Insulation – Cold service

ASTM C-680 Standard Practice for Heat Loss or Gain and Surface Temp.

1.3 Deviations: Should unforeseen difficulties arise to comply with requirements of this standard.

Alternative material and application techniques superior to the requirements of this standard be submitted with complete details for approval of owner.

In case of contradiction between requirements of this standard and the NIT/Work order, the later will be followed.

1.4 LIMITATIONS

Temperature Limits.

This standard deals with insulation applied externally on piping equipments etc. as per the table below:-

Maximum Operating Temperature	Type of Insulation
60°C to 750°C for C.S., A.S. & S.S.	HOT
-180°C to 20°C	COLD

1.5 THICKNESS DESIGN BASIS

Thickness calculation method as per procedure given in ASTM C-680

1. Hot Insulation

Design Ambient Temperature	: 35°C
Design Surface Temperature	: 60°C
Permissible Heat Loss	: 150 kcal./m ² hr.



**TECHNICAL SPECIFICATION
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Permissible Wind Velocity Outside : 1 m/sec
Permissible Wind Velocity Inside : 0.25 m/sec

2. Cold Insulation

Design Ambient Temperature : 35°C
Design Surface Temperature : 2 °C below ambient/ 0.5 Deg C above the Dew Point
Permissible Heat Gain : 10-12 kcal/m² hr
Relative Humidity : 85%
Permissible Wind Velocity Outside : 1 m/sec.
Permissible Wind Velocity Inside : 0.25 m/sec.

1.6 GENERAL REQUIREMENTS.

1.6.1 Information to be supplied to contractor

- Material of construction / dimension of equipments / pipes required to be insulated.
- Temperature
- Location of equipment (Indoor/Outdoor/Elevn.)
- Requirement of removable box type insulation if any
- Special requirements if any regarding type of insulation material and other properties.
- These information shall be supplied in form of insulation schedule.

1.6.2 STORAGE OF MATERIAL

Insulation material shall at no time be stacked directly on the ground; instead it will be stored at a level higher than ground level. It should not only be covered by tarpaulin but other effective protections against weather are also to be provided. The contractor shall provide a properly covered storage to the satisfaction of engineer-in-charge (Refer IS: 10556)..

1.6.3 HYDROSTATIC TEST FOR PIPES

Before taking up insulation job on piping or vessels it shall be ensured that hydrostatic test of the concerned equipment / piping is completed. Where it is felt necessary to take up the insulation job before such testing are performed all welded and mechanical joints shall be left un-insulated for a length of at least 150mm on either side of the joint.

1.6.4 PROTECTION OF INCOMPLETE JOBS

Any part of insulation job which is not provided with final weather proofing will be adequately protected by means of tarpaulins and other aids. After the day's work similar protection should be provided for the partially completed jobs to be continued the next day to avoid any absorption of rain / moisture during the night.

2.0 INSULATION SUPPORTS (CLEATS) TO BE PROVIDED BY EQUIPMENT SUPPLIER

Suitable supports (cleats) in the form of rings, lugs, studs or pins shall be provided on equipment by equipment supplier as per Annexure-I, However should any additional supports or anchorage be felt necessary by the insulation contractor the same will be recommended by



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them to the Engineer-in-charge for his approval before installation. These will be installed by the contractor free of any extra cost.

3.0 MATERIAL REQUIREMENTS

3.1 INSULATION MATERIALS

3.1.1 General

- Whenever reference to any Standard is made it is presumed that the latest revision as on date should be considered unless otherwise specified.

3.1.2 Specification and other requirements

Specification and other requirements will be as per TS-6701 for Hot Service and TS-6702 for Cold Service.

3.2 AUXILIARY MATERIALS FOR CLADDING

a) Aluminium Cladding

- Horizontal Vessels

Aluminium sheet as per IS-737 (designation 31000, condition H3 for flat sheet & 31500/51300, H4 for corrugated sheets)) shall be used for cladding. Insulation on overall piping, vessel and equipment, cladding will be coated on the side in contact with insulation with 3 mil thick polysurlyn film.

Specifications for aluminium Cladding material shall be as follows :

Material	Reference Code / Standard	Thickness	Application
Aluminium sheet with applied moisture barrier of 3 mil thick Polysurlyn coating	IS : 737 / ASTM C-653	22 SWG (0.71mm)	For all piping, tanks, vessels, heat exchanger, flanges, valves, equipments etc. upto 24" outside dia
		20 SWG (0.91mm)	For piping, tanks, vessels, heat exchanger, flanges, valves etc. above 24" outside dia
Removable cover for flanges, valves etc. shall be made out of 1.0mm thickness Aluminium Sheets.			

- Vertical Vessels

Cladding material for vessels with insulation O.D. 900 mm and less shall be same as for pipes. For vessels above 900 mm insulation O.D. 22 SWG corrugated aluminium sheet as per IS-1254 or ribbed aluminium sheet 32 mm x 5 mm deep corrugations may be used.

b) Screws

Screws used with aluminium sheeting shall be of self tapping type, A No.8x12mm long cadmium plated / SS of high quality at intervals of 150mm..



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- e) **S-Clips.**
Aluminium, 20x1.5mm or 25mm wide stainless steel banding bent to form a shape of "S" provide a minimum lap of 50mm.
- d) **Bands for securing cladding.**
Aluminium of dimensions 12mm width x 0.56 mm thick (24 SWG) for pipes. Stainless Steel bands Type 304, 0.4mm thick x 13mm wide for large dia pipes (above 24") and cylindrical equipment up to outside dia 900mm, 0.5mm thick x 19mm wide for cylindrical equipment above 900mm outside dia meter.
- e) **Quick release clips for removable covers.**
Suitable quick release clips will be made as shown in fig. 7 from 20Cm width x 20 SWG aluminium sheet and some fig.7 from 20mm width x 20 SWG aluminium sheet and some suitable rectangular ring.
- f) Sealant for cladding joints with MAS 94/ Foster 91-44 Mastics or equivalent.
- g) **Rivets**
Aluminium 'POP' blind eye type / Stainless Steel 9.5mm long x 5mm dia meter.

4.0 INSPECTION.

4.1 General

All insulation material shall be subject to inspection by owner before application. In case of doubt Owner's representative will have the liberty to get the material tested by the contractor at any approved test laboratory. Any material not meeting specified requirement will be rejected and the rejected material shall have to be replaced by the contractor with material of specified type and quality. Insulation found to be improperly installed shall be removed and reinstalled properly.

4.2 Inspection

Inspection of materials and / or installation by owner shall not relieve the contractor of his responsibility to ensure that finished insulation conform to specified requirements and is free from defects, contractor shall correct any defects due to poor workmanship.

4.3 Test for thickness

Test for thickness shall be carried out after application. Thickness at any point shall not be less than 2mm than the indicated thickness and excess thickness up to 115% of the specified thickness is Permissible. .

4.4 Testing for bulk density

Testing of bulk density of the insulating materials shall be carried out before the application of insulation. This should be within $\pm 15\%$ of the specified value. Test location shall be selected by owner and its repair shall be done by contractor.



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5.0 APPLICATION

5.1 General

Insulation thickness shall be as specified in the insulation schedule/specification/isometric drawings prepared for equipments/piping. Wherever the thickness is not indicated the same may be selected from TS-6701 & 6702.

Insulation for pipes should be in preformed shape in two halves upto 14"nb dia meter for first Layer and beyond that mattress to be used.

5.2 No. of Layers

When insulation thickness exceeds 75 mm, the insulation shall be applied in multi-layers with all joints staggered. Each layer will be separately secured with metallic bands/wires.

No. of layers shall be as follows:

<u>Insulation Thickness</u>	<u>No. of Layers (Min.)</u>
Up to 75mm	1 Layer
76 to 150 mm	2 Layers
151 and above	3 Layers or more.

5.3 GENERAL REQUIREMENTS

5.3.1 Surface preparation

- Surface to be insulated shall be cleaned of all dirt. Oil loose scale etc. by wire brushing. All insulation shall be applied at ambient temperature and both the metal surface and insulation material shall be dry prior to application of insulation.
- The surface for cold insulation shall be then coated with a bitumen emulsion or a mastic coating.
- If the vessel is made of stainless steel, it shall be wire-brushed. with stainless steel wire brush.

5.3.2 Expansion / contraction joint

Depending on the type of insulation used the operating temperatures and nature of the material it may be necessary to provide expansion/contraction joints on vessels or pipes to prevent the insulation from rupturing/buckling when the surface expands/contracts. It is recommended that expansion joints will be provided in the intervals as follows:

Temperature	Intervals	Remarks
201 ⁰ C to 300 ⁰ C	4 ^M Interval	This is not reqd. where flexible wool is used as insulation
301 ⁰ C to 400 ⁰ C	3 ^M Interval	
401 ⁰ C & above	2 ^M Interval	
Cold service	5 ^M Interval	

- Expansion joints in horizontal vessel insulation shall be close to fixed support saddle (s)



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- At the expansion joint there shall be a complete cut through the insulation.
- On piping, expansion joints shall be provided on both sides and within 900 mm of each bend (within the above guide line for interval).
- The cut out in insulation shall be at-least 25 mm wide and dry filled with loose insulation.

5.3.3 Filling of Voids

All voids, irregularities and joints shall be packed with loose insulation material/insulation cement trowelled smooth whichever is applicable.

5.4 INSULATION PROCEDURE

5.4.1 Insulation procedure shall be as per TS-6701 & TS-6702 for hot & cold service respectively.

5.5 Metal Jacketing

a) General

- All joints shall have minimum 75 mm overlap arranged such as to shed water. For horizontal vessels and pipes, horizontal overlap shall be installed within 5-6-7 O - clock position.
- Jacket shall be secured to the spacer rings and to itself by self tapping screws, described earlier, at a pitch of 150 mm for longitudinal joints and 100 mm for circumferential joints or by metal bands.
- All outlets and cut outs shall be cut as close as possible to nozzles, manholes, supports, branch connections etc. and sealed weather proof. (Ref Fig.3).
- At all joints, edges of the jacket will be grooved.
- All openings through insulation finish shall be flashed weather tight by vapour seal mastic, particularly where connections are not insulated.
- Insulation of flange assemblies, valves, manholes hand-holes removable heads of heat exchangers etc. shall be of removable type.

b) Horizontal Vessels

Jacketing for dished heads shall be fabricated in form with the radial overlapped joint (with adequate overlap) secured by self tapping screws @100 mm pitch where it is not possible, suitable metal bands shall be provided as approved by Engineer-in-charge. The ends shall be secured to the vessels sheeting (Cylindrical shell) by circumferentially tensioned bands and reinforced by self tapping screws set at 150 mm pitch.

c) Vertical Vessel

Corrugated / Ribbed aluminium sheeting shall be adequately rolled and installed parallel to the axis of the vessels as shown in fig. 4 and shall be secured to the insulation supports available on the vessels. Otherwise they shall be secured to themselves and rings provided by the contractor by self tapping screws. All individual sheets shall be overlapped by at least 75 mm on longitudinal joints and 2 corrugations on circumferential joints, to shed water wherever possible. All joints shall be staggered.

Circumferential end laps shall be supported with S-clips so that top section can rest on the lower one and top section.

-Heads

Guide lines for horizontal vessels will be followed.

- d) Corrugated / Ribbed aluminium sheet shall be fixed with the help of suitable pop rivets on the sides of the tank. Flat sheet will be used for top of tank. Sheet to sheet longitudinal joints shall be sealed only with pop rivets and no screws shall be used. Circumferential joints need not be riveted.
- e) **Heat Exchangers**
Guide line for vessels shall be followed.
- f) **Machineries like pumps, Turbines, Compressors etc.**
Wherever sheeting will be required it will be specifically asked for and contractor shall submit his proposed details for each equipment for approval of the Engineer-in charge.
- g) **Spherical Vessels**
Guide lines for horizontal vessels shall be followed.
- h) **Piping Items:**

Elbows / Bends

On piping cladding shall be supplied with longitudinal and circumferential laps of 50 mm and secured by aluminium bands spaced 300 mm centres or by aluminium self tapping screws at 150 mm canters. Longitudinal laps on horizontal pipes shall be arranged minimum 300 below the horizontal centre line to shed water. Circumferential lap joints should be sealed with suitable adhesive sealer.

Cladding of insulation over large bends shall be as per Fig.5 Cladding of insulation over elbows shall be spun aluminium jacket and the joint with cladding of adjacent straight pipe shall be flashed and banded as shown in fig. 5 (a).

- Valves & Flanges.

Where flanges and valves are not insulated, the end of insulation on both sides shall be suitably covered as shown in Fig.6 when these are required to be insulated they will have removable box or pad insulation as indicated on Fig. 7,8,9 & 10.

Cladding of insulation over valves and flanges shall be prefabricated in half-sections and screwed together. The ends joining adjacent pipe jacket shall lap 50 mm and be sealed weather tight with reinforced mastic. In case of pad insulation, the pads will be tied tightly over the valves and flanges with suitable arrangements.

6.0 MEASUREMENT OF INSULATION WORK.

6.1 Measurement of insulation works shall be as per IS: 14164.



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7.0 GUARANTEE

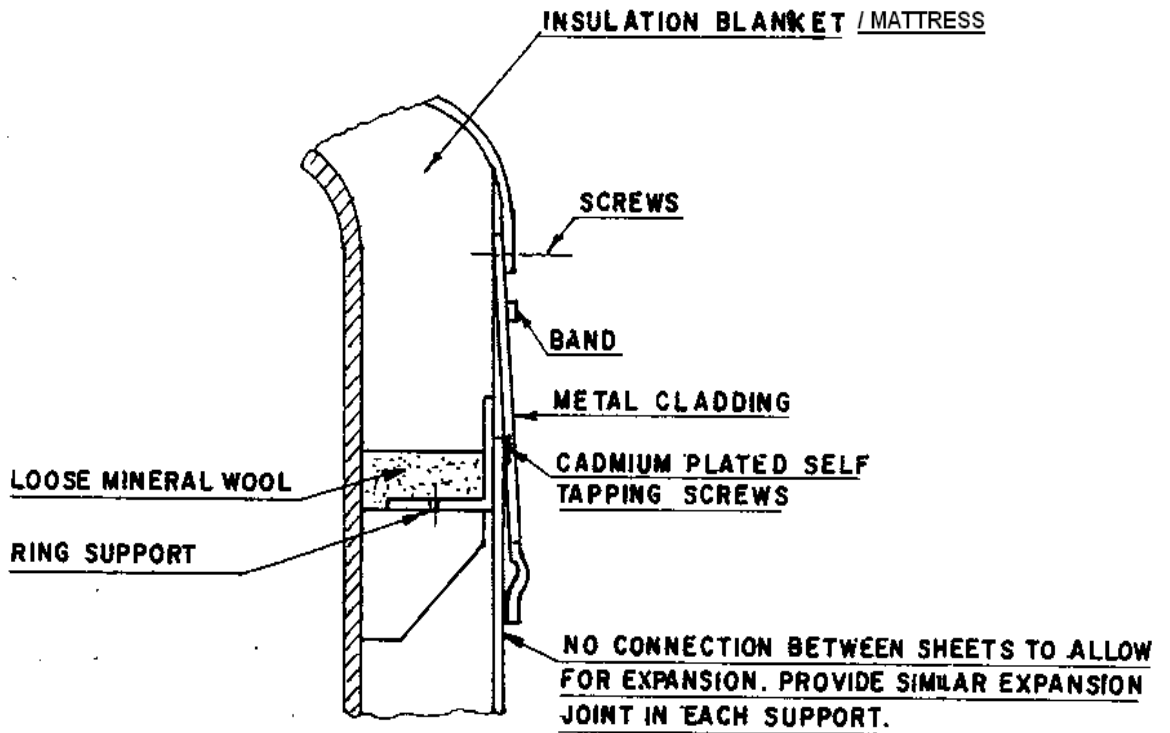
- The guarantee test shall be carried out when plant is fully operative.
- The surface temperature, reading shall be taken at six points per pipe line and at each point it shall be taken on all four sides in top, bottom, left side and right side.
- The above reading shall be taken at 2 hours intervals and shall be taken for 18 hours starting from 11 a.m. in the morning
- Simultaneously ambient temperature shall be taken as per IS: 14164
- A graph shall be plotted between ambient and surface temperature reading
- From this graph the surface temperature against ambient temperature shall be found out
- The ambient and surface temperature shall be measured by the instrument provided by the contractor. The instrument shall be calibrated to the satisfaction of owner/consultant.
- The contractor is required to guarantee the surface temperature of 60 °C (max.) for equipments and piping in case of Hot Insulation. For cold insulation of equipments and piping, the difference between skin temperature and ambient temperature shall not exceed 2 °C .

Ambient temperature and surface temperature shall be measured by duly calibrated instruments provided by CONTRACTOR.

The CONTRACTOR shall undertake immediate replacement of insulation material damaged in transit, storage or application.

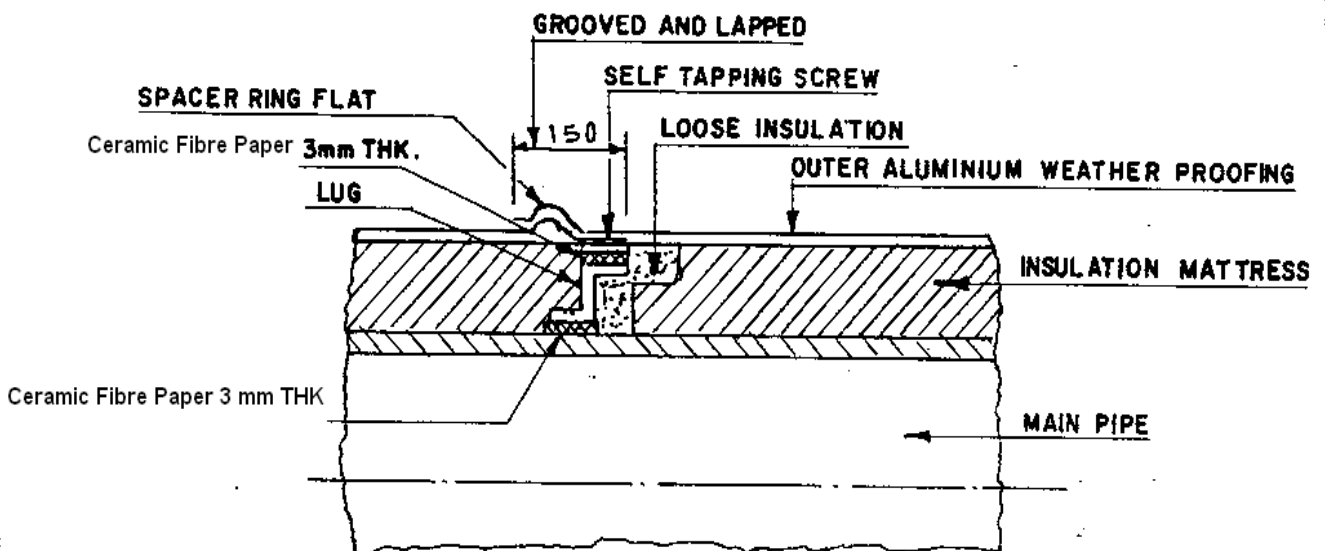
Insulation contractor shall produce required number of copies of test certificates as per relevant IS/ASTM Standard. Insulation contractor shall certify that:

- All materials are new and unused and are as per specifications called for in this standard.
- The operating thermal conductivity shall be as specified
- The workmanship shall be in accordance with good practice.
- Other terms & conditions of the guarantee clause shall be as per NIT / purchase order.



**EXPANSION JOINT - BLANKET INSULATION
WITH METAL CLADDING**

FIG.-1



**INSULATION EXPANSION JOINT
FOR RIGID MATERIAL FOR PIPES**

FIG.- 2

**APPLY MASTIC TO BEVELED PIPE
INSULATION. INSTALL JACKET
SNAPPING ENDS TO BEND OVER
BEVEL AND ALONG PIPE.**

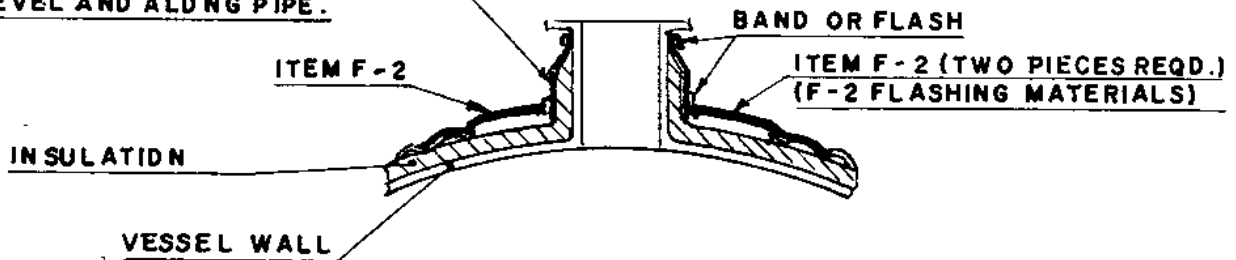
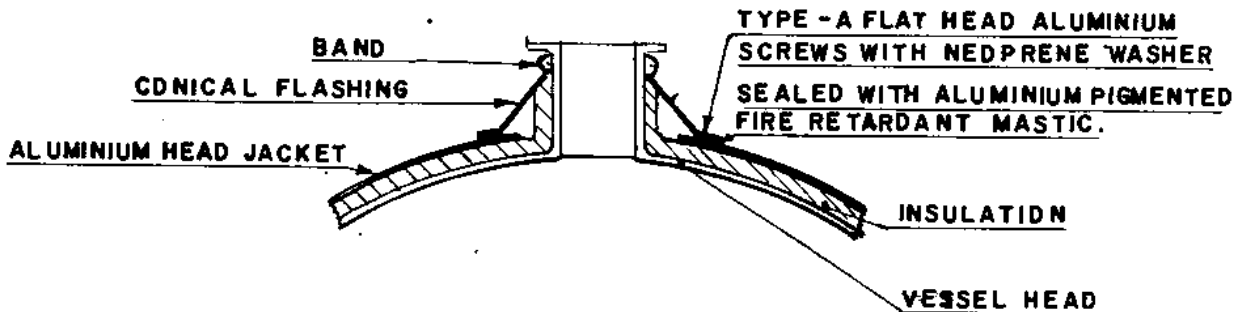


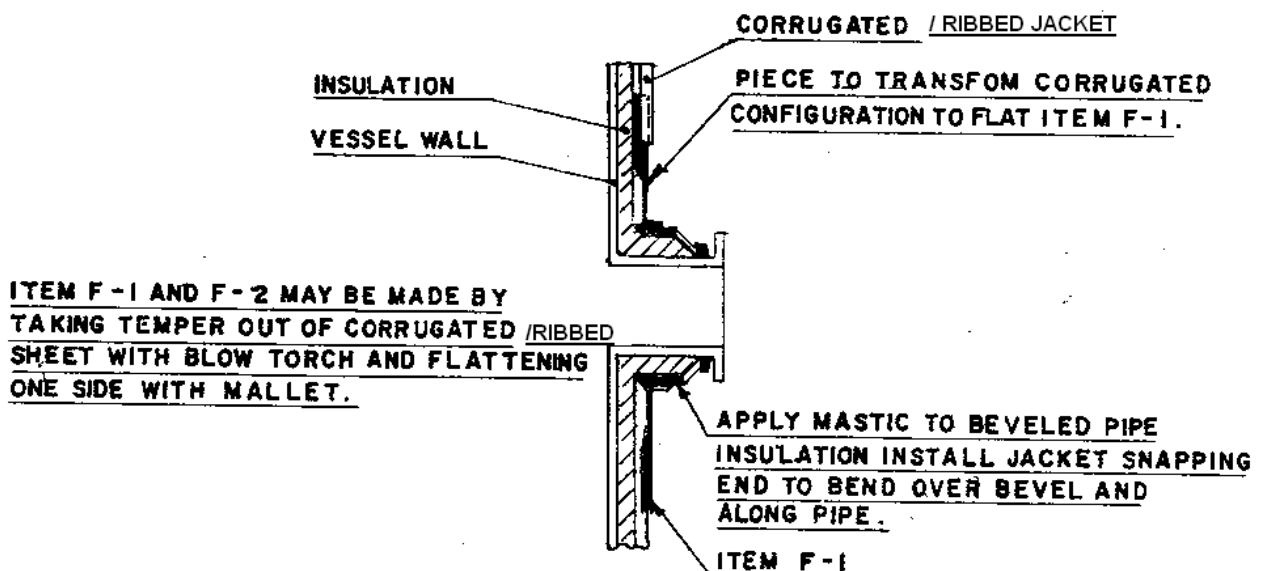
FIG. 3a



JACKETING DETAILS TOP OUTLET FLASHING

FIG. 3b

**TOP OUTLET FLASHING DETAIL MAY BE USED FOR SIDE
OUTLET AFTER TRANSFORMATION OF SHAPE FROM
CORRUGATED TO FLAT HAS BEEN TAKEN CARE OF.**



**ITEM F-1 AND F-2 MAY BE MADE BY
TAKING TEMPER OUT OF CORRUGATED / RIBBED
SHEET WITH BLOW TORCH AND FLATTENING
ONE SIDE WITH MALLET.**

JACKETING DETAILS SIDE OUTLET FLASHING

FIG. - 3c

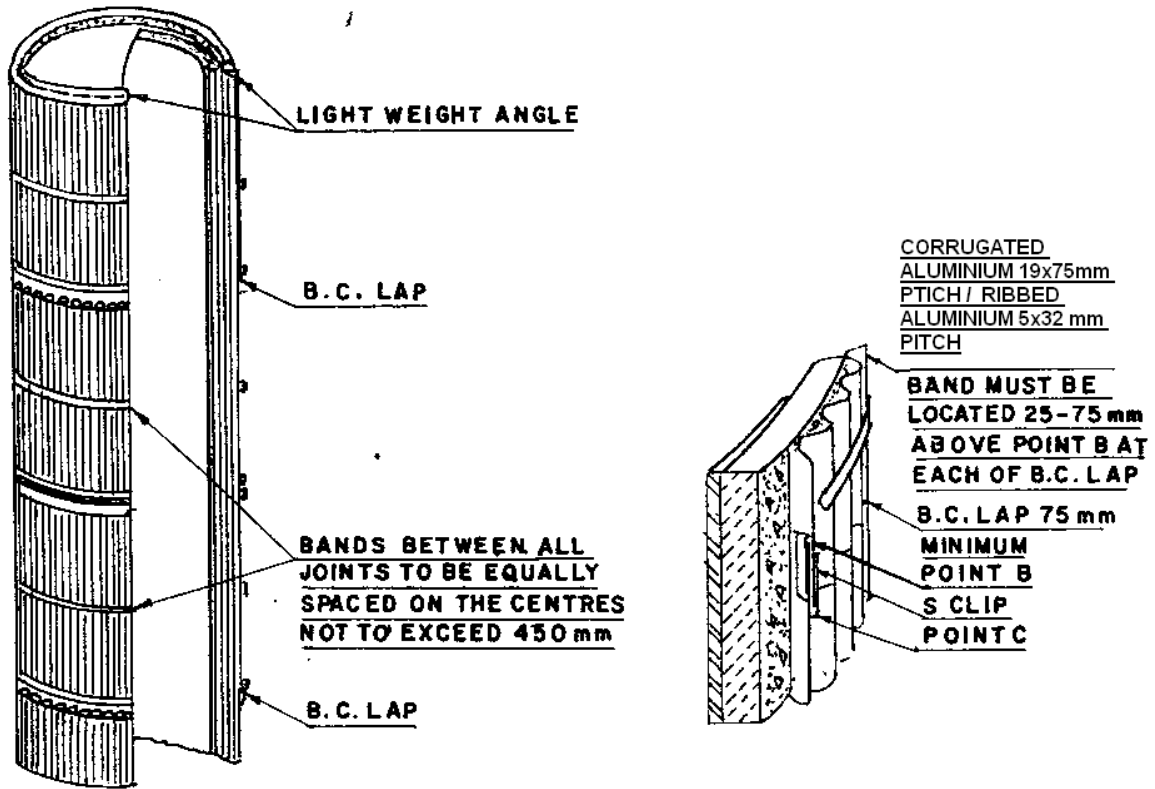


FIG. 4

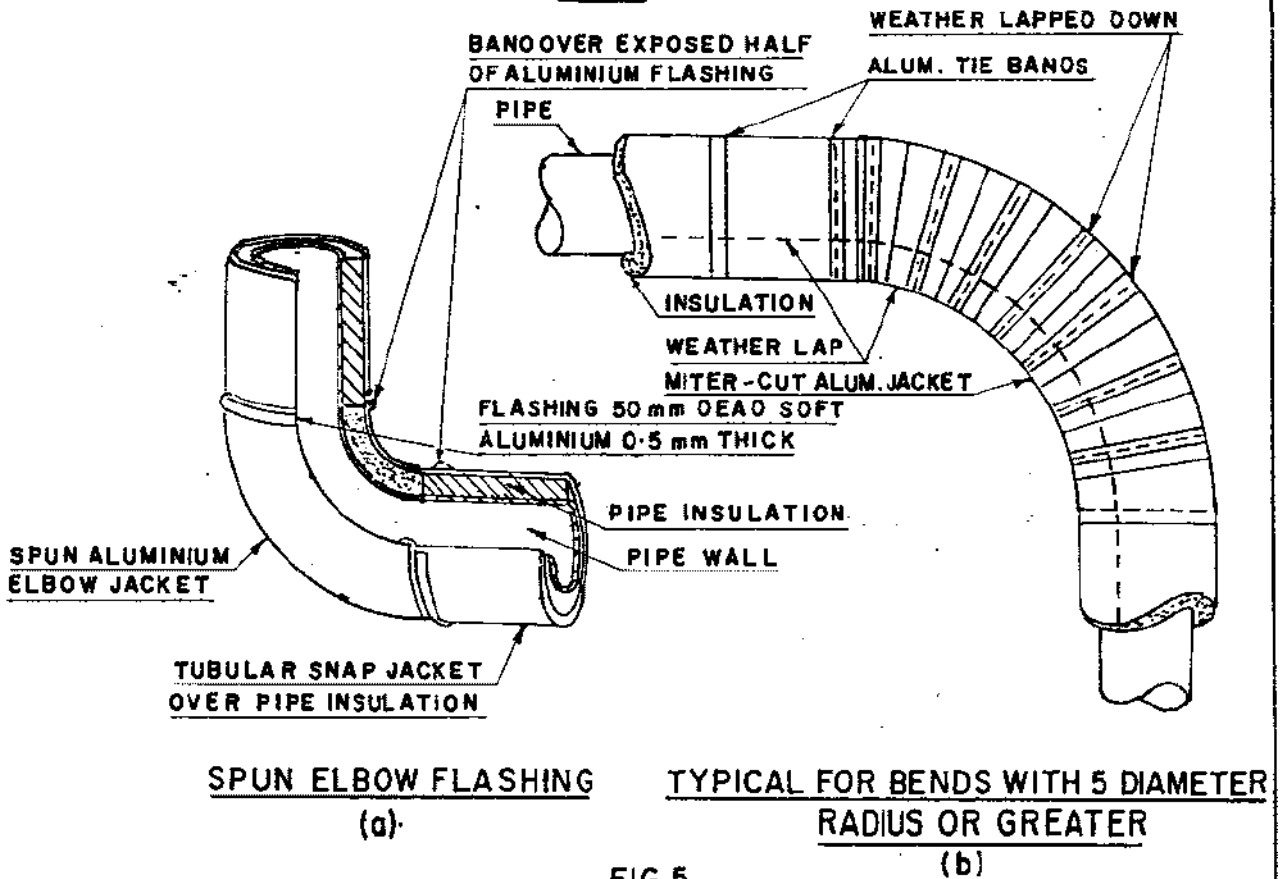
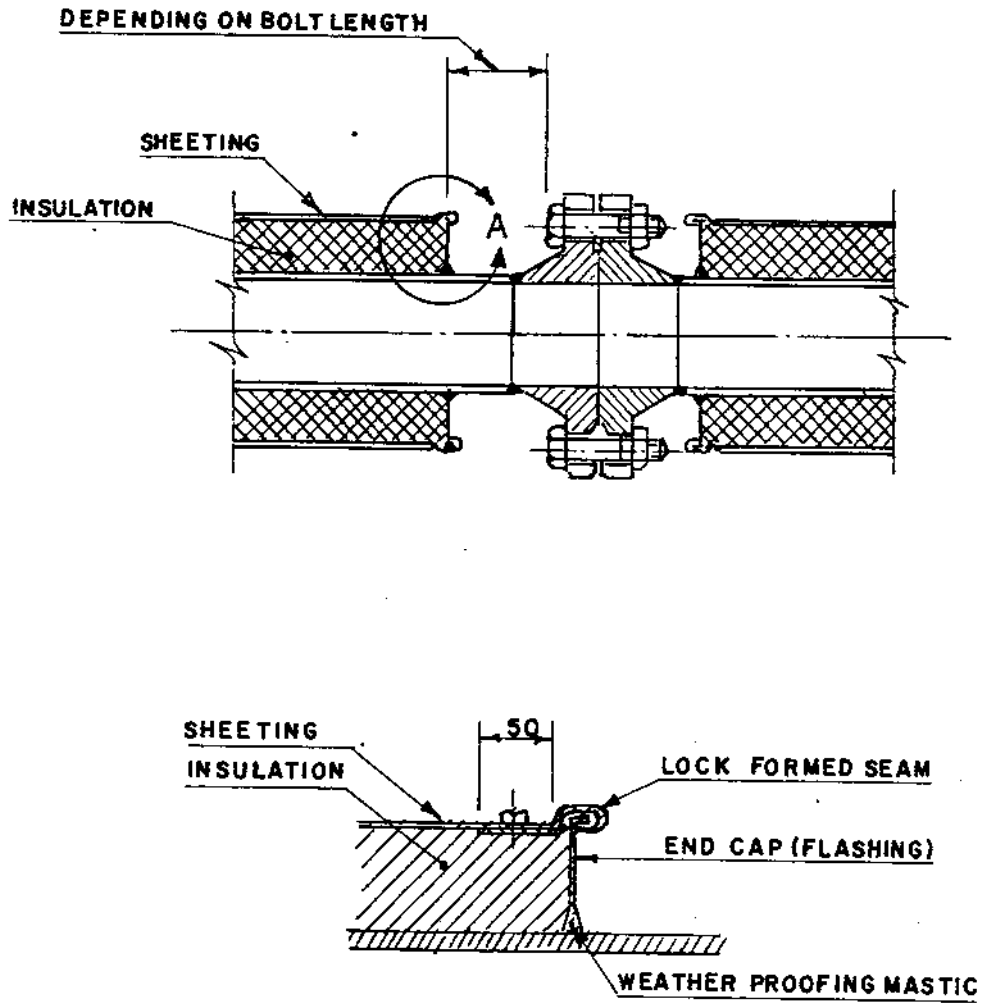


FIG. 5



DETAIL - A

FIG. - 6 FLANGE ASSEMBLIES - UN INSULATED

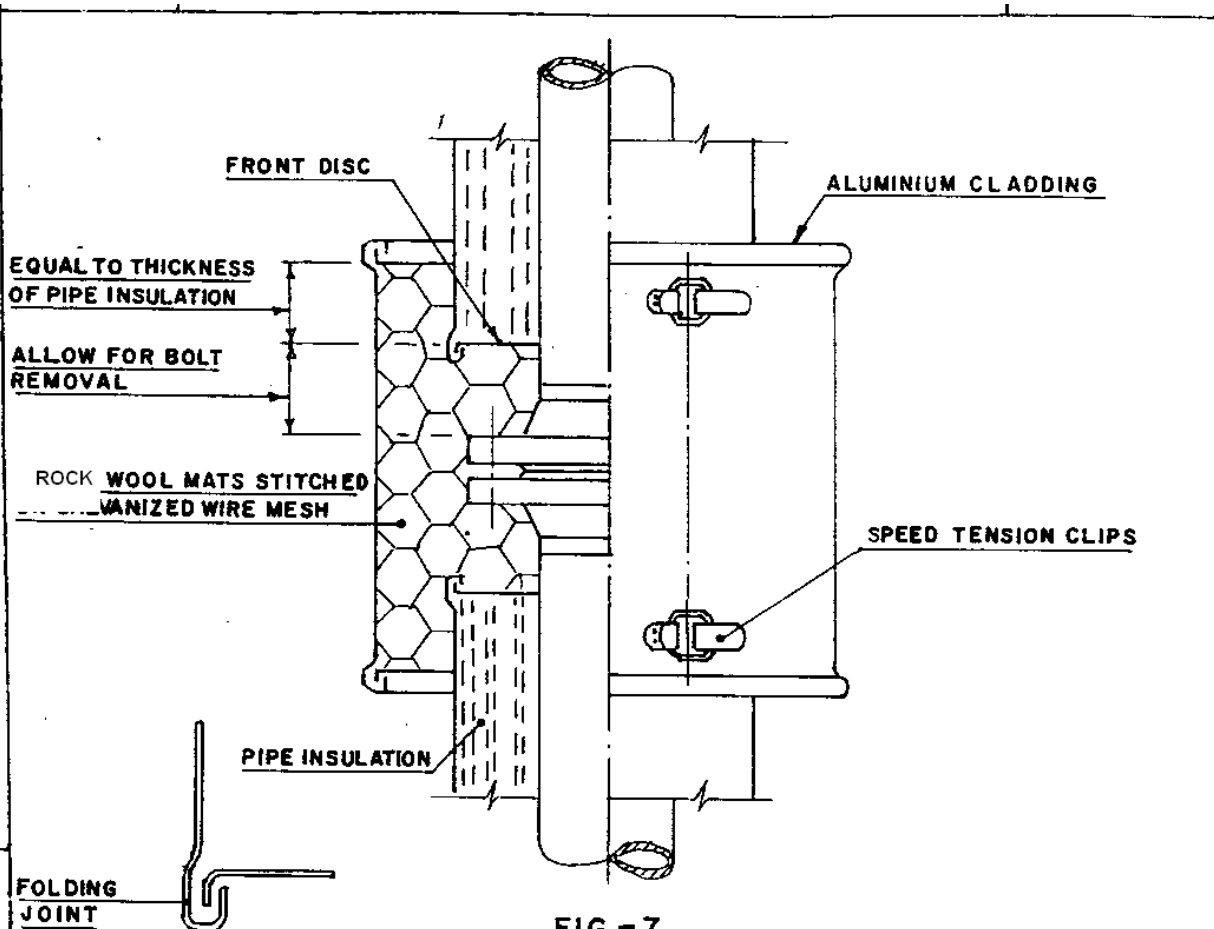


FIG - 7
REMOVABLE FLANGE BOX IN HORIZONTAL LINES (HOT SERVICE)

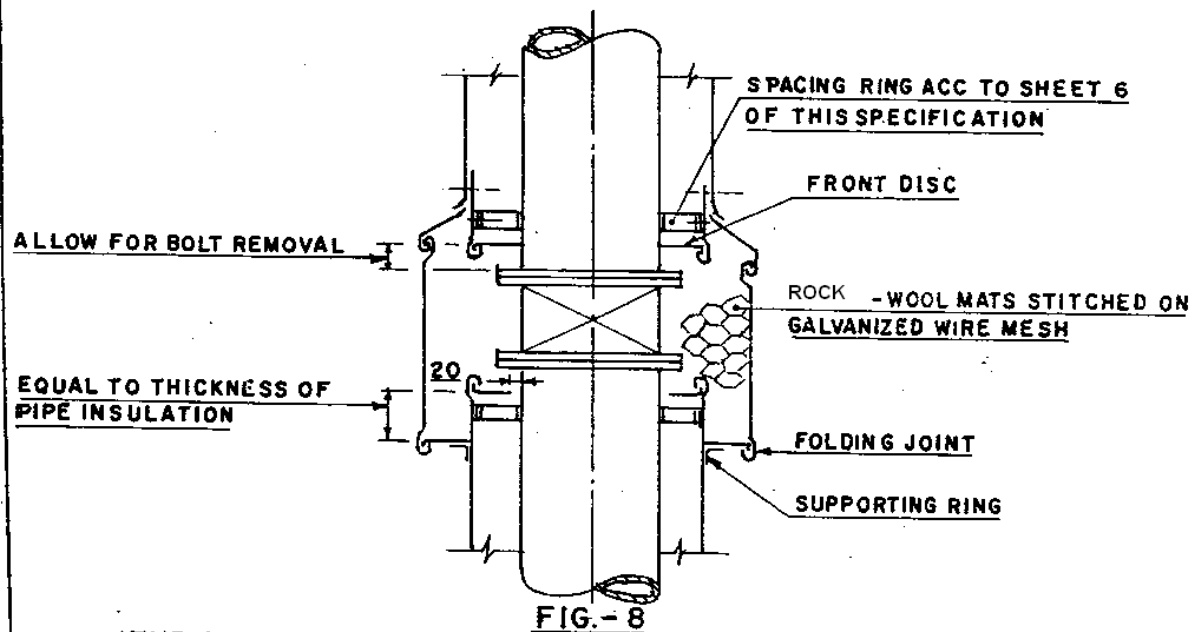
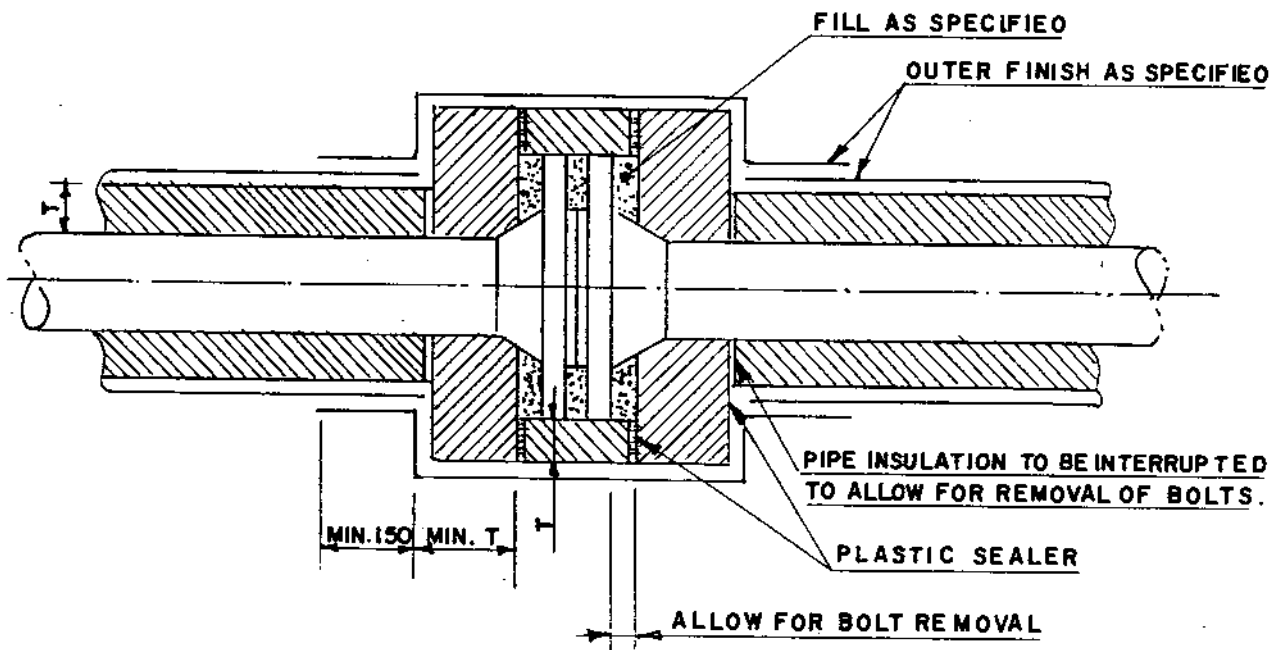


FIG - 8
TYPICAL DETAILS FOR REMOVABLE BOXES FOR VALVE & FLANGE CONNECTIONS IN VERTICAL LINES (HOT SERVICE)



REMOVABLE BOX FOR FLANGE ASSEMBLY
USING BLOCK INSULATION

FIG. - 9

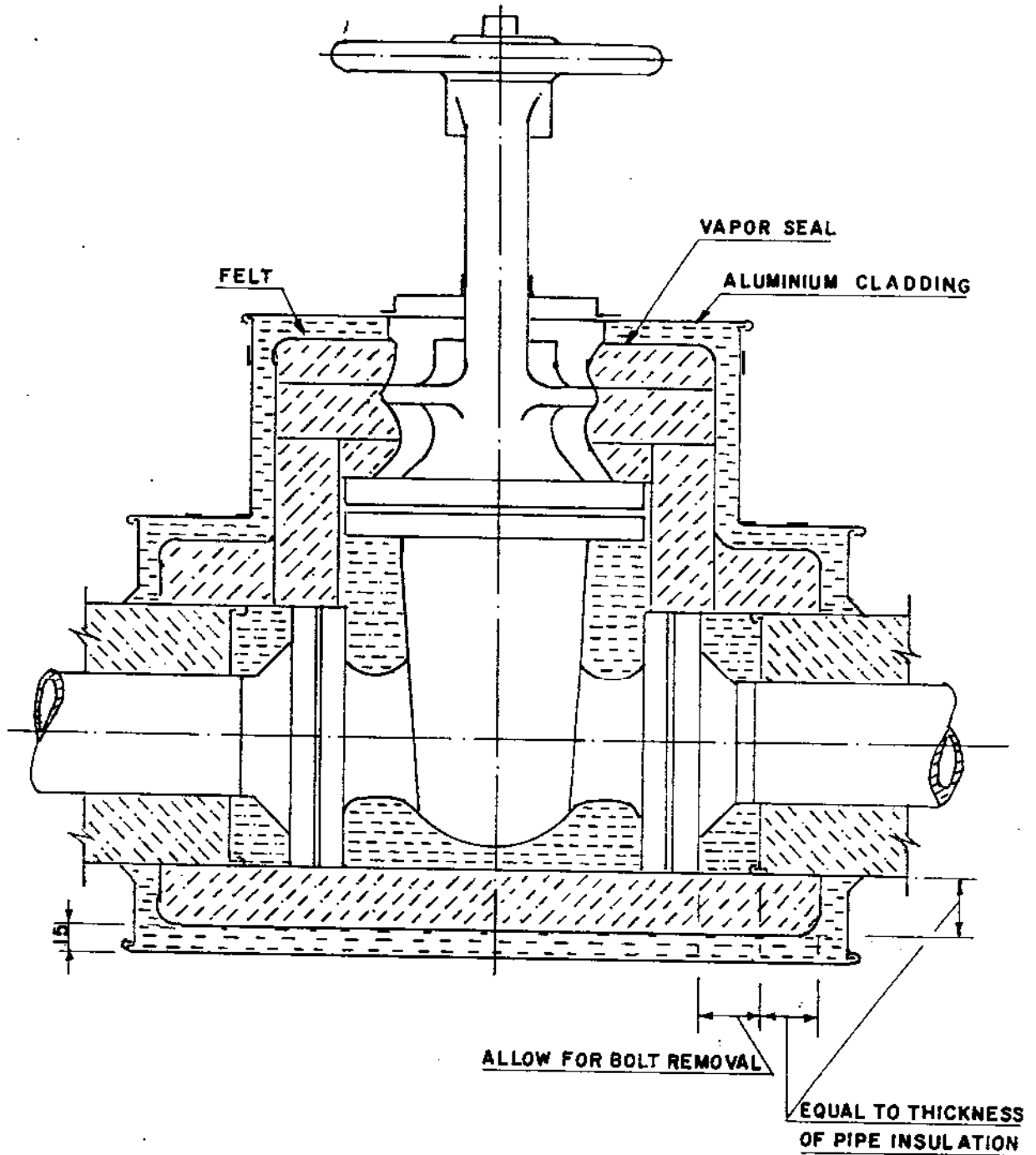


FIG - 10

TYPICAL DETAIL FOR VALVE INSULATION BOX
(USING BLOCK INSULATION)



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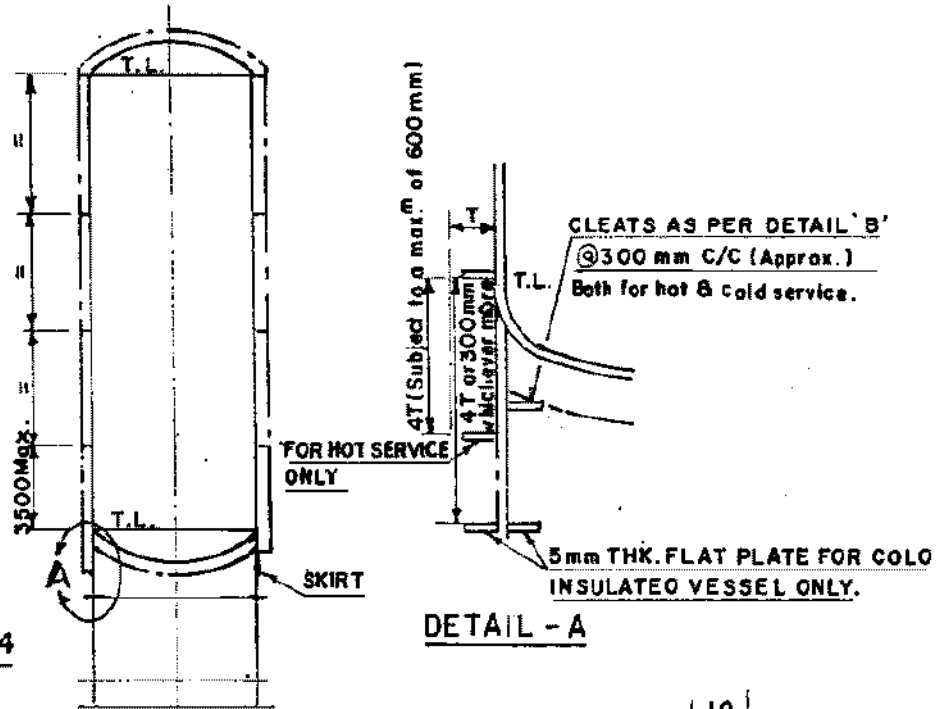
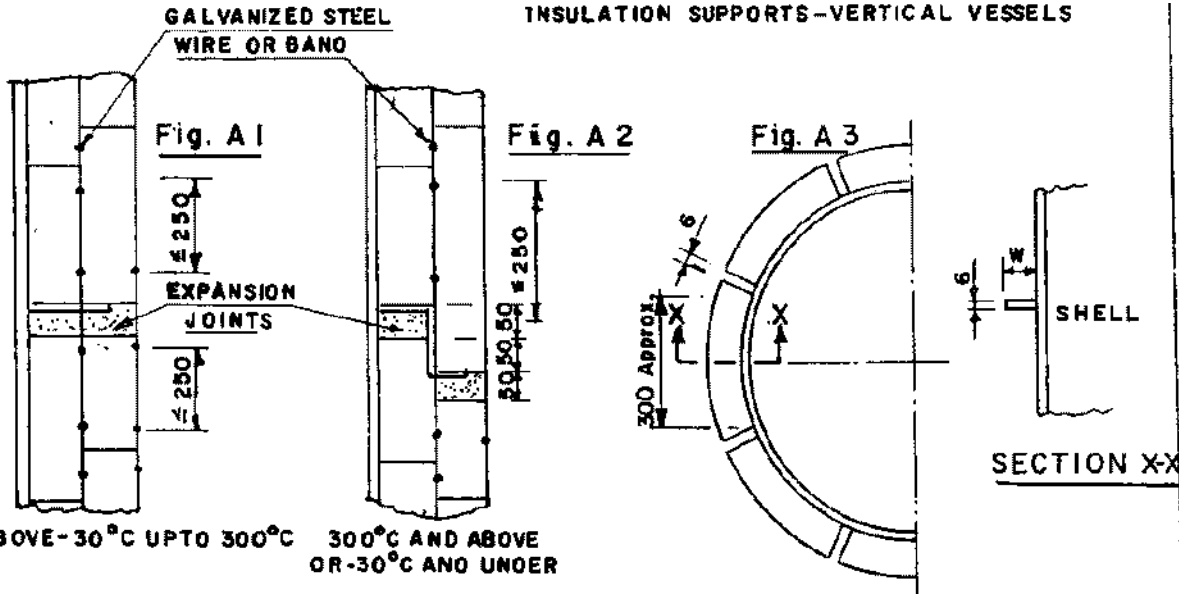
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ANNEXURE - I

INSULATION SUPPORTS ON VESSELS

- 1 Suitable supports in the form of rings, lugs, studs or pins shall be used to support insulation on vessel and pipes. Block insulation of vertical vessels and piping shall be supported by support rings. Welding studs are not to be used on any vessel having shell thickness less than 3 mm or shells of aluminium or other alloy materials where spot wildings is not permitted on the vessel surface. Approval must be obtained from the Engineer before welding will be permitted on any vessel or equipment. Normally insulation supports are provided after final erection of the plant. If site welding is not permitted then same should be considered at the design stage itself.
- 2 Support ring shall be 6 mm. thick and shall be as per fig. A I-A6. In case of stress relieved vessels insulation supports shall preferably be shop welded.
- 3 If support rings are used on a vessel, the insulation of the head shall be held in place with bands radiating from a floating ring made of 6 mm. round M.S. rod. The bands shall be spaced not more than 300 mm. apart at the tangent line. In case of cold insulation, lugs or supports shall in no case be more than 75% of the total insulation thickness in order to not to puncture the vapour barrier.
- 4 Stiffener angles, weld protrusions, ladder supports, insulation support rings, pipe hangers or any metal connections not otherwise scheduled to receive insulation shall be insulated if in direct contact with the cold surface in case of cold insulation. The insulation over such protrusions shall have an insulation thickness over them of at least 80% of the thickness of the adjoining insulation. In all such cases the insulation shall be extended to ensure that the nearest exposed surface has a temperature above 0°C or above dew point as specified by purchaser.
- 5 On large vertical vessels of a height of 6 m or more and on continuous run of 6 m or more of vertical pipe, support rings shall be provided at not more than 3 m interval, such rings shall encompass the vessel and pipe, and the material lugs thereon shall have a length equal to 75% of the total insulation thickness. Extra insulation shall be provided over the support rings. This shall extend for 25 cm. on each side of the ring and shall be mitred to 45 cm. for water-shed on the upper.
- 6 Where studs, clips or pins are used to support insulation, their spacing shall be approximately 600 mm centre for blanket insulation and one per block for block insulation. Split pins, if used, shall be spread, bent over and imbedded into the insulation.

INSULATION SUPPORTS - VERTICAL VESSELS

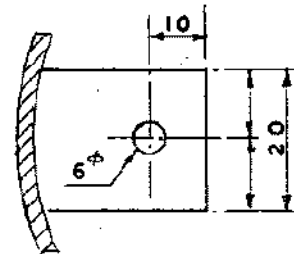


$$W = \frac{T_1}{2} \text{ FOR SINGLE LAYER INSULATION.}$$

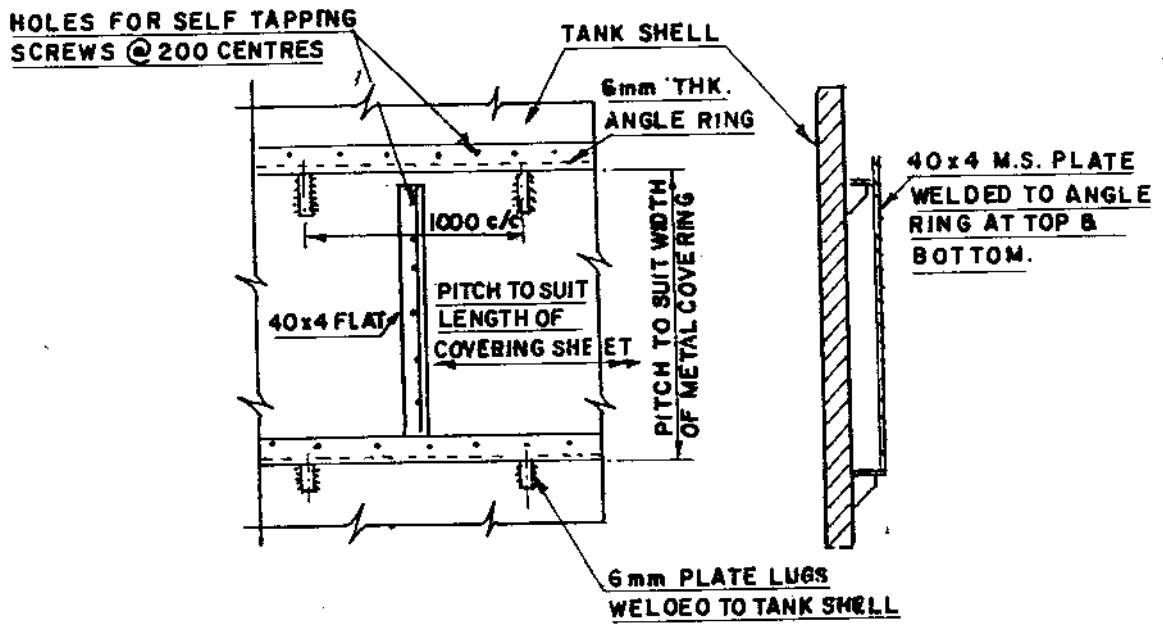
$$W = T_1 + \frac{T_2}{2} \text{ FOR DOUBLE LAYER INSULATION.}$$

T₁ = THICKNESS OF FIRST LAYER OF INSULATION.

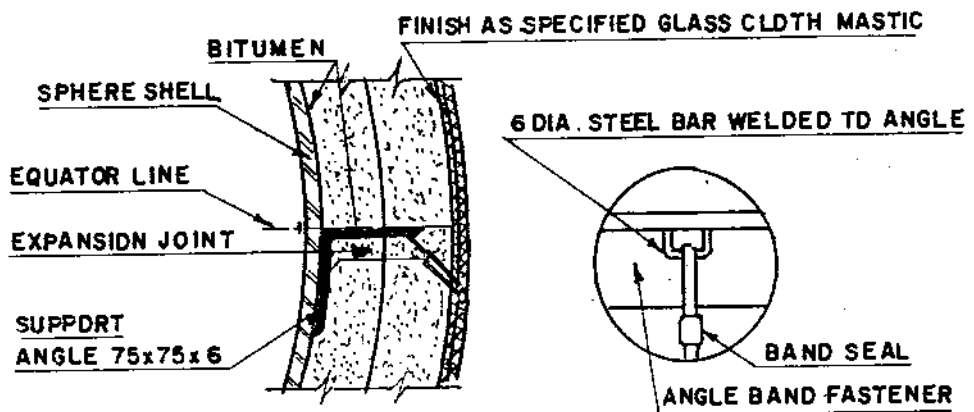
T₂ = THICKNESS OF SECOND LAYER OF INSULATION.



DETAIL - 'B'



**TYPICAL DETAIL OF SUPPORT TANK
FIG - A5**



**SUPPORT ANGLE DETAIL FOR HORTON SPHERE
FIG - A6**



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FOR
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HOT SERVICE**

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P	27.06.2013	ISSUED FOR COMMENT	Rupesh	AS	AMAR
REV	DATE	PURPOSE	PREPD	REVWD	APPD

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3.0 APPLICATION OF INSULATION

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3.3 Insulation Procedure



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1.0 GENERAL

1.1 SCOPE

This standard covers the requirement for supply and application of materials for thermal insulation of equipment, piping and other items for Hot Service. TS -6700 is supplementary to this standard and all the applicable requirements of TS-6700 shall be complied with in conjunction with the requirements specified here in.

1.2 REFERENCE STANDARDS

TS-6700	Thermal Insulation – General Requirements
IS:14164	Code of Practice for Industrial Application and finishing of thermal insulation material at temperature -80°C and up to 750°C.
IS:8183	Specification for bonded mineral wool
IS: 9842	Specification for performed fibrous pipe insulation
IS:8154 / IS:9428	Calcium silicate pipe sections & blocks
IS:9743	Insulating cement
IS:9742	Specification for spray able mineral wool.
IS : 15402	Specification for Ceramic Fibre Insulation
ASTM C-680	Standard Practice for Heat Loss or Gain and Surface Temp.
ASTM C-795	Standard Specification for Insulation use over Austenitic Stainless Steel.

1.3 DEVIATIONS

Should unforeseen difficulties arise to comply with requirements of this standard.

- Alternative materials and application techniques equivalent or superior to the requirements of this standard may be submitted with complete details for approval of PDIL.
- In case of contradiction between requirements of this standard and the NIT/work order, the latter will be followed.

1.4 LIMITATIONS

Temperature Limits

This standard deals with insulations applied externally on piping / equipments etc. for temperature ranging from 60°C to 750°C.



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1.5 GENERAL REQUIREMENTS

1.5.1 Personnel Protection (PP)

Insulation for personnel protection is usually called for when the surface temperature is above 60°C and process requirement does not necessitate any insulation. Wherever, requirement of such insulation for P.P. is indicated, extent of insulation will be as follows:

- Insulation all such portions of the surface which could be touched in the course of normal operation / maintenance duties.
- Insulate up to a height of 2.5 M above grade level/working platform level.
- Insulate all portions of the surface within a distance of 600 mm from the edge of any walk way / operating platform/ladder.

2.0 MATERIAL REQUIREMENTS

2.1 INSULATION MATERIALS

2.1.1 General

- Wherever reference to any standard is made it is presumed that the latest revision as on date should be considered.

2.1.2 Specification and other requirements as per table below:

Sl. No.	Specification	Applied density Kg/m ³ (minim.)	Temp. limit °C	Maxim. Thermal conductivity mW/cm °C at 100°C mean temp. # .
1	2	3	4	5
A)	For Vessels/Equipments/Large Pipes			
	i) Bonded rock wool mattress/slabs as per IS:8183 Gr.3	100	400	0.51
	ii) Bonded glass wool mattress/slabs as per IS:8183 Gr.3	85	400	0.51
	iii) Bonded rock wool mattress / slabs as per IS:8183 Gr.3	150	401-550	0.51
B)	For Pipes			
	i) Preformed bonded Rock wool/glass wool pipe sections as per IS:9842 Gr. 2	85	400	0.51



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	ii) Preformed bonded rock wool pipe sections as per IS:9842 Gr. 2	150	550	0.51
	iii) Preformed calcium silicate pipe sections as per IS:8154/9458 & ASTM C 533.	250	750	0.6
C)	Ceramic Fibre Blanket Insulation as per IS : 15402	128	750	0.76 at 200°C
D)	Ceramic Fibre Pad Insulation	128	750	0.76 at 200°C
E)	Inner layer Ceramic Fibre and subsequent outer layers Rockwool Insulation	128 & 150	501-750	0.76 at 200°C
F)	Ceramic Fibre Rope 18-24mm for Insulation of Impulse / Small dia pipelines (1 ½ inch & below) as per IS : 15402	250	750	0.76 at 200°C

Please also refer Thermal Conductivity Values at different mean Temperatures.

NOTES:

1. Insulation material manufactured from slag is not acceptable.
2. Bonding agent will not be more than 4.5% by weight in the insulation material.
3. Insulation material on application directly over austenitic stainless steel (upto 450°C) shall not contain leachable chloride more than 10 ppm. For application on C.S. & A.S. surfaces and on S.S. surfaces covered with aluminium foil (upto 450°C), leachable chloride in the insulation material up to 100 ppm could be permitted. In case of calcium silicate, suitable corrosion inhibitor (sodium silicate) shall be added and sodium silicate content shall not be less than 20 ppm for each ppm of leachable chloride. Factory inhibited insulation shall be preferable, whereby sodium silicate solution will be sprayed on to the Insulation at factory.
4. Where foot traffic is expected on the insulated surface, the minimum density of applied insulation will be 150 Kg/m³ irrespective of temperature.
5. Sprayable Mineralwool as per IS: 9742 or Ceramic Pads as per IS:15402 may be considered for irregular shaped equipments like turbines, pumps, valves, flanges etc.
6. All optional requirements as per cl.3.10.3, 3.10.5, 3.10.6, 3.10.7 of IS: 8183 and cl.3.12.1, 3.12.4 of IS: 9842 shall be complied with.
7. Large pipe means pipe having nominal size 26" NB and higher.
8. Pipe sections shall be applied up to 14" NB Dia pipelines.
9. For multi layer insulation, only first layer to be pipe sections and subsequent layers with mattress insulation.

10. For water prone areas Water Repellant Grade insulation to be used as per BS: 2972.

2.2 AUXILIARY MATERIALS

2.2.1 Paints

- a) Heat resisting (for application on S.S. surface Hot Service)

Type	Single pack
Composition	Silicon resin based with aluminium flakes as pigment.
Dry film thickness	20 microns / coat (minim.)
No. of coats	2 coats
Other requirement	It should be suitable to with stand temperature up to 550°C.

2.2.2 Insulation Cement

This is used for filling voids & surface irregularities. This shall be high grade mineral wool/calcium silicate plastic composition based cement having a volumetric shrinkage not exceeding 20% of wet coverage and with a max thermal conductivity of 0.01 mw/cm degree C at 205°C mean temperature.

2.2.3 Hard Setting Plaster

Hard setting plaster shall be a mixture of cement sand or cement mineral fibre or plaster of paris - mineral fibre. This will be applied over the specified wire netting/chain link mesh. The plaster shall conform to IS: 9743.

2.2.4 Wire (for netting, lacing or stitching)

Wire netting for machine stitched mattresses shall be galvanized steel wire of dia 0.56 mm (minimum) making 25 mm hexagon meshes. Lacing wire to bind the ends of wire netting shall be galvanized steel wire of minimum dia 0.56 mm.

2.2.5 Banding Wire

Wire for securing insulating blankets or sections shall be galvanized soft, annealed steel wire of 1.625 mm diameter for pipes and 2.640 mm dia for vessels.

2.2.6 Lacing Wire

Lacing Wire to stitch wire netting of adjacent mattresses shall be of G.I. wire of 22 SWG.

2.2.7 Bands for securing Insulation material

Shall be aluminium or S.S. 20x0.5 mm. For spherical surfaces only S.S. bands will be used.



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2.2.8 Foil for wrapping S.S. surfaces

Aluminium foil of 0.1 thicknesses, free from pin holes.

2.2.9 Spacer Ring

1. Spacer rings shall be provided when mattress insulation is used to provide frame work on which aluminium sheeting (Refer Fig. 1) used for protecting the insulation, is cladded. These rings shall be fabricated from 25 x 3 mm MS flats.

Spacer rings are not required when pipe lines are insulated with performed pipe section.

The outside dia of these rings shall be equivalent to the diameter of the pipes/vessels measured over the insulation. Spacer rings shall not be required when insulation in the form of performed rigid pipe sections is used.

2. Spacer rings may not be used for pipes where insulation O.D. is less than 150 mm.
3. Spacer rings shall be provided with “Z” shaped stays fabricated from the same size MS flats. Stays shall be provided at intervals of not more than 300 mm along the circumference of the insulation, subject to a minimum of 3 stays spacer rings shall be provided on the pipes at a pitch of not more than 900 mm.
4. To minimize direct heat conduction through the stays, a packing of 2 sheets of 3 mm thick Ceramic Fibre Paper (density 320 kg/m³) shall be provided at the joints of the stays and pipes, while the joints of stays and MS rings shall be riveted by 6 mm dia. MS rivets with 2 sheets of 3 mm thick Ceramic Fibre paper interposed as shown in Fig. 1.

2.2.10 Aluminium cladding with inner side coated with Polysurlyn coating – As per TS: 6700

2.2.11 Heat transfer putty (viz. thermo bond) for tracers.

3.0 APPLICATION OF INSULATION

3.1 THICKNESS OF INSULATION

Insulation thickness shall be as specified in the insulation schedule/specification/isometric drawings prepared for equipments/piping. Wherever the thickness is not indicated the same may be selected from Table – I.

3.2 GENERAL REQUIREMENT

3.2.1 Extent of Insulation

- All steam traced lines, steam jacketed piping and vessels shall be insulated.
- Stem trap and piping downstream of it shall not be insulated.
- Turbines, pumps and compressors operating below 120°C shall not be insulated unless otherwise specified.
- Flanges & flanged valves on lines operating above 65°C but below 200°C shall normally not be insulated expect for personnel protection. In such cases, insulation shall terminate at such a distance from the joints as to provide sufficient space for removal of bolts.



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- Drain and vent piping for hot service up to the first valve on insulated equipment shall be insulated with similar type of insulation and finish as the equipment to which attached.
- Steam supply headers, and tracer lines used for steam tracing as shown on steam trap hook-ups shall be insulated.
- All instruments which are steam traced shall be insulated for heat conservation.
- All sample connections and drains on steam lines shall be insulated.
- All name plates and vessel markings should remain visible.

3.2.2 Insulated of S.S. Surface

For operating temperatures up to 450°C the stainless steel surface shall be wrapped with Minimum 0.05 mm thick aluminium foil with 50 mm overlap at longitudinal and circumferential joints before application of insulation. All joints of the aluminium foil shall be lapped and sealed to be Proof against leakage. Aluminium foil shall be firmly secured on to the stainless surfaces by aluminium bands at a pitch of 450 mm. Care shall be taken while applying aluminium foil over the pipes to ensure that the foil is not punctured at any place during wrapping and clapping with aluminium bands.

For operating temperatures from 451 to 550°C, the stainless steel surfaces shall be painted with two coats of heat resistant paint before application of insulation. When the paint becomes dry, the painted surfaces shall show no discontinuity.

In case of factory made inhibited grade insulation within 10 ppm, same can be applied directly on to the SS surface upto 450°C

3.3 INSULATION PROCEDURE

The application procedure described in for rock/glass wool. For other insulations, the application procedure shall be submitted by the tenderers.

3.3.1 Vessels and Columns

3.3.1.1 General

Insulation blankets shall be applied with the retaining wire mesh exposed on the outside. The edges of blankets shall be well butted up to each other and laced together with galvanized wire and secured to the vessel with circumferential bands as shown in Fig. 2, 3, 4 & 5 when two layers are to be applied the first layer may be secured by means of galvanized wire in lieu of the bands.

On flat surfaces, blankets/blocks/slabs shall be applied by impaling them over 9 gauge galvanized wire pins welded perpendicular to the surface. The extending ends of the wires shall then be bent upward at right angles and pressed into the blanket. The edges of blankets shall be tightly butted and laced together with galvanized wire. Where more than one layer of insulation is applied, securing bands of the layers shall not coincide with each other. All joints in successive layer shall be staggered.

3.3.1.2 Vessel Heads

Insulation on heads shall be secured by radial bands from a floating ring centered at the crown of head and tied to a circumferential band placed approx 300 mm inside the tangent line on insulation O.D. Ref. Fig. 2. On to heads of vertical vessels, these radial bands protecting the blanket insulation shall be provided with distance pins placed every 300 mm and of a length equal to insulation thickness. The pins shall be welded or riveted to the strip steel.

For bottom heads, in all skirt supported vessels insulation supports are provided inside the skirt as indicated in the equipment drawings. Floating rings or wire loops around the nozzle and bands may be used to support downward facing of insulation. Such a floating ring may be supported from the lagging support ring fixed inside the skirt. Blanket shall be shaped and secured on to the head by means of bands stretched across the floating ring and insulation support rings. The insulation shall be covered with galvanized wire netting firmly laced together and secured in place. Insulation details shall be as per Fig. 6. All wire ends shall be cut short and turned into the insulation.

For vertical vessels having temperatures more than or equal to 450°C, the upper 600 mm of the supporting skirt shall be insulated both on inside and outside.

3.3.2 Tanks

The details of support cleats will be as indicated in Fig. 7.

- Mineral wool mattresses faced with galvanized iron wire netting shall be pressed onto the supporting pins of 8 SWG GI wire. All joints shall be closely butted as shown in Fig. 7 A, B.
- For the top of tank the following procedure shall be adopted where angle supports/wire lugs are not provided by fabricator. All these will be supplied by insulation contractor.
- Laying of central and peripheral angle rings and details are shown in fig. 3, 3a, 3b.
- Welding M6 studs of length $T + 6$ mm (where T = thickness of insulation) at 300 mm pitch to MS flats shall then be laid on the tank top connecting the central and peripheral rings riveted/welded at both ends. Fix the 15 x 6 mm flat cross stiffeners with stud welded.
- Fix resin bonded mineral wool slabs of required thickness by pressing on to the studs.
- Stretch 20 SWG chain link mesh, anchoring it to the M.S. studs by means of speed washers.
- Apply approx. 19 mm thick hard setting plaster trowelled to a smooth and even finish.
- When hard setting compound is completely dry apply a standard four course bitumen felt, water proof treatment as per IS: 1346 or 3mm thick APP modified Bitumen Felt.
- Fix a “shed-water” shroud constructed from 200 galvanized iron plain sheet at the periphery of the tank. This shall be fitted prior to the application of the hard setting compound.

3.3.3 Heat Exchangers

Exchangers shall be insulated with insulation mattresses as specified for vessel. Channels and channel covers will be insulated with removable aluminium covers lined with insulation. Unless otherwise mentioned flange bolting shall be left un-insulated for hot service ref. Fig. 4.

3.3.4 Machineries like pumps, turbines, compressors etc.



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In general these will be insulated in such a way that the same is of removable type to allow easy maintenance. The contractor shall supply insulation detail to engineer-in-charge for approval.

3.3.5 Piping

a) General

- Vertical lines shall be provided with welded support rings Ref. Fig. 8 spaced at approximately 4000 mm. Expansion/contraction joints shall be provided under each support ring for hot./cold service.
- Insulation around support shoes etc. shall be trimmed closely and thoroughly sealed with vapour seal mastic. For hanger support special care shall be given for weather proofing jacket and sealing mastic. Ref. Fig. 9 & 10.

b) Hot Service

The performed pipe section of required thickness shall be fixed on the pipe surface with the help of 20 mm x 24 SWG aluminium band.

The blankets shall be wrapped round the pipe closely, completely covering the outer surface. Edges shall be tightly butted and laced with galvanized wire Ref. Fig. 11 & 12. The blankets shall be secured in place with galvanized bands/wires spaced at 300 mm. Ends of the wire loops shall be twisted and pressed back into the insulation. All voids, irregularities and joints shall be painted up and trowelled smooth with insulations cement. Longitudinal joints in jackets on horizontal pipes shall be located 30° below center line of pipe. Spacer rings as shown in Fig. 1 shall be installed at 100 mm interval to support the jacket.

In consideration of possible pipe line movement with change in fluid temperature different pipes should be separately insulated.

For temperatures above 500°C, combination of first layer Ceramic Fibre (25mm) followed by Rockwool Mattress will be tied with SS bands.

Flanges, valves & expansion joints shall be insulated with removable type pad arrangement as per requirement of TS: 6700.

For Small dia pipes of 1 inch & below Ceramic Fibre rope (18-24mm dia) may also be used and covered with Aluminium tape wherever exposed to atmosphere.

c) Steam Traced Lines

The steam traced line shall first be wrapped with 24 SWG x ¾" hexagonal mesh GI wire netting so that it passes round the supporting hooks for the tracer line or lines. Thus ensuring tracer pipe bearing tightly against the line which is steam traced. This prevents the insulating material from entering the air jacket formed between the insulation and the pipes. The details are give in Fig. 13 & 14. In case of steam traced lines with thermo-bond or with Al foil the material supply and application, as per ES: 6016 will be in the scope of insulation contractor.

For stainless steel main lines having steam tracer, the method of application of insulation shall be the same as described in above except that an aluminium foil, shall be wrapped round the main pipe and tracer pipe as per the procedure described in clause 3.3.2.



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For Electric traced lines, the tracer wires to be wrapped over the pipes and held in position with aluminium tape. Subsequently insulation mattress to be applied and tied with bands.

- 3.3.6 Aluminium cladding with inner side (in contact with insulation) coated with Polysurlyn shall be applied over the finished insulation surface as per TS:6700.

**TABLE-1
INSULATION THICKNESS (MM) FOR HOT SERVICE**

DESIGN CRITERIA

AMBIENT TEMPERATURE	:35 Deg. C
SURFACE TEMPERATURE	: 60 Deg. C
WIND VELOCITY	: 1 m/s
DESIGN HEAT LOSS	: 150 Kcal/hr.m ²
MATERIAL	: ROCKWOOL (Density =100 Kg/m ³ up to 400 Deg. C & 150 Kg/m ³ from 401-650 Deg. C as per IS 8183 Gr. 3)

OPERATING TEMPERATURE (Deg. C)														
HOT INSULATION												PERSONNEL PROTECTION		
PIPE DN (MM)	<=150	151-200 °C	201-250 °C	251-300 °C	301-350 °C	351-400 °C	401-450 °C	451-500 °C	501-550 °C	551-600 °C	601-650 °C	UPTO 250 °C	251-400 °C	401-500 °C
15	25	25	35	40	50	60	70	80	80	95	110	30	30	30
20	25	25	35	45	55	65	75	85	85	100	115	30	30	30
25	25	30	35	45	55	65	80	90	90	105	125	30	30	30
32	25	30	40	50	60	70	80	95	95	110	130	30	30	30
40	25	30	40	50	60	70	85	100	100	115	135	30	30	30
50	25	30	40	50	60	75	90	105	105	125	140	30	30	30
65	25	30	40	55	65	80	90	105	110	130	150	30	30	30
80	25	30	45	55	65	80	95	110	115	135	155	30	30	30
100	25	35	45	55	70	85	100	120	125	145	165	30	30	40
125	25	35	45	60	75	90	105	125	130	150	175	30	30	40
150	25	35	45	60	75	90	110	130	135	160	185	30	30	40
200	25	35	50	65	80	95	115	135	145	170	200	30	30	50
250	25	35	50	65	80	100	120	145	155	180	210	30	40	50
300	25	35	50	65	85	105	125	150	160	190	220	30	40	50
350	25	35	50	65	85	105	130	150	160	190	225	40	40	50
400	25	35	50	70	90	110	130	155	165	195	230	40	40	50
450	25	40	55	70	90	110	135	160	170	200	235	40	40	50
500	25	40	55	70	90	110	135	160	175	205	240	40	50	50
550	25	40	55	70	90	115	135	160	175	210	245	40	50	50
600	25	40	55	75	90	115	140	165	180	210	245	40	50	50
>600/ Flat Surface	25	40	60	80	100	130	160	195	220	270	325	40	50	50

NOTE 1: For temperatures above 500deg.C,first layer of 50mm Ceramic Fibre Blanket of density 128 kg/m³ to be applied and subsequent layers with Rockwool Mattress
2- Flat surface includes Equipments and large dia pipes (DN>600).

TABLE -2

INSULATION THICKNESS (MM) FOR HOT SERVICES

DESIGN CRITERIA

AMBIENT TEMPERATURE :35 Deg. C

SURFACE TEMPERATURE : 60 Deg. C

WIND VELOCITY : 1 m/s

DESIGN HEAT LOSS : 150 Kcal/hr.m²

MATERIAL : CALCIUM SILICATE

OPERATING TEMPERATURE (Deg. C)											
HOT INSULATION											
PIPE DN (MM)	<=150 °C	151-200 °C	201-250 °C	251-300 °C	301-350 °C	351-400 °C	401-450 °C	451-500 °C	501-550 °C	551-600 °C	601-650 °C
15	25	35	45	50	60	70	80	90	105	120	135
20	25	35	45	55	65	75	85	95	110	125	145
25	30	40	45	55	65	75	90	100	115	135	150
32	30	40	50	60	70	80	95	110	125	140	160
40	30	40	50	60	70	85	95	110	125	145	165
50	30	40	55	65	75	90	100	115	135	150	175
65	30	45	55	65	80	90	105	120	140	160	180
80	35	45	5	70	80	95	110	125	145	165	190
100	35	45	60	70	85	100	115	135	155	175	200
125	35	50	60	75	90	105	120	140	160	185	215
150	35	50	65	75	90	110	125	145	170	195	225
200	35	50	65	80	95	115	130	155	180	210	235
250	35	50	65	85	100	120	140	165	190	220	250
300	35	55	70	85	105	125	145	170	195	225	260
350	35	55	70	85	105	125	150	175	200	230	260
400	35	55	70	90	110	130	150	175	205	235	270
450	35	55	75	90	110	130	155	180	210	240	275
500	40	55	75	90	110	135	155	185	210	245	280
550	40	55	75	95	115	135	160	185	215	250	285
600	40	55	75	95	115	135	160	190	220	255	290
>600/ Flat Surface	40	60	80	105	130	160	190	230	275	325	385

Note Flat surface includes Equipments and large dia pipes (DN>600).



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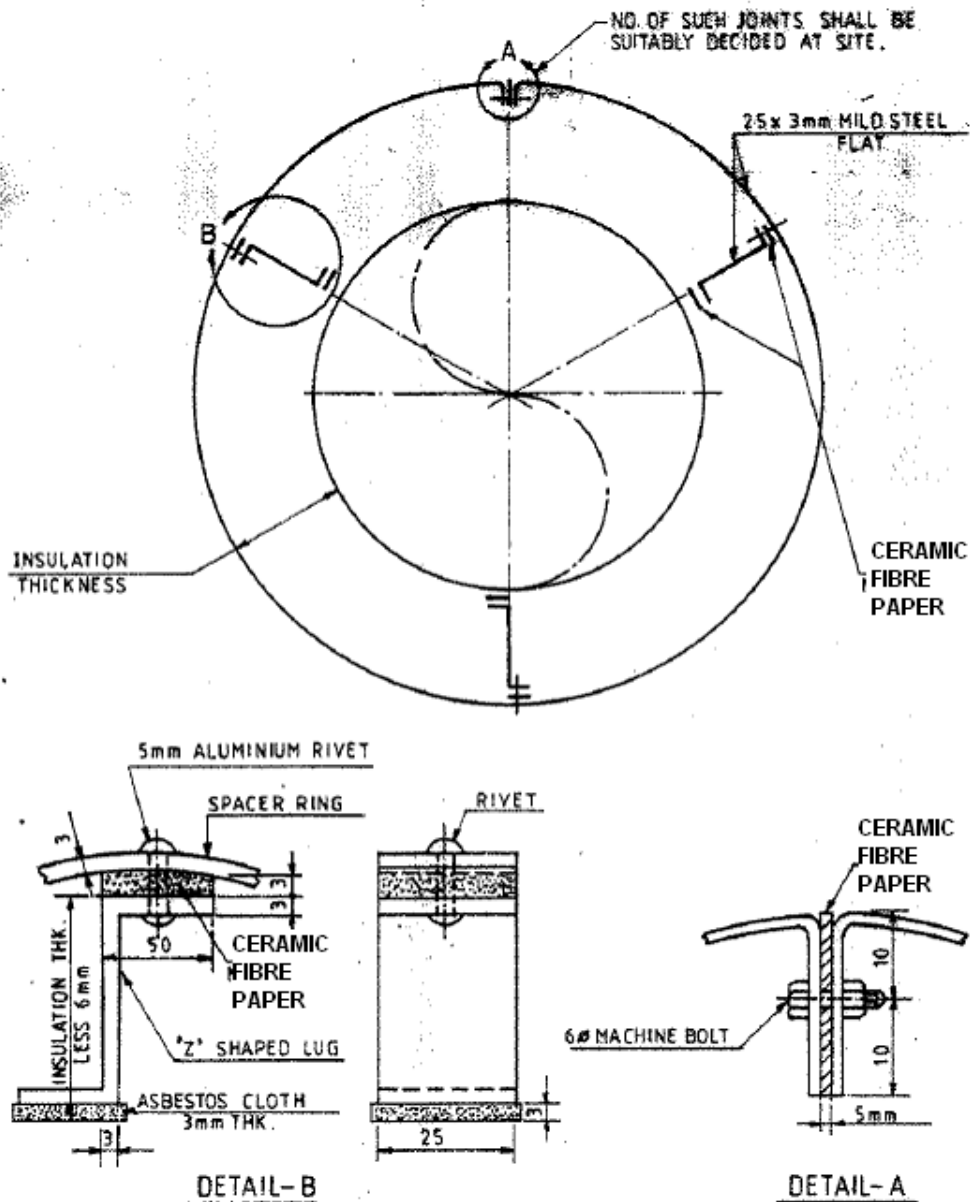
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Thermal Conductivity Table for Insulation Materials

Sl.No .	Mean Temp. Deg.C	Rockwool			Rockwool			Calcium Silicate		Ceramic Fibre	
		Density-100kg/m ³ IS 8183			Density-150/144 kg/m ³ IS 8183/9842			Density-250 kg/m ³ IS 8154		Density -128 kg/m ³ IS 15402	
		w/mk	<u>mW/c</u> m	kcal/mhr	w/mk	<u>mW/cm</u>	<u>kcal/mh</u> r	w/mk	<u>kcal/mh</u> r	w/mk	<u>kcal/mh</u> r
		-	<u>deg. C</u>	<u>deg C</u>	-	<u>deg. C</u>	<u>deg C</u>	-	<u>deg C</u>	-	<u>deg C</u>
1	100	0.052	0.52	0.0447	0.052	0.52	0.0447	0.06	0.052		
2	150	0.062	0.62	0.0533	0.062	0.62	0.05331	0.07	0.06		
3	200	0.073	0.73	0.06276	0.068	0.68	0.05795	0.08	0.069	0.076	0.06535
4	250	0.084	0.84	0.07222	0.08	0.8	0.06878	0.09	0.077		
5	300	0.095	0.95	0.08168	0.09	0.9	0.07738	0.1	0.086	0.081	0.06964
6	400									0.122	0.1049
7	500									0.15	0.12897



DETAILS OF SPACER RING

FIG. I

NOTE:- SPACER RINGS SHALL NOT BE REQUIRED WITH PREFORMED PIPE SECTION.

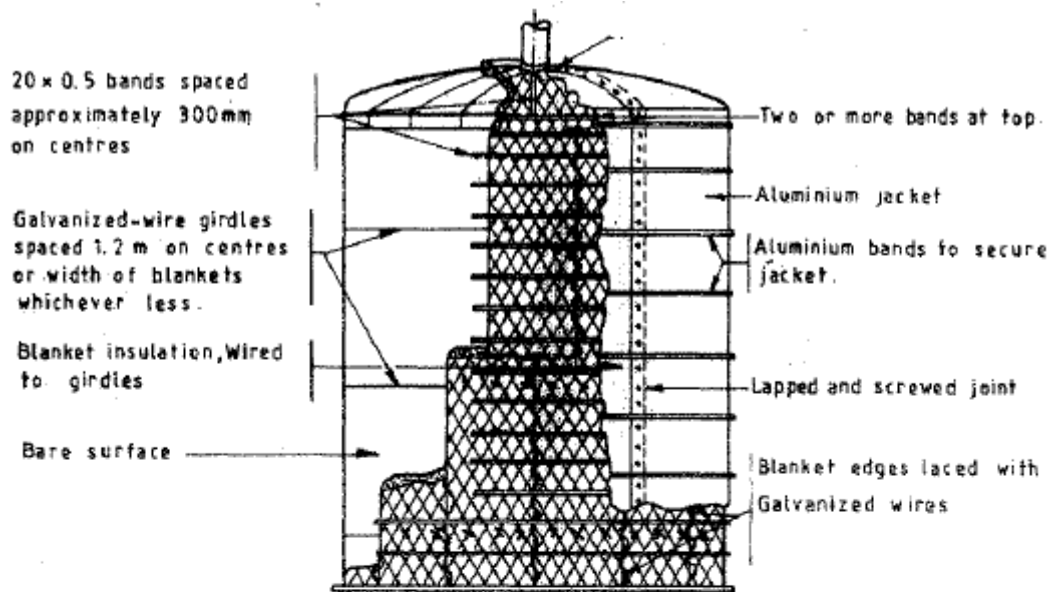


FIG. 2 Application of mineral wool blanket insulation for tanks 3 m dia and above.

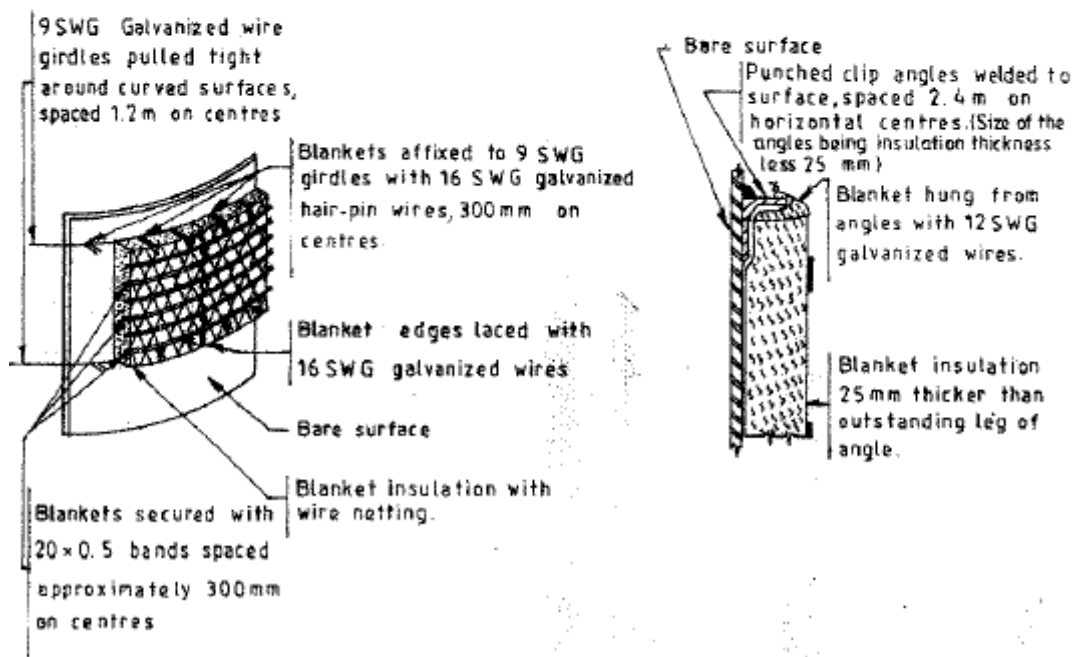
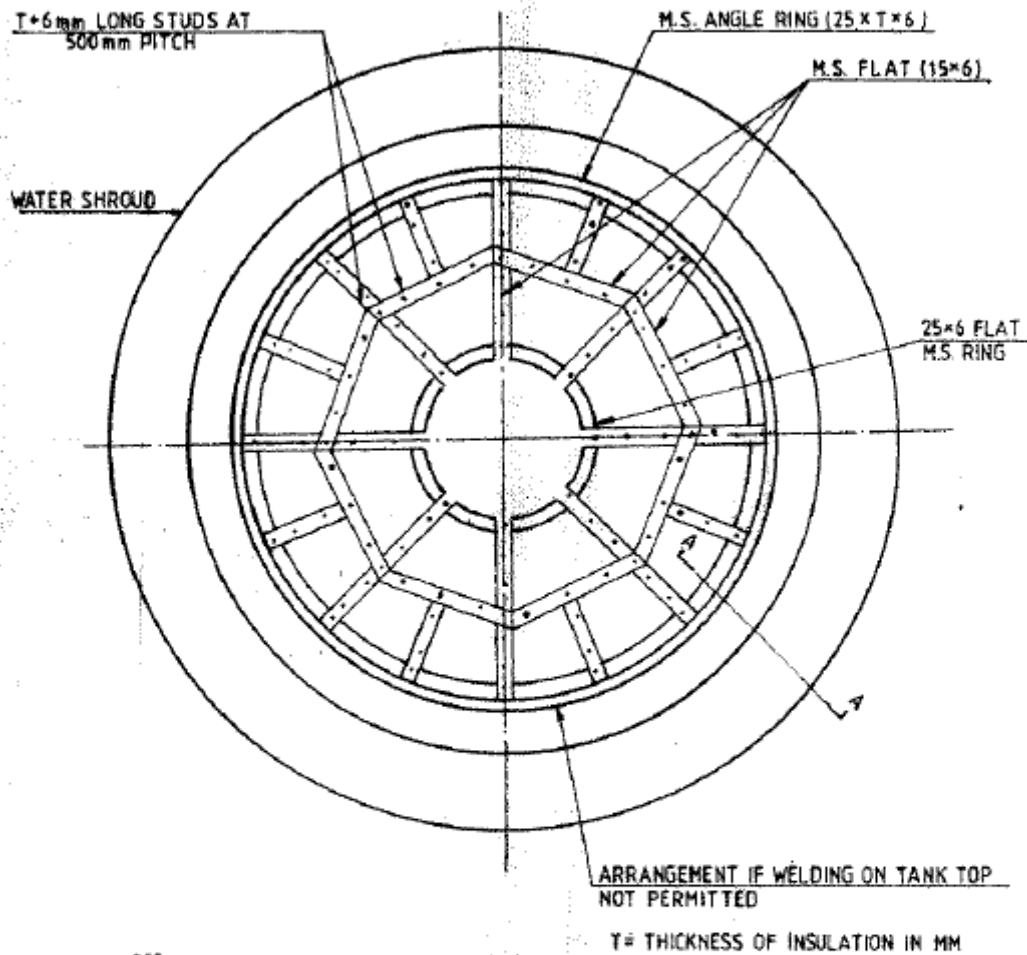
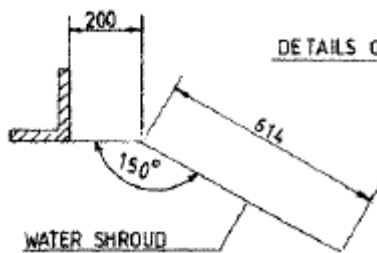


FIG. 3 Methods of fixing mineral wool blankets

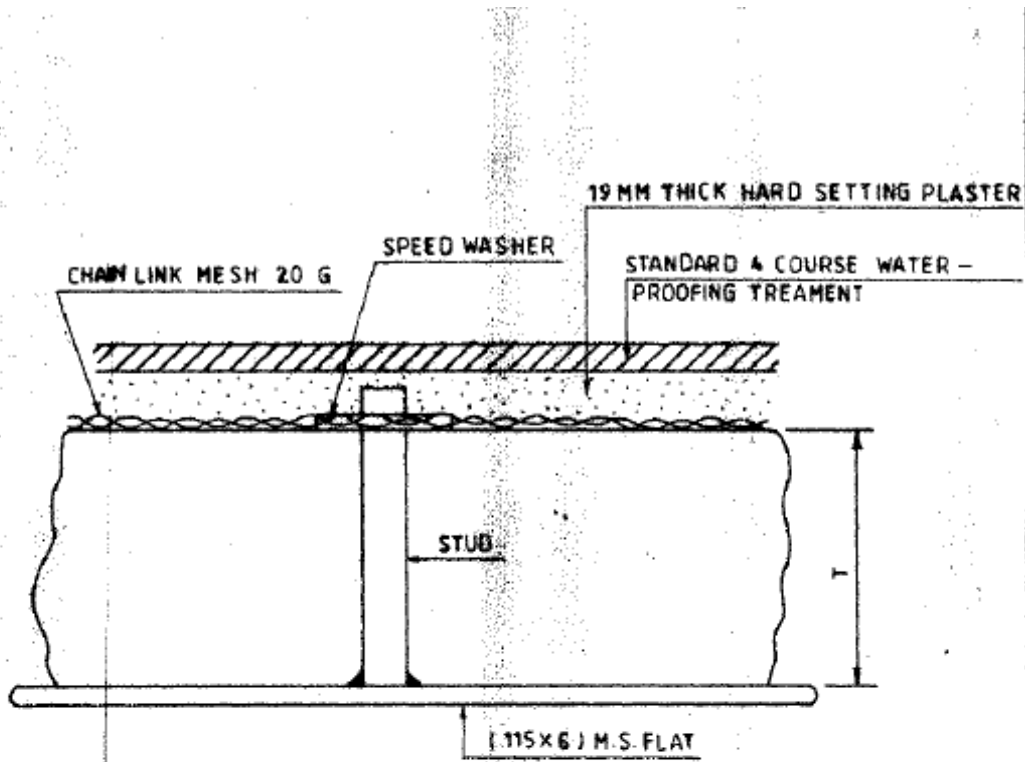


DETAILS OF TANK ROOF INSULATION SUPPORTS



SECTION A-A

FIG. 3a



T = THICKNESS OF INSULATION IN MM.

DETAILS OF TANK TOP SETTING PLASTER FINISH

FIG. 3b

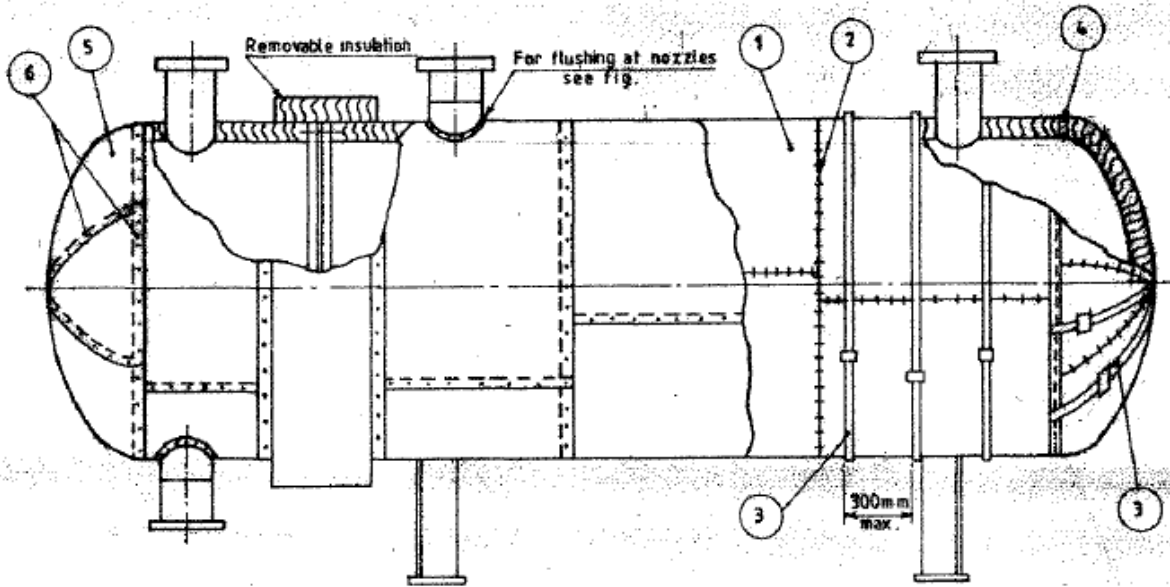
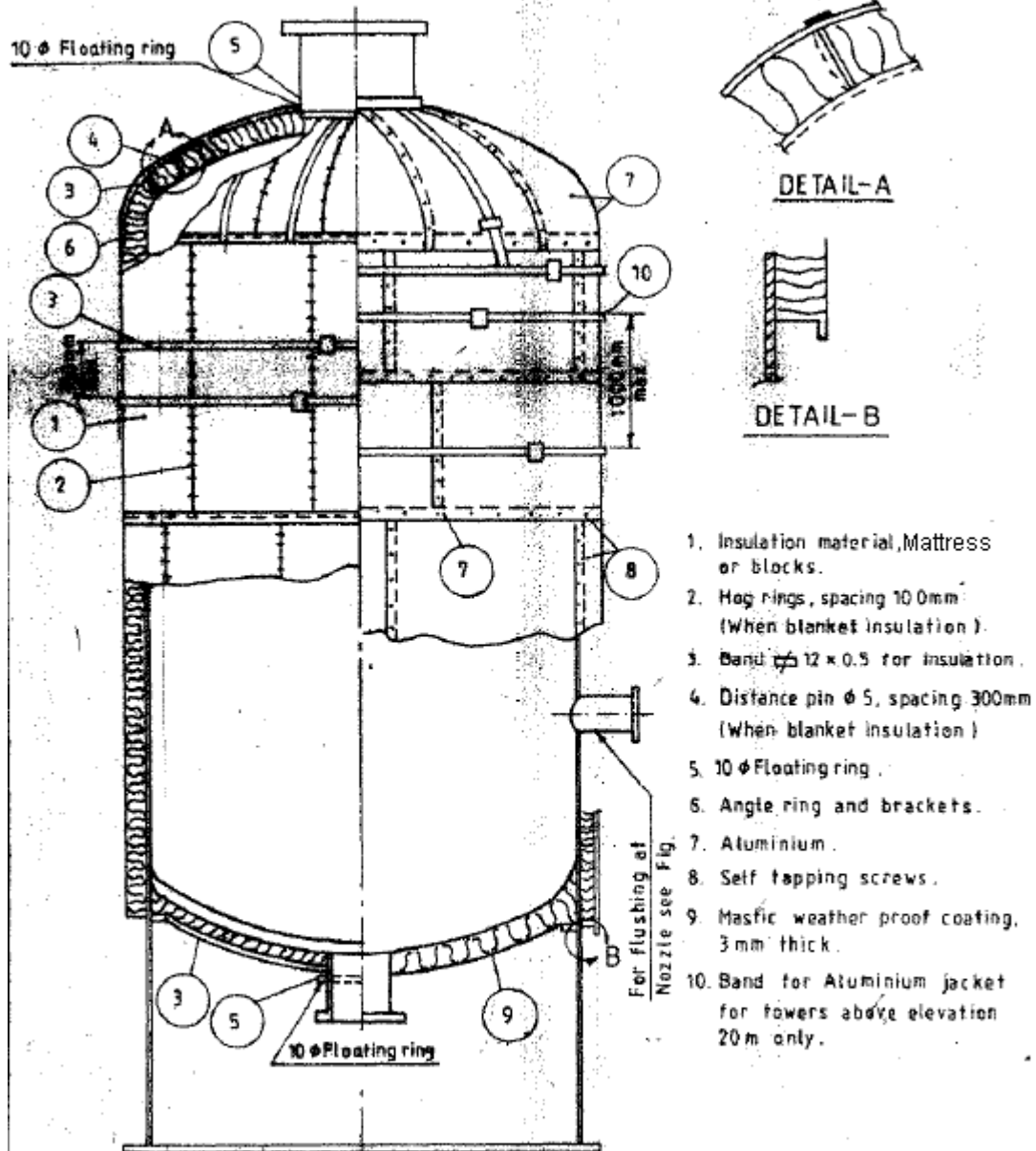


FIG. 4 HORIZONTAL VESSELS AND EXCHANGERS-HOT INSULATED

1. Insulation material blankets or blocks
2. Hog clips spacing 100mm (When blanket insulation)
3. Band ϕ 20 x 0.5
4. Angle ring and brackets
5. Aluminium jacket
6. Self tapping screws



**FIG. 5. VERTICAL VESSEL S/ EXCHANGER –
HOT INSULATED**

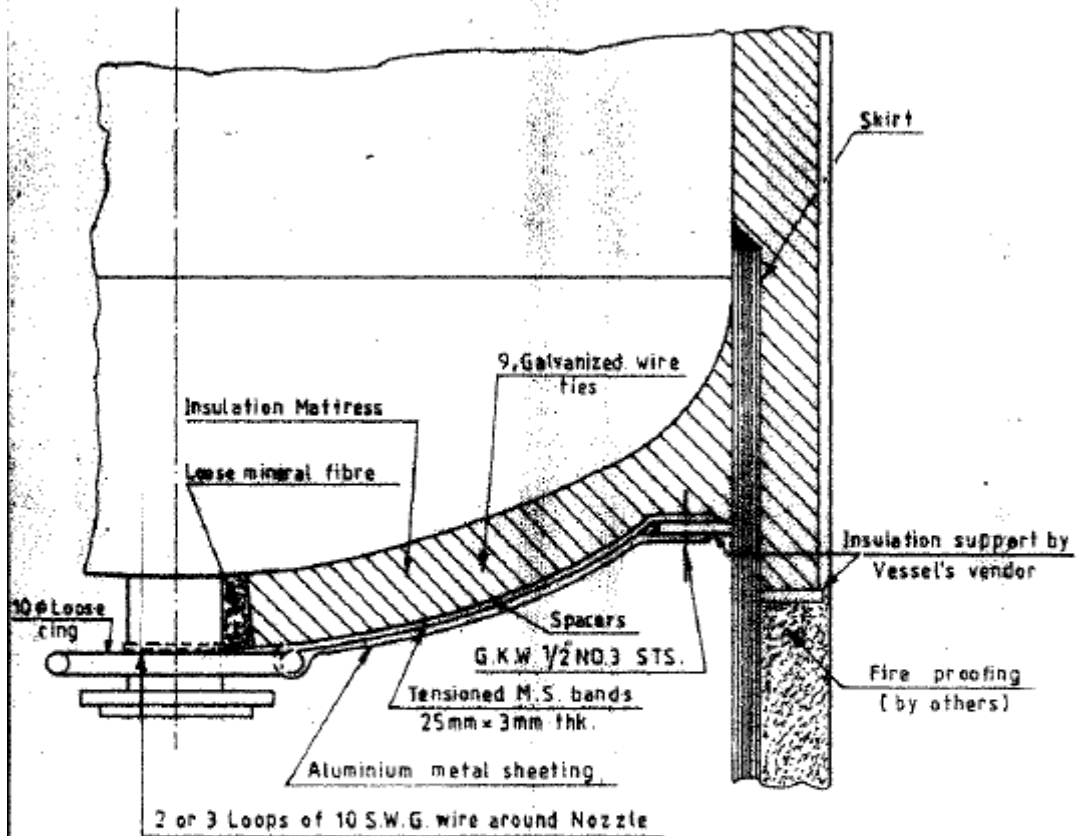
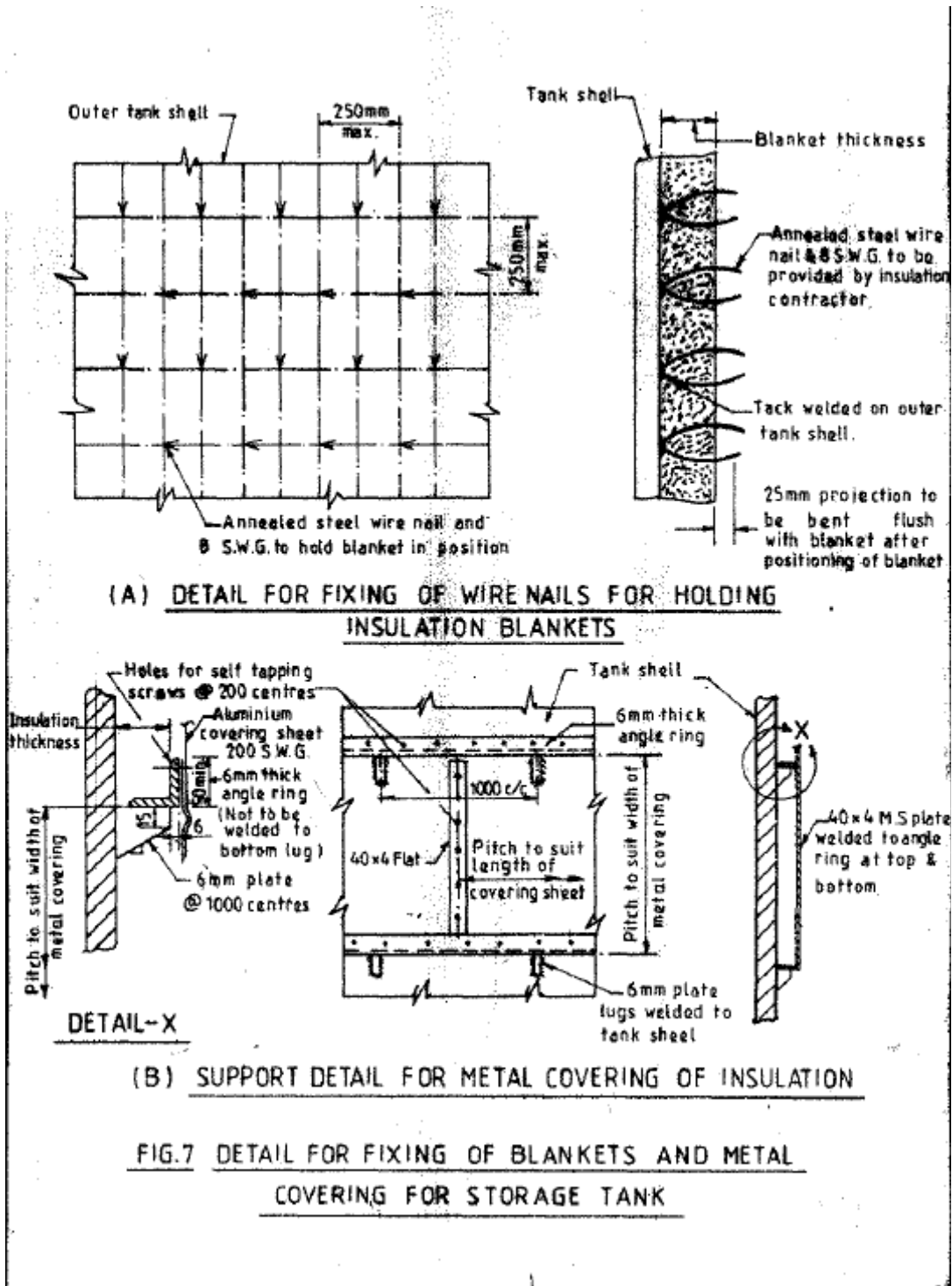
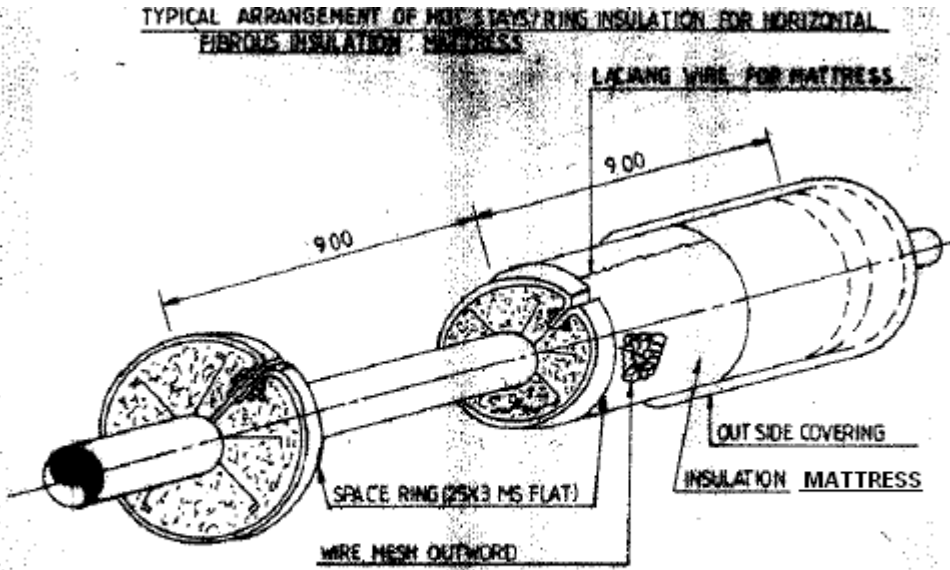


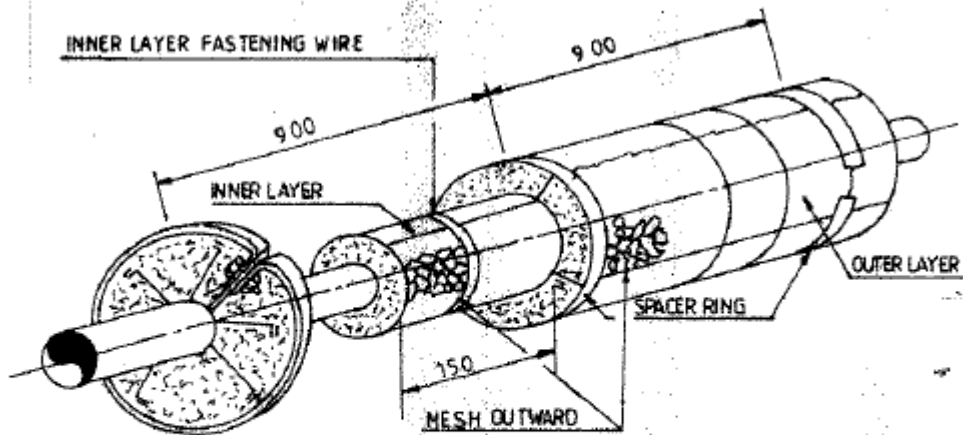
FIG. 6 BOTTOM HEAD WEATHER PROOFING
FOR VERTICAL VESSELS





SINGLE LAYER MATTRESS INSULATION WITH ALUMINIUM SHEET FINISH.

FIG. 8 c



MULTIPLE LAYER FIBROUS INSULATION. SPACER RING FOR HORIZONTAL PIPE

FIG. 8 d

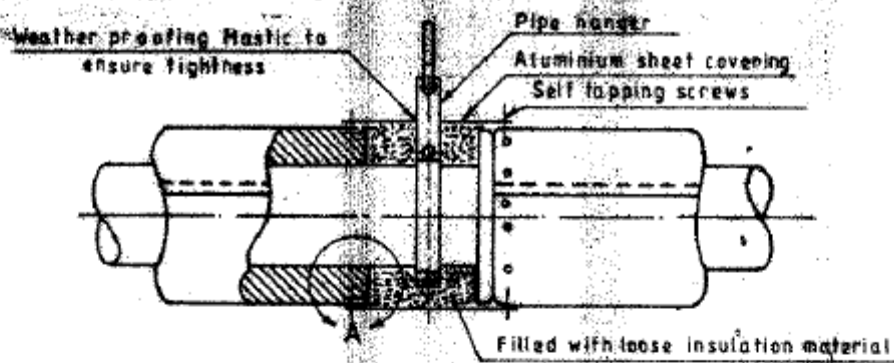
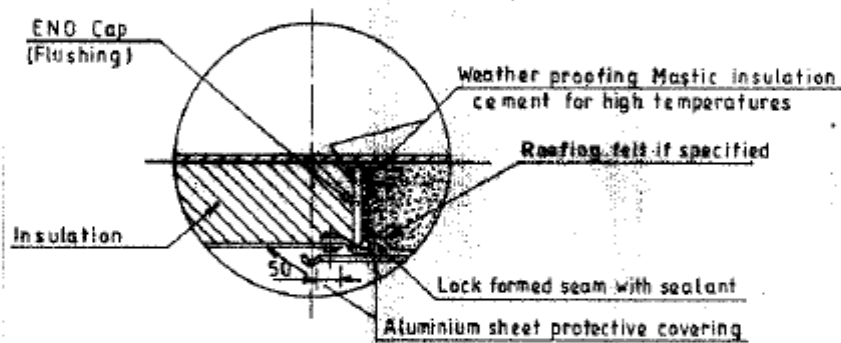


FIG. 9 HANGER SUPPORT (Hot service)



DETAIL-A

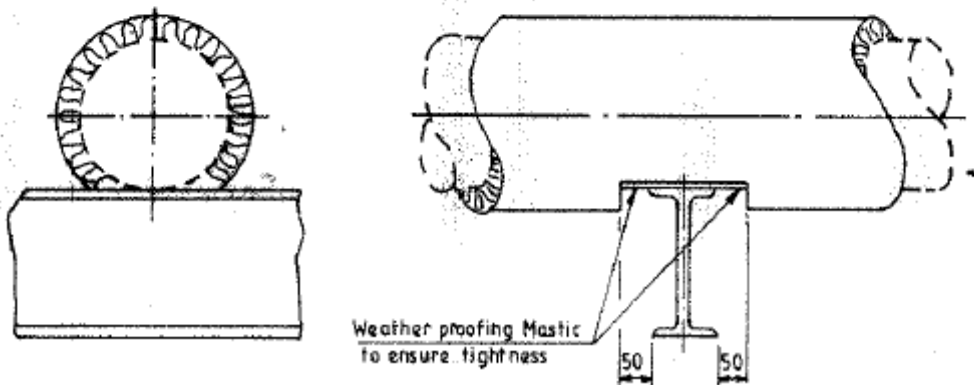


FIG.10 RESTING SUPPORT (Hot service)

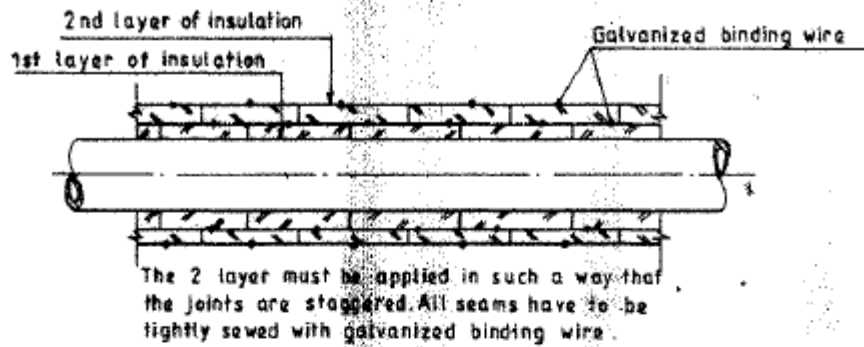
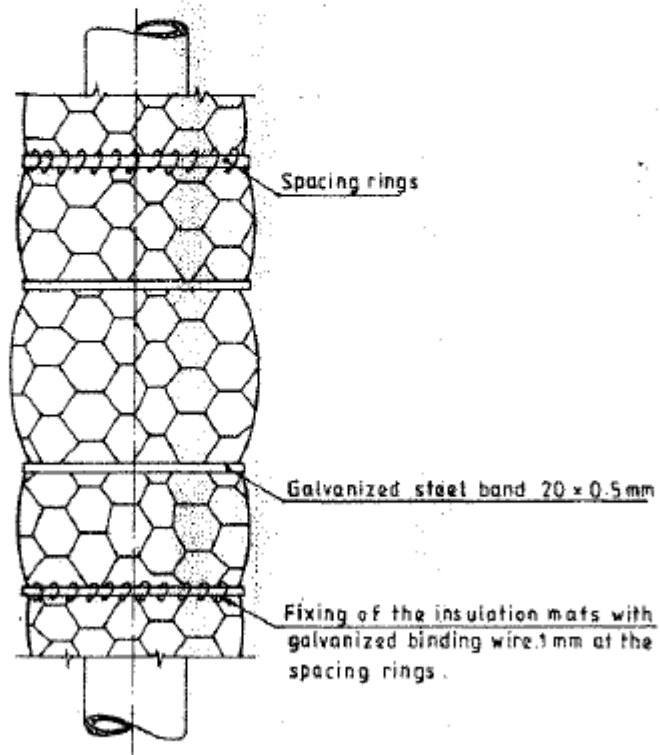


FIG.11 DOUBLE THICKNESS INSULATION



**FIG.12 APPLICATION OF INSULATION MATS
ON VERTICAL LINES**

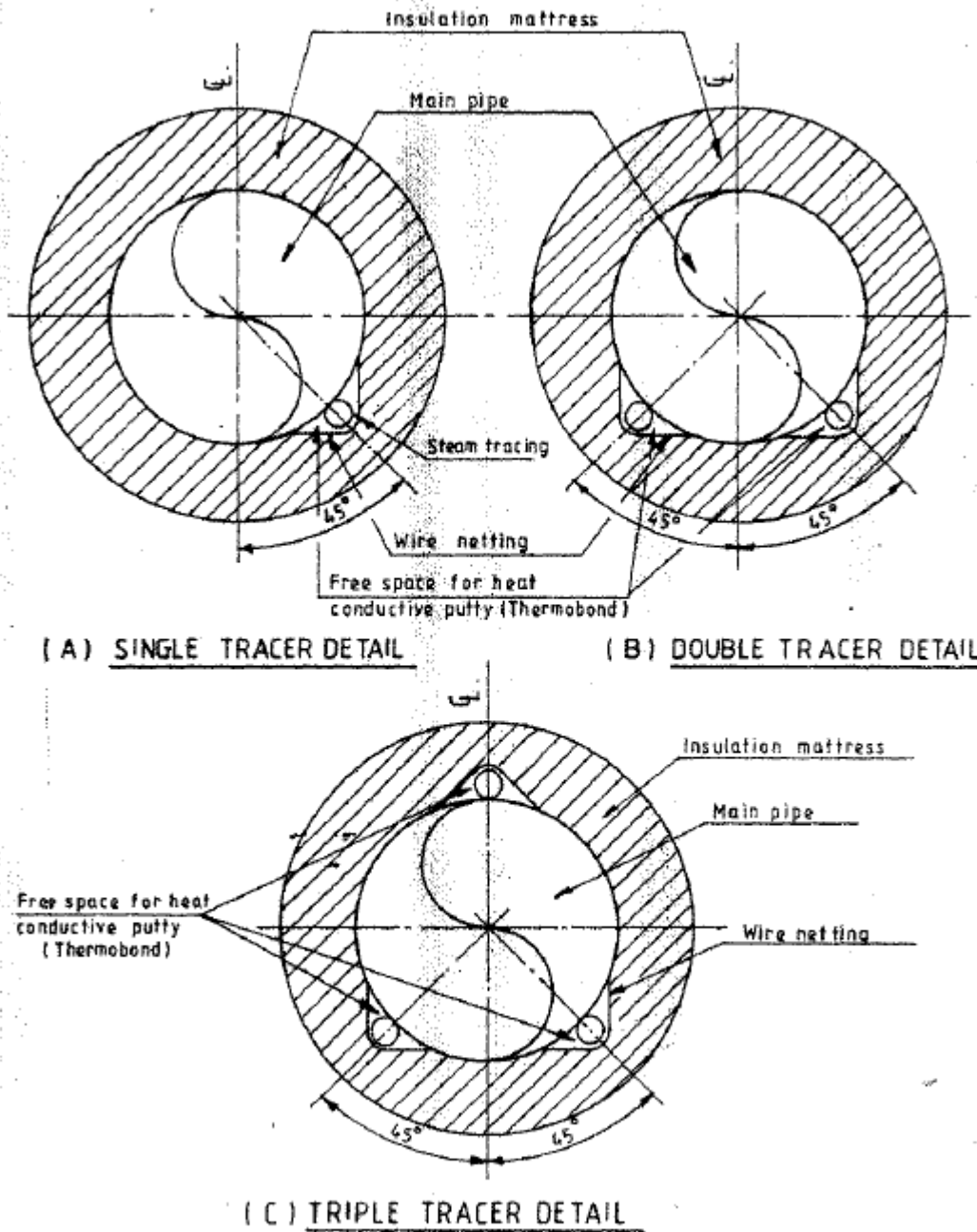
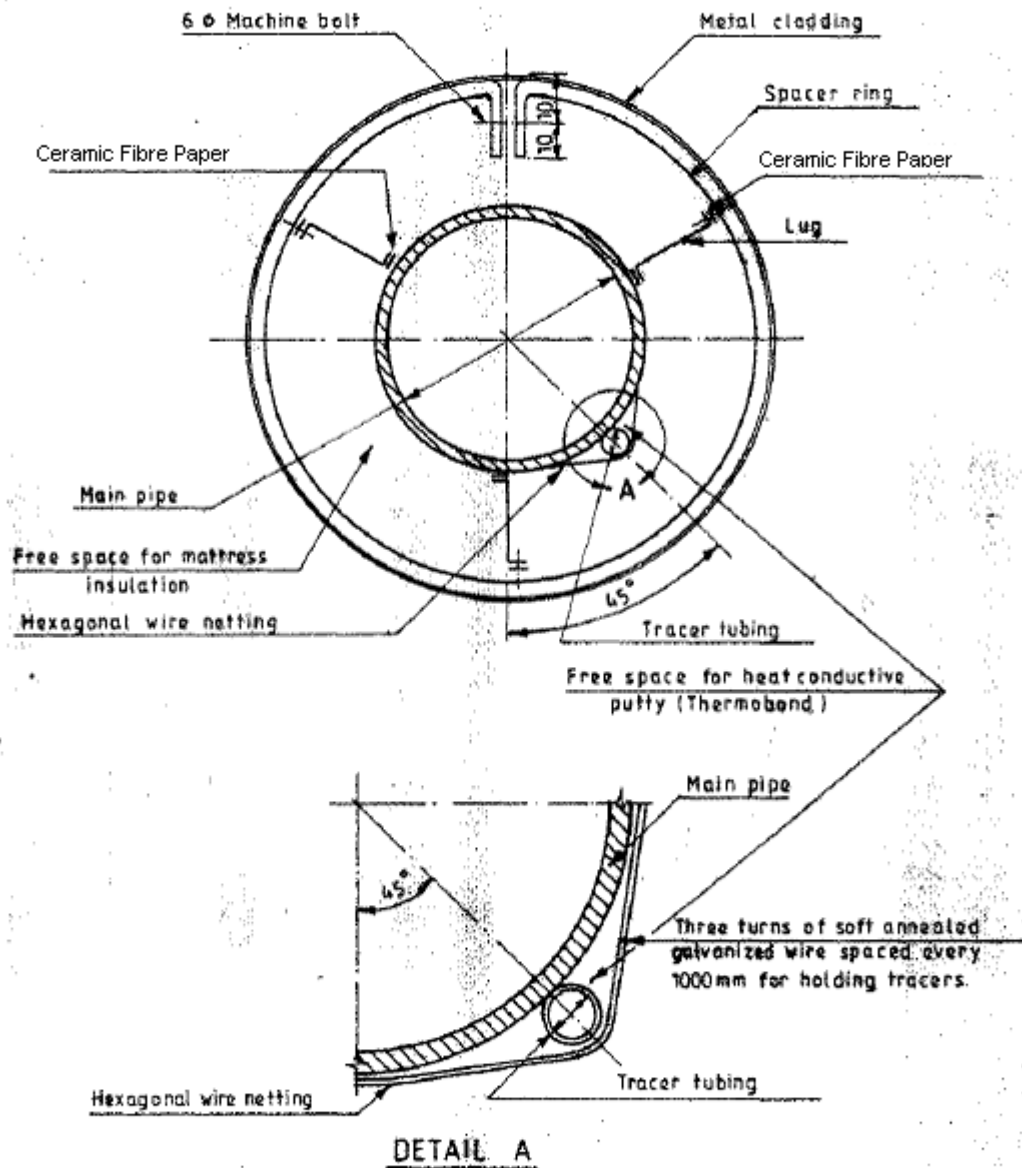


FIG.13 STEAM TRACING INSULATION



**FIG.14 DETAILS OF INSULATION ON STEAM TRACING
(WITH SPACER RING)**



**TECHNICAL SPECIFICATION
FOR
THERMAL INSULATION
COLD SERVICE**

0	15.07.2013	ISSUED	Rupesh	AS	AMAR
P	27.06.2013	ISSUED FOR COMMENTS	Rupesh	AS	AMAR
REV	DATE	PURPOSE	PREPD	REVWD	APPD

CONTENTS

1.0 GENERAL

- 1.1 Scope
- 1.2 Reference Standards
- 1.3 Deviation
- 1.4 Limitations

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- 2.1 Insulation Materials
- 2.2 Auxiliary materials

3.0 APPLICATION OF INSULATION

- 3.1 Thickness of Insulation
- 3.2 Extent of Insulation
- 3.3 Insulation Procedure
 - 3.3.1 Vessels & Columns
 - 3.3.1.1 General
 - 3.3.1.2 Vessel heads
 - 3.3.1.3 Spherical Vessels
 - 3.3.2 Machineries (Pumps, Turbines, Compressors etc.)
 - 3.3.3 Piping
- 3.4 Weather Proofing
 - 3.4.1 Vapour seal mastic
 - 3.4.2 Protective layer for cold insulation



**TECHNICAL SPECIFICATION
THERMAL INSULATION – COLD SERVICE**

PC65-TS-6702

0

DOCUMENT NO

REV

SHEET 3 OF 13

1.0 GENERAL

1.1 SCOPE

This standard covers the requirement for supply and application of materials for cold insulation of equipment, piping and other items except Horton sphere.

1.2 REFERENCE STANDARDS

TS-6700	Thermal Insulation – General Requirements
IS:14164	Code of Practice for Industrial Application and finishing of thermal insulation Materials at temperatures - 80°C to 750° C.
IS:12436	Specification for preformed rigid Polyurethane and Poly-isocyanurate foams for thermal insulation.
IS : 13205	Specification for Cast-in-Situ Polyurethane and Polyisocyanurate Foams for Thermal Insulation
ASTM C-680	Standard Practice for Heat Loss or Gain and Surface Temperature.

1.3 DEVIATION

Should unforeseen difficulties arise to comply with requirements of this standard.

- Alternative materials and application techniques superior to the requirements of this standard may be submitted with complete details for approval of Owner.
- In case of contradiction between requirements of this standard and the NIT/work order, the latter will be followed.

1.4 LIMITATIONS

Temperature Limits

This standard deals with insulations applied externally on piping's/equipments etc. for working temperatures between -180°C to 20°C.



TECHNICAL SPECIFICATION THERMAL INSULATION – COLD SERVICE

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2.0 MATERIAL REQUIREMENTS

2.1 INSULATION MATERIALS

2.1.1 General

Whenever reference to any standard is made it is presumed that the latest revision as on date should be considered.

2.1.2 Specification and other requirements as per table below:

Polyurethane foam prefabricated sections conforming to IS: 12436 with the following characteristics:

Density	-	36+/-2 kg/m ³ (min)
Thermal conductivity	-	0.03 W/mK hr (0.026 kcal/m ² hr) at 50 ⁰ C mean temp Or 0.021W/mK (0.018 kcal/m ² hr) at 10 ⁰ C.
Horizontal Burning	-	IS: 11239 part 12/ BS: 4735 - Extent of burn 125 mm (max.)

Self extinguishing as per ASTM D 1692

Or

Poly isocyanurate foam prefabricated sections conforming to IS: 12436 having the following characteristics:

Density	-	32 +/-2 kg/m ³ (min)
Thermal conductivity	-	0.03 W/mK (0.026 kcal/m ² hr) at 50 ⁰ C mean temp. Or 0.021W/mK (0.018 kcal/m ² hr) at 10 ⁰ C
Horizontal Burning	-	IS: 11239 part 12/ BS: 4735. - Extent of burn 25 mm (max.)
Surface spread of flame	-	over claded surface (optional) Class I as per BS: 476 Part 7

Or

Polyurethane / Polyisocyanurate Cast-in-Situ application of density 45-60 kg/m³, thermal conductivity 0.03 W/mK (0.026 kcal/m²hr) at 50⁰C mean temp Or 0.023W/mK (0.020 kcal/m²hr) at 10⁰C to be applied over pipes, tanks and equipments upto -50⁰C.

NOTE:

In case of dual temp application where the system is expected to be steam cleaned or where the temp may rise occasionally beyond 120 deg C, first layer of bonded mineral wool as per IS:8183 of suitable thk to ensure interface temp. <100 deg C.

2.2 AUXILIARY MATERIALS:

2.2.1 Paints

a) Asphaltic/Bitumen base primer density about 1200 kg/cu.mtr (IS:1322)

2.2.2 Joint Sealer



**TECHNICAL SPECIFICATION
THERMAL INSULATION – COLD SERVICE**

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MAS-35 or Foster 30- 45.

2.2.3 Coating and vapour seal mastic
MAS- 130 or Foster 60 - 35coating.

2.2.4 Banding wire
Wire for securing insulation shall be galvanized, soft, annealed steel wire of 1.625 mm diameter.

2.2.5 Bands or straps for securing insulation material aluminium or S.S. 20x0.5mm thk. For spherical surfaces only S.S. bands shall be used.

2.2.6 Reinforcing fabric (for cold insulation) 10x10x5 micron mesh glass fabric

2.3 Insulation material, joint sealer, vapour seal mastic and glass fabric shall be approved by PDIL.

3.0 APPLICATION

3.1 THICKNESS OF INSULATION

Insulation thickness shall be as specified in the insulation schedule/specification prepared for equipments/piping. Wherever the thickness is not indicated the same may be selected from Table – I.

3.2 EXTENT OF INSULATION

For cold service all portions of piping, connections for drains, instrument connections, sample points along with valve flanges etc. shall be insulated, only name plates of equipments will be kept visible.

3.3 INSULATION PROCEDURE

3.3.1 Surface Preparation

The surface of the tanks, vessels, piping and valves etc. on which cold insulation is to be applied shall be free of dust, loose paints or any other foreign matters.

3.3.2 Vessels and Columns

3.3.2.1 General

In general, vessels and columns for cold services shall be insulated by “in situ” application as per IS: 13205 specifications.

Suitable curved blocks or mitre-cut blocks of Specified thickness to fit the diameter of the vessels shall be employed. Insulation blocks shall be installed with all joints staggered and tightly butted. Joints shall be carefully fitted and filled with a joint sealer. The inner most layer is normally dry-set however with joints duly sealed with sealant.

All butt edges and ends of the blocks shall be sealed with recommended thickness of Joint sealer.

Final layer of insulation shall be secured in place with bands at 300 mm centers, Ref. Fig. 1. Band shall be provided with band-seals. When banding is impracticable banding wire shall be used. Inner layers, however require to be held in place using pressure sensitive adhesive tapes.

When multi layers of insulation is required the outer layer shall have side and end joints staggered over proceeding layer, so that two joints do not coincide and each layer shall be separately secured in place.

For Cast-in-Situ application, spacer blocks equal to the thickness of insulation to be applied over the vessel / tank surface at 300mm centre to centre and held in position with aluminium bands. Aluminium sheet cladding to be fixed over the spacer blocks and band applied over it. Holes will be drilled through the aluminium cladding and chemicals will be poured. The procedure to be from bottom to top. Finally the holed to be capped.

Insulation for hand holes, manholes etc. shall be carried out in semi-removable construction as shown in Fig. 2.

Nozzles in cold service shall be insulated as shown in Fig. 2 & 3.

3.3.2.2 Vessel Heads

Insulation on heads shall be secured by radial bands from a floating ring (made by 2-3 loops of wire) centered at the crown of head and tied to a circumferential band placed approx 300 mm inside the tangent line on insulation O.D.

Supporting legs and skirts shall be insulated simultaneously with the insulation of the vessel. The insulation shall be extended on the legs up to a length equal to four times the insulation thickness. The insulation thickness on the supports shall have the same thickness as that of the vessel and shall be laid starting from the supporting plate welded to the vessel. The insulation shall be sealed with mastic carefully.

In case the vessel is resting on a metal plate skirt, the skirt shall be insulated as shown in Fig. 1.

3.3.3 Machineries like pumps, turbines, Compressors etc.

In general these will be insulated in such a way that the same is of removable pad type to easy maintenance. (The contractor shall supply insulation detail to engineer-in-charge for approval). All such Insulation normally cannot be re-used

3.3.4 Piping

a) General

Insulation shall be applied to piping in the form of moulded pipe sections (upto 14" NB pipe dia) covering of specified thickness with all successive layers of insulation with cut slab pieces staggered and tightly butted and sealed with recommended thickness of joint sealer. In general application of various pipes shall be as per Fig. 5. For typical details of supported horizontal lines Ref. Fig. 6.



**TECHNICAL SPECIFICATION
THERMAL INSULATION – COLD SERVICE**

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The final layer of insulation shall be secured with aluminium bands at 300 mm centers on all pipe covering.

In single layer application for temperatures below 0°C shiplap finished edge pipe sections are to be used.

For Cast-in-Situ applications suitable cavity to be formed over the pipe surface equivalent to the thickness of insulation by placing insulation blocks over the pipe surface fixed with adhesives placed at 300mm centre to centre & held in position by applying bands. Aluminium sheet cladding will be fixed over the spacers and held in position with self tapping screws & bands. Finally insulation chemicals will be poured through drilled holes on the cladding. The drilled holes to be finally sealed with caps. Application shall be in compliance with IS: 13205 specifications.

Flanges, valves and other fitting shall be insulated employing larger sections of pipe covering the same specified thickness as for adjacent pipes as illustrated in Fig. 6. Bends shall be insulated with mitre-cut insulation to suit the curvature of the bend. Valves shall be insulated upto the backing gland.

3.4 WEATHER PROOFING

3.4.1 Vapour Seal Mastic

- a) After insulation is installed, before jacketing over it, heavy adhesive coat vapour seal mastic shall be applied by spraying, brushing or trowelling. While still tacky, glass fabric shall be laid smooth and embedded in the coating. Care must be exercised that weave does not rupture and fabric is overlapped 75mm at joints. A final coating of vapour seal mastic shall be applied over the glass fabric uniformly to give a total dry thickness of as per recommendation.
- b) Junctions of insulation at supports shall be vapour sealed as follows:

While the second coat of vapour seal mastic is still tacky at the support, a 300 mm. wide glass fabric shall be laid smooth and embedded in the coating. The fabric shall overlap at least 75mm at the joint. A second coat of vapour seal mastic is applied over the glass cloth as in para 3.4.1 (a).
- c) Subsequently a 25 mm thick bonded mineral wool blankets shall be applied tightly over the vapour seal mastic and fixed with 20 x 0.5 thk. bands at a spacing of 300 mm.
- d) The insulation shall be finished with aluminium Cladding with inner side (in contact with insulation) coated with 3 mil thick polysurlyn.



**TECHNICAL SPECIFICATION
THERMAL INSULATION – COLD SERVICE**

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INSULATION THICKNESS TABLE FOR COLD INSULATION

DESIGN CRITERIA

AMBIENT TEMPERATURE	:	35 Deg. C
RELATIVE HUMIDITY	:	85%
SURFACE TEMPERATURE	:	33 Deg. C
WIND VELOCITY	:	1 m/s
DESIGN HEAT GAIN	:	10-12 Kcal/hr.m ²
MATERIAL	:	POLYURETHANE (PUF) (Density 36±2Kg/m ³) / POLYISOCYANURATE (PIR) FOAM (Density 32±2Kg/m ³)

OPERATING TEMPERATURE (Deg. C)																	
DN(M M)	20	10	10 - 00	-01- -10	-11-- -20	-21- -30	-31- -40	-41- -50	-51- -60	-61- -70	-71- -80	-81- -90	-91 - 100	-101- -120	-121- -140	-141- -160	-161 - -180
15	25	30	40	50	55	65	70	80	85	95	100	110	115	135	155	180	195
20	25	35	45	55	60	70	75	85	90	100	110	115	125	145	165	190	205
25	25	35	45	55	65	75	80	90	100	105	115	125	130	150	170	200	215
32	25	40	50	60	70	80	85	95	105	115	120	130	140	160	180	210	225
40	25	40	50	60	75	85	90	100	110	120	125	135	145	165	190	220	235
50	25	40	55	65	80	90	95	105	115	125	135	145	155	175	200	230	245
65	30	45	55	70	80	90	100	110	120	130	140	150	160	180	210	245	265
80	30	45	60	75	85	95	105	115	130	140	150	160	175	195	220	260	285
100	30	50	65	80	90	100	115	125	135	150	165	175	190	210	235	270	300
125	30	50	65	85	95	110	120	135	145	155	170	180	195	215	250	285	320
150	35	50	70	85	100	115	125	140	150	170	175	195	210	230	270	300	325
200	35	55	75	90	105	120	135	150	165	175	190	210	215	235	280	310	335
250	35	60	80	95	110	125	140	155	170	190	205	215	230	250	295	315	350
300	35	60	80	100	115	135	150	165	185	195	210	220	235	260	305	330	360
350	35	60	80	100	120	135	150	165	185	195	210	225	240	270	315	345	375
400	40	65	85	100	125	140	155	170	185	195	210	230	245	280	320	360	395
450	40	65	85	105	125	140	160	175	190	210	225	235	250	285	325	375	405
500	40	65	85	105	125	140	160	175	190	210	225	240	255	285	325	380	415
550	40	65	85	110	125	140	165	180	195	210	225	240	255	290	335	380	425
600	40	65	85	110	125	145	165	180	195	215	230	255	270	300	345	390	425
>600 / Flat Surface	40	65	85	110	125	145	165	180	200	220	245	260	285	320	360	405	440

Note: - 1.Flat surfaces include Equipments and large dia pipes(DN>600).
2.Upto 60 mm thickness only single layer of Insulation shall be used.

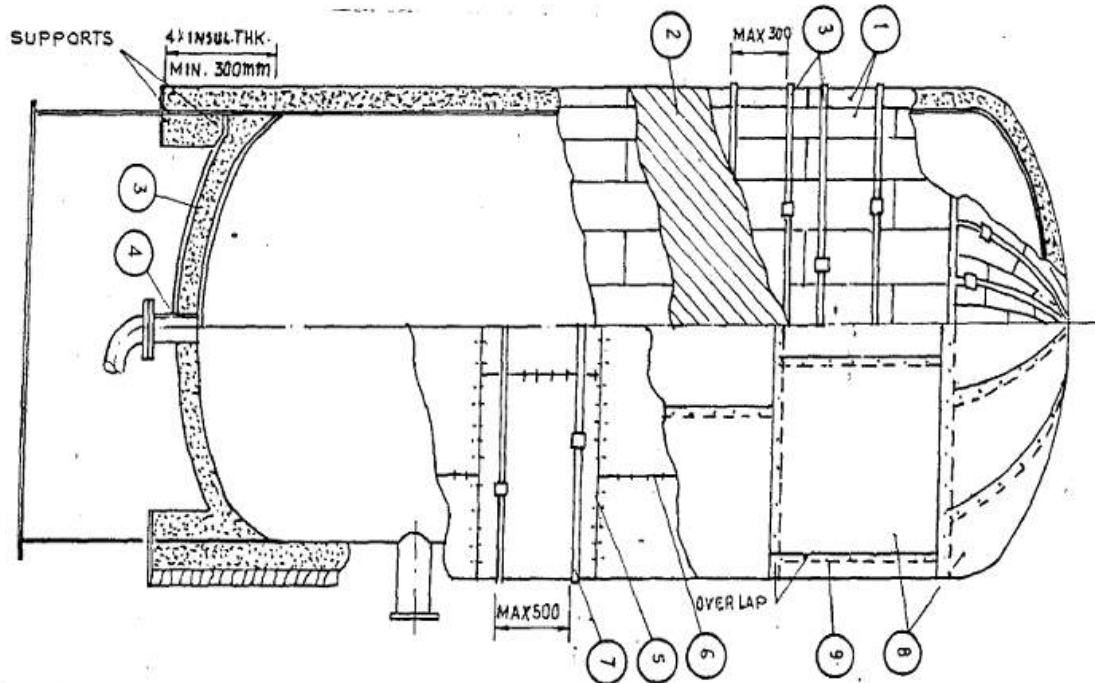
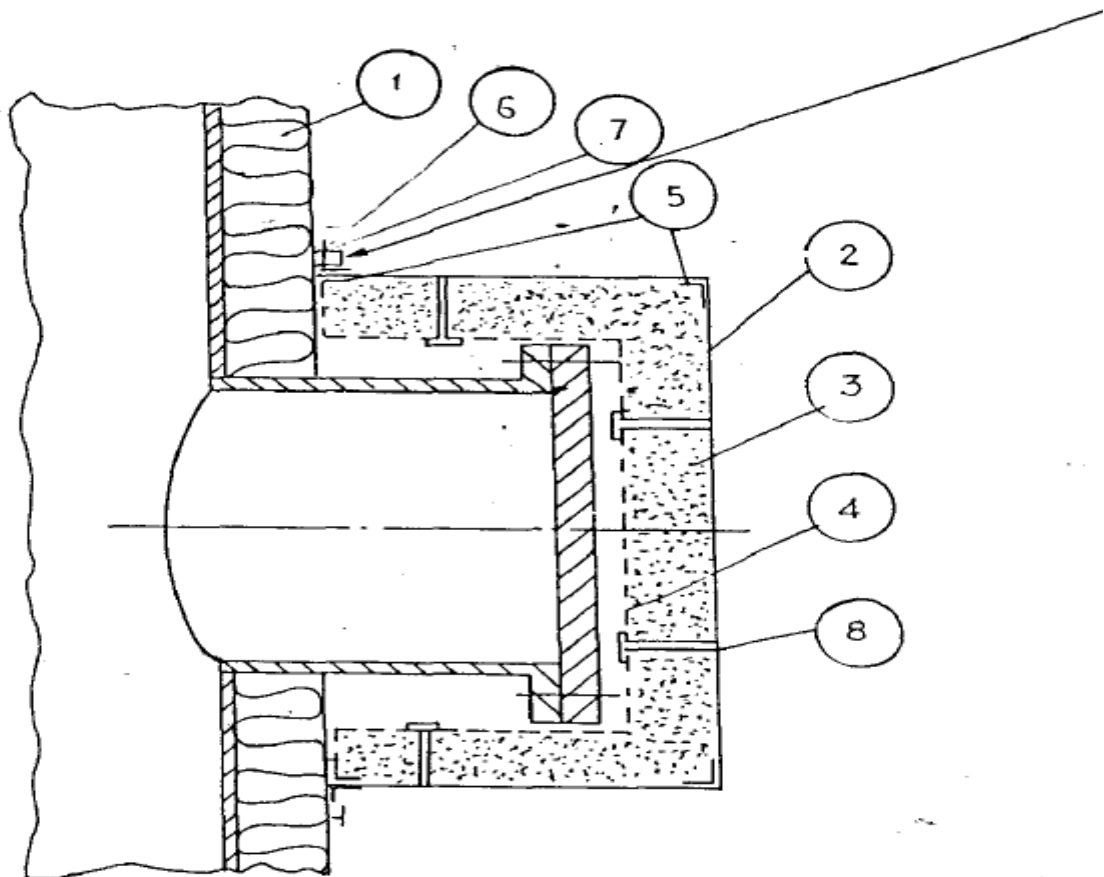


FIGURE - 1
 COLD INSULATED VESSELS

- | | |
|---|-----------------------------|
| 1. INSULATION. | 6. HOG RINGS, SPACING 100mm |
| 2. VAPOUR Barrier | 7. BAND FOR MINERAL WOOL |
| 3. BAND FOR POLYURETHANE SEC. | 8. ALUMINIUM JACKET |
| 4. Glove Cloth | 9. SELF TAPPING SCREWS. |
| 5. 25 mm BONDED MINERAL WOOL WITH WIRE MESH | |

FIG. - 2

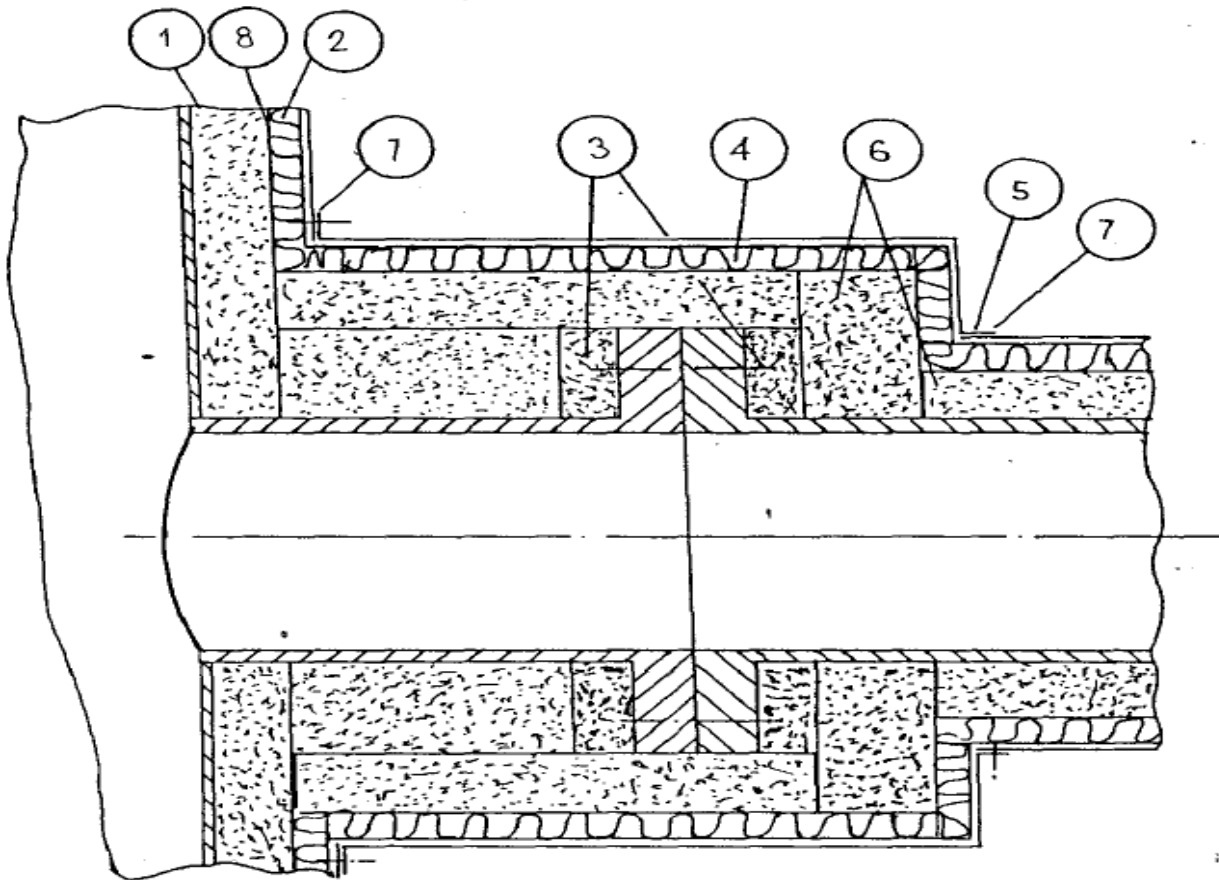
REMOVABLE GAP FOR MANHOLE AND HANDHOL



1. FIXED INSULATION
2. REMOVABLE HOOD
3. INSULATION
4. GALV. WIRE MESH
5. SECTIONAL REINFORCEMENT OR ANGLES.
6. WEATHER PROOFING MASTIC
7. SNAP FASTENER
8. CLIPS TO FIX INSULATION TO HOOD

FIG.-3

PIPE TO VESSEL CONNECTION OF COLD INSULATED VESSELS



1. INSULATION BLOCK.
2. 25 mm BONDED MINERAL WOOL BLANKET FOR PROTECTION OF VAPOUR SEAL
3. RAW STUFFING MATERIAL
4. ALUMINIUM JACKET
5. SELF TAPPING SCREWS
6. PLASTIC SEALER
7. WEATHER PROOFING MASTIC
8. VAPOUR SEAL

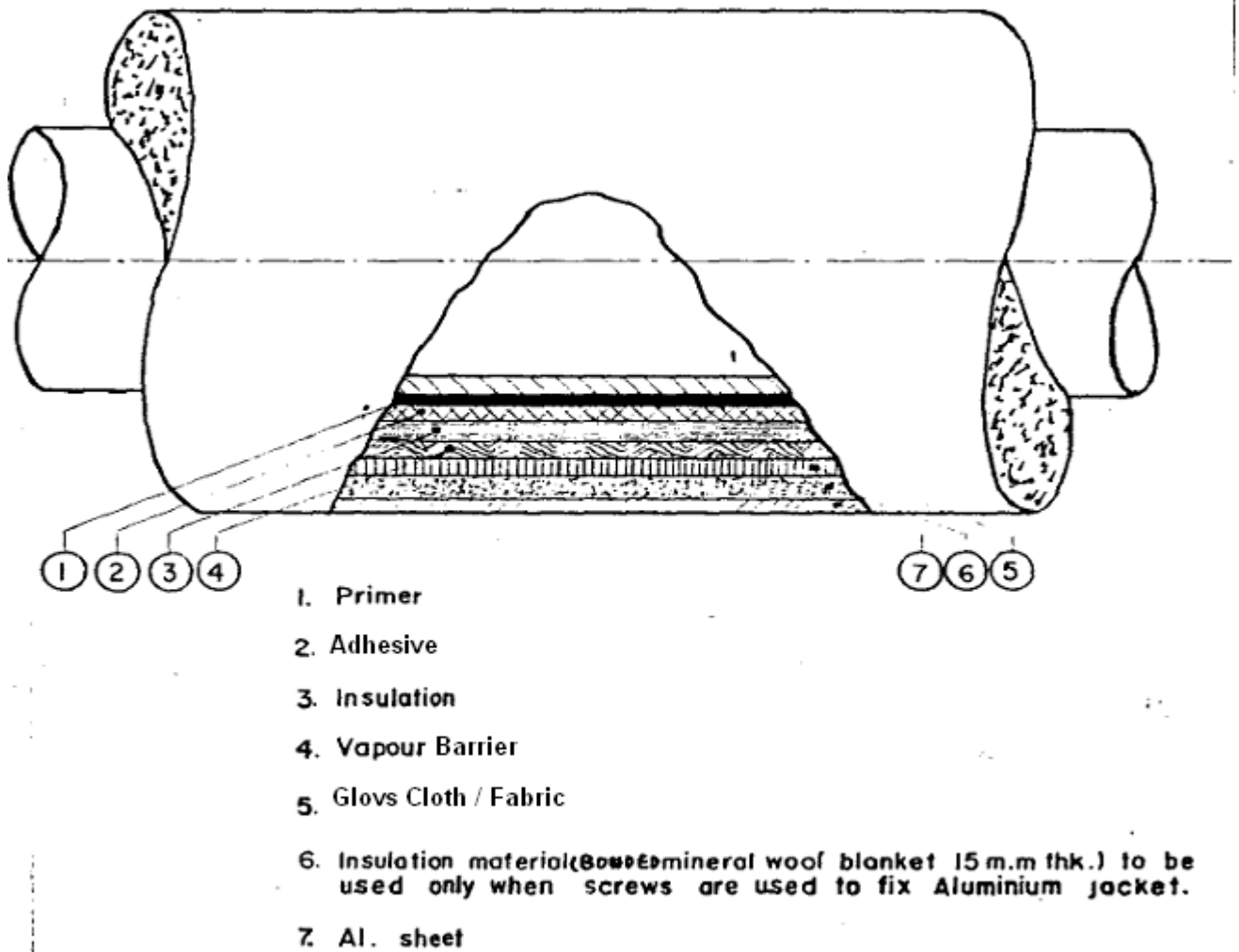
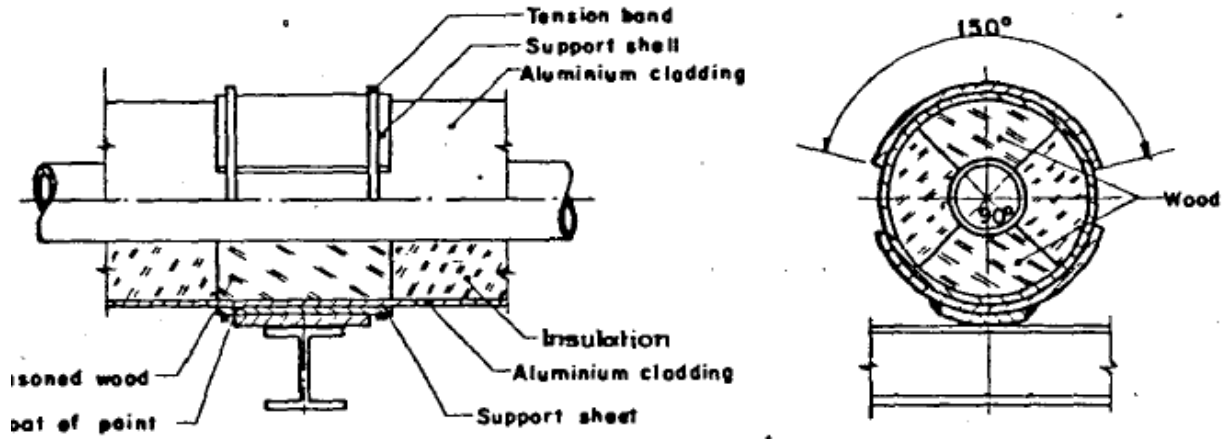


Fig..4 Different Layers of piping Insulation (Cold service.)

FIG.-5 COLD INSULATION - SUPPORTED HORIZONTAL LINES



Notes:

- (1) Material for support sheet— Carbon steel
- (2) The length of the wood underlayer equals the length of the support sheet

FORMS & PROCEDURES

Form No: F- 01 (Rev 00)

OFFER FORWARDING LETTER / TENDER SUBMISSION LETTER

(To be typed and submitted in the Letter Head of the Company/Firm of Bidder)

Offer Reference No:.....

Date:.....

To,

(Write Name & Address of Officer of BHEL inviting the Tender)

Dear Sir,

Sub : Submission of Offer against Tender Specification No:

I/We hereby offer to carry out the work detailed in the Tender Specification issued by Bharat Heavy Electricals Limited, HPVP, Visakhapatnam, in accordance with the terms and conditions thereof.

I/We have carefully perused the following listed documents connected with the above work and agree to abide by the same.

1. Amendments/Clarifications/Corrigenda/Errata/etc issued in respect of the Tender documents by BHEL
2. Notice Inviting Tender (NIT)
3. Price Bid
4. Technical Conditions of Contract
5. Special Conditions of Contract
6. General Conditions of Contract
7. Forms and Procedures

Should our Offer be accepted by BHEL for Award, I/we further agree to furnish 'Security Deposit' for the work as provided for in the Tender Conditions within the stipulated time as may be indicated by BHEL.

I/We further agree to execute all the works referred to in the said Tender documents upon the terms and conditions contained or referred to therein and as detailed in the appendices annexed thereto.

I/We have deposited/depositing herewith the requisite Earnest Money Deposit (EMD) as per details furnished in the Check List.

Authorised Representative of Bidder

Signature :

Name :

Address :

Place:

Date:

Form No: F-02 (Rev 00)

DECLARATION BY AUTHORISED SIGNATORY OF BIDDER

(To be typed and submitted in the Letter Head of the Company/Firm of Bidder)

To,

(Write Name & Address of Officer of BHEL inviting the Tender)

Dear Sir,

Sub : **Declaration by Authorised Signatory**

Ref : 1) NIT/Tender Specification No:,
2) All other pertinent issues till date

I/We, hereby certify that all the information and data furnished by me with regard to the above Tender Specification are true and complete to the best of my knowledge. I have gone through the specifications, conditions, stipulations and all other pertinent issues till date, and agree to comply with the requirements and Intent of the specification.

I further certify that I am authorised to represent on behalf of my Company/Firm for the above mentioned tender and a valid Power of Attorney to this effect is also enclosed.

Yours faithfully,

(Signature, Date & Seal of Authorized
Signatory of the Bidder)

Date:

Enclosed : Power of Attorney

Form No: F-03 (Rev 00)

NO DEVIATION CERTIFICATE

(To be typed and submitted in the Letter Head of the Company/Firm of Bidder)

To,

(Write Name & Address of Officer of BHEL inviting the Tender)

Dear Sir,

Sub : **No Deviation Certificate**

Ref : 1) NIT/Tender Specification No:,
2) All other pertinent issues till date

We hereby confirm that we have not changed/ modified/materially altered any of the tender documents as downloaded from the website/ issued by BHEL and in case of such observance at any stage, it shall be treated as null and void.

We also hereby confirm that we have neither set any Terms and Conditions and nor have we taken any deviation from the Tender conditions together with other references applicable for the above referred NIT/Tender Specification.

We further confirm our unqualified acceptance to all Terms and Conditions, unqualified compliance to Tender Conditions, Integrity Pact (if applicable) and acceptance to Reverse Auctioning process.

We confirm to have submitted offer in accordance with tender instructions and as per aforesaid references.

Thanking you,

Yours faithfully,

(Signature, date & seal of authorized
representative of the bidder)

Form No: F-04 (Rev 00)

DECLARATION CONFIRMING KNOWLEDGE ABOUT SITE CONDITIONS

(To be typed and submitted in the Letter Head of the Company/Firm of Bidder)

To,

(Write Name & Address of Officer of BHEL inviting the Tender)

Dear Sir,

Sub : **Declaration confirming knowledge about Site conditions**

Ref : 1) NIT/Tender Specification No:,

2) All other pertinent issues till date

I/We, _____ hereby declare and confirm that we have visited the Project Site as referred in BHEL Tender Specifications and acquired full knowledge and information about the Site conditions including Wage structure, Industrial Climate, the Law & Order and other conditions prevalent at and around the Site. We further confirm that the above information is true and correct and we shall not raise any claim of any nature due to lack of knowledge of Site conditions.

I/We, hereby offer to carry out work as detailed in above mentioned Tender Specification, in accordance with Terms & Conditions thereof.

Yours faithfully,

(Signature, Date & Seal of Authorized
Representative of the Bidder)

Date :

Place:

CONTRACT AGREEMENT

THIS AGREEMENT MADE THIS _____ DAY OF _____ between BHARAT HEAVY ELECTRICALS LIMITED (A Government of India Enterprise) a Company incorporated under the Companies Act, 1956, having its Registered Office at BHEL House, Siri Fort New Delhi- 110049 (herein after called BHEL) of the ONE PART.

AND

M/S _____ (hereinafter called the `Contractor') of the SECOND PART.

WHEREAS M/s _____ state that they have acquired and possess extensive experience in the field of _____

And Whereas in response to an Invitation to Tender No. _____ issued by BHEL for execution of _____ the contractor submitted their offer No.-

_____ And whereas BHEL has accepted the offer of _____ of the Contractor on terms and conditions specified in the Letter of Intent No. _____ dated _____ readwiththereferences_____

THIS AGREEMENT WITNESSES AND it is hereby agreed by and between the parties as follows:

1. Thatthecontractorshallexecutetheworkof_____ andmore particularly described in Tender Specification No _____ including Drawings and Specifications (hereinafter called thesaid works) in accordance with and subject to terms and conditions contained in these presents, instructions to Tenderers, General Conditions of Contract, Special Conditions, Annexures, Letter of Intent dated _____ and such other instructions, Drawings, Specifications given to him from time to time by BHEL.
2. The Contractor is required to furnish to BHEL Security deposit in the form of cash/ approved securities/Bank Guarantee valid upto _____ forasumofRs. _____ towards satisfactory performance and completion of the Contract.
3. The Contractor has furnished a Bank Guarantee bearing no. _____ dated _____ ---forasumofRs. _____ executed by _____ in favour of BHEL towards Security Deposit valid upto _____

OR

The Contractor has furnished to BHEL an initial Security Deposit of Rs. _____ in the form of cash / approved Securities/ B.G No. _____ dated _____ for Rs. _____ executed by _____ in favour of BHEL valid upto _____ and has agreed for recovery of the balance security deposit by BHEL @ 10% of the value of work done from each running bill till the entire Security Deposit is recovered.

OR

The contractor has furnished to BHEL an initial Security Deposit of Rs.----- (Rs.----- vide Bankdraft No.----- dated----- and by adjusting EMD of Rs.----- submitted vide Bankdraft No.----- dt. -----) and has agreed for recovery of balance Security Deposit by BHEL @ 10% of the value of work done from each running bill till the entire security deposit is recovered.

4. The Contractor hereby agrees to extend the validity of the Bank Guarantee for such further period or periods as may be required by BHEL and if the Contractor fails to obtain such extension(s) from the Bank, the Contractor, shall pay forthwith or accept recovery of Rs.----- from the bills in one installment and the contractor further agrees that failure to extend the validity of the Bank Guarantee or failure to pay the aforesaid amount in the manner specified above shall constitute breach of contract. In addition to above, BHEL shall be entitled to take such action as deemed fit and proper for recovering the said sum of Rs.-----

OR

In case the contractor furnishes the bank guarantee at a later date the contractor hereby agrees to extend the validity of bank guarantee for such further period or periods as may be required by BHEL and if the contractor fails to obtain such extension(s) from the bank, the contractor shall pay forthwith or accept recovery of the amount of bank guarantee given in lieu of security deposit from the bills in one installment and the contractor further agrees that failure to extend the validity of bank guarantee or failure to pay the aforesaid amount in the manner specified above shall constitute breach of contract. In addition to above, BHEL shall be entitled to take such action as deemed fit and proper for recovering the said sum.

5. That in consideration of the payments to be made to the Contractor by BHEL in accordance with this Agreement the Contractor hereby covenants and undertakes with BHEL that they shall execute, construct, complete the works in conformity, in all respects, with the terms and conditions specified in this Agreement and the documents governing the same.
6. That the Contractor shall be deemed to have carefully examined this Agreement and the documents governing the same and also to have satisfied himself as to the nature and character of the Works to be executed by him.
7. That the Contractor shall carry out and complete the execution of the said works to the entire satisfaction of the Engineer or such other officer authorised by BHEL, within the agreed time schedule, the time of completion being the essence of the Contract.
8. That BHEL shall, after proper scrutiny of the bills submitted by the Contractor, pay to him during the progress of the said works such sum as determined by BHEL in accordance with this Agreement.
9. That this Agreement shall be deemed to have come into force from ----- the date on which the letter of intent has been issued to the Contractor.

FORMS & PROCEDURES

10. That whenever under this contract or otherwise, any sum of money shall be recoverable from or payable by the Contractor, the same may be deducted in the manner as set out in the General Conditions of Contract or other conditions governing this Agreement.
11. That all charges on account of Octroi, Terminal and other taxes including sales tax or other duties on material obtained for execution of the said works shall be borne and paid by the Contractor.
12. That BHEL shall be entitled to deduct from the Contractor's running bills or otherwise Income Tax under Section 194 (C) of the Income Tax Act, 1961.
13. That BHEL shall be further entitled to recover from the running bills of the Contractor or otherwise such sum as may be determined by BHEL from time to time in respect of consumables supplied by BHEL, hire charges for tools and plants issued (Where applicable) and any other dues owed by the Contractor.
14. That it is hereby agreed by and between the parties that non- exercise, forbearance or omission of any of the powers conferred on BHEL and /or any of its authorities will not in any manner constitute waiver of the conditions hereto contained in these presents and the liability of the Contractor with respect to compensation payable to BHEL or Contractor's obligations shall remain unaffected.
15. It is clearly understood by and between the parties that in the event of any conflict between the Letter of Intent and other documents governing this Agreement, the provisions in the Letter of Intent shall prevail.

16. The following documents

1. Invitation to Tender No-----
and the documents specified therein.

2. Contractor's Offer No-----
dated-----.

3. _____

4. _____

5. _____

6. Letter of Intent No _____ dated _____.

7. _____

shall also form part of and govern this Agreement.

IN WITNESS HEREOF, the parties hereto have respectively set their signatures in the presence of

WITNESS

(CONTRACTOR)

FORMS & PROCEDURES

1. (to be signed by a person holding
a valid Power of Attorney)

2.

WITNESS

(For and on behalf of BHEL)

1.

2.

BANK GUARANTEE FOR SECURITY DEPOSIT

B.G. NO.

Date

This deed of Guarantee made this ----- day of -----two thousand ---- by <Name and Address of Bank> hereinafter called the "The Guarantor" (which expression shall unless repugnant to the context or meaning thereof be deemed to include its successors and assigns) in favour of M/s Bharat Heavy Electrical Limited (A Govt. of India Undertaking) a company incorporated under the Companies Act, 1956, having its registered office at BHEL House, Siri Fort, Asiad, New Delhi – 110049 through its unit at Bharat Heavy Electricals Limited – HPVP, Visakhapatnam -530012 hereinafter called "The Company" (which expression shall unless repugnant to the context or meaning thereof be deemed to include its successors and assigns)

WHEREAS < Contractor's Name and Address > (hereinafter referred to as the Contractor) have entered into a contract arising out of Letter of Intent no. < LOI REF & Date > (hereinafter referred to as "the contract") for < Name of Work > with the company.

AND WHEREAS the contract inter-alia provides that the contractor shall furnish to the company a sum of Rs.----- (Rupees-----) towards security deposit for due and faithful performance of the contract in the form and manner specified therein.

AND WHEREAS the contractor has approached the Guarantor and in consideration of the arrangement arrived at between the contractor and the Guarantor, the Guarantor has agreed to give the Guarantee as hereinafter mentioned in favour of the company.

The Guarantor do hereby guarantee to the company the due and faithful performance, observance or discharge of the Contract by the contractor and further unconditionally and irrevocably undertake to pay to the Company without demur and merely on a demand, to the extent of Rs.----- (Rupees-----) against any claim by the company on them for any loss, damage, costs, charges and expenses caused to or suffered by the company by reasons of the contractor making any default in the performance, observance or discharge of the terms, conditions, stipulations or undertakings or any of them as contained in the contract.

The decision of the company whether any default has occurred or has been committed by the contractor in the performance, observance or discharge of any of the terms, conditions, stipulations or undertakings or any one of them as contained in the contract and / or as to the extent of loss, damage, costs, charges and expenses caused to or suffered by the company by reason of the contractor making any default in the performance, observance or discharge of any of the terms, conditions, stipulations or undertakings or any one of them shall be conclusive and binding on the Guarantor irrespective of the fact whether the contractor admits or denies the default or questions the correctness of any demand made by the company in any Court, Tribunal or Arbitration proceedings or before any other Authority.

The company shall have the fullest liberty without affecting in any way the liability of the Guarantor under this Guarantee, from time to time to vary any of the terms and conditions of the contract or extend time of performance by the contractor or to postpone for any time and from time to time any of the powers exercisable by it against the contractor and either enforce or forebear from enforcing any of the terms and conditions governing the contract or securities available to the company and the Guarantor shall not be released from its liability under these presents by any exercise by the company of the liberty with reference to the matters aforesaid or by reasons of time being given to the contractor or any other forbearance, act or commission on the part of the company or any indulgence by the company to the contractor or any other matter or thing whatsoever which under the law relating to sureties would, but for this provision have the effect of so releasing the Guarantor from its liability under this guarantee.

The Guarantor further agrees that the Guarantee herein contained shall remain in full force and effect during the period that would be taken for the performance of the contract and its claim satisfied or discharged and till the company certifies that the terms and conditions of the contract have been fully and properly carried out by the contractor and accordingly discharges this Guarantee, subject however, that the company shall have no claim under this Guarantee after ----- i.e. (the present date of validity of Bank Guarantee unless the date of validity of this Bank Guarantee is further extended from time to time, as the case may be) unless a notice of the claim under this Guarantee has been served on the Guarantor before the expiry of the said period in which case the same shall be

enforceable against the Guarantor notwithstanding the fact that the same is enforced after the expiry of the said period.

The Guarantor undertakes not to revoke this Guarantee during the period it is in force except with the previous consent of the Company in writing and agrees that any liquidation or winding up or insolvency or dissolution or any change in the constitution of the contractor or the Guarantor shall not discharge the Guarantor's liability hereunder.

It shall not be necessary for the company to proceed against the contractor before proceeding against the Guarantor and the Guarantee herein contained shall be enforceable against them notwithstanding any security which the Company may have obtained or obtain from the Contractor shall at the time when proceedings are taken against the Guarantor hereunder be outstanding or unrealized.

Notwithstanding anything contained herein before, our liability under the Guarantee is restricted to Rs.-----
----- (Rupees-----). Our guarantee shall remain in force until -----, i.e. (the present date of validity of Bank Guarantee unless the date of validity of this Bank Guarantee is further extended from time to time) unless a claim or demand under this guarantee is made against us on or before ----- we shall be discharged from our liabilities under this Guarantee thereafter.

Any claim or dispute arising under the terms of this documents shall only be enforced or settled in the courts of at Nagpur only.

The Guarantor hereby declares that it has power to execute this guarantee and the executant has full powers to do so on behalf of the Guarantor.

FORMS & PROCEDURES

IN WITNESS whereof the ----- (Bank) has hereunto set and subscribed its hand the day, month and year first, above written.

(Name of the Bank)

Signed for and on behalf of the Bank

(Designation of the Authorized Person Signing the

Guarantee)

(Signatory No.-----)

DATED:

SEAL

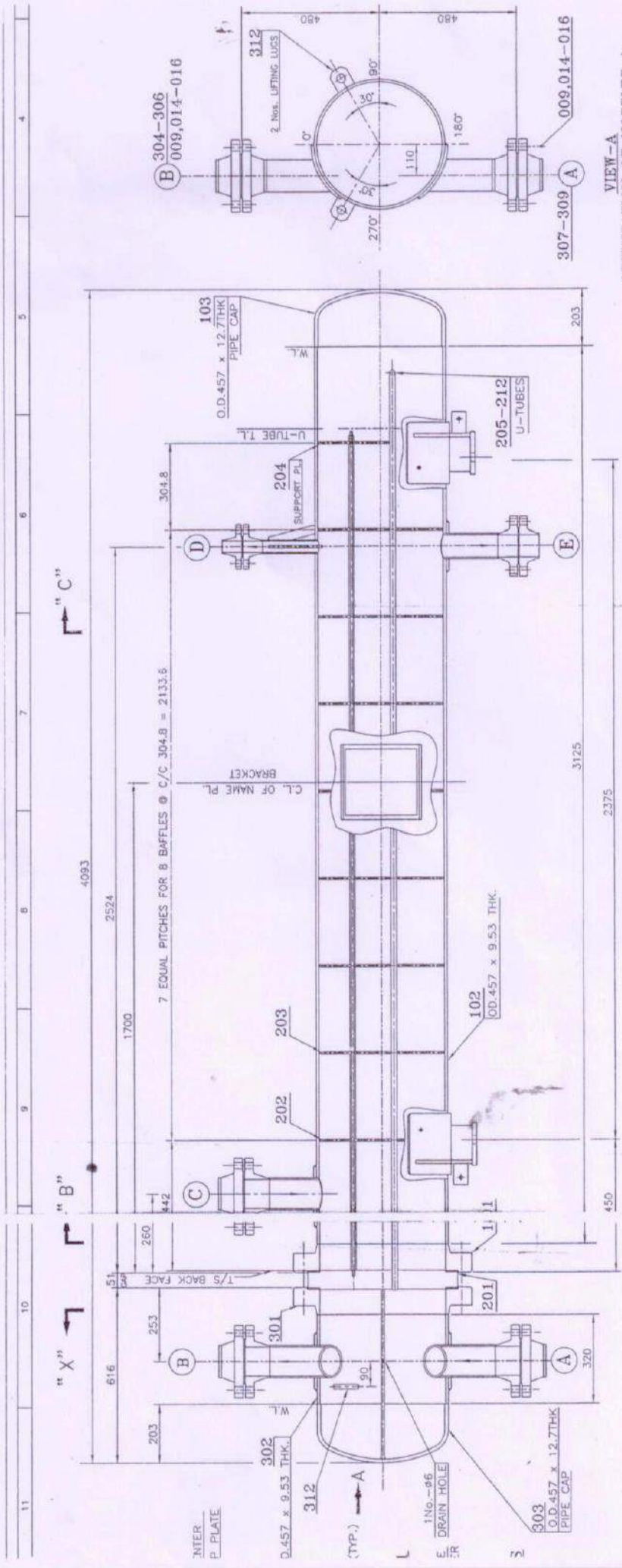
=====

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Notes :

1. The BG shall be executed on non-judicial stamp papers of adequate value procured in the name of the Bank in the State where the Bank is located.
2. The BG is required to be sent by the executing Bank directly to BHEL at the address where tender is submitted / accepted under sealed cover.

ONLY FOR TENDER PURPOSE

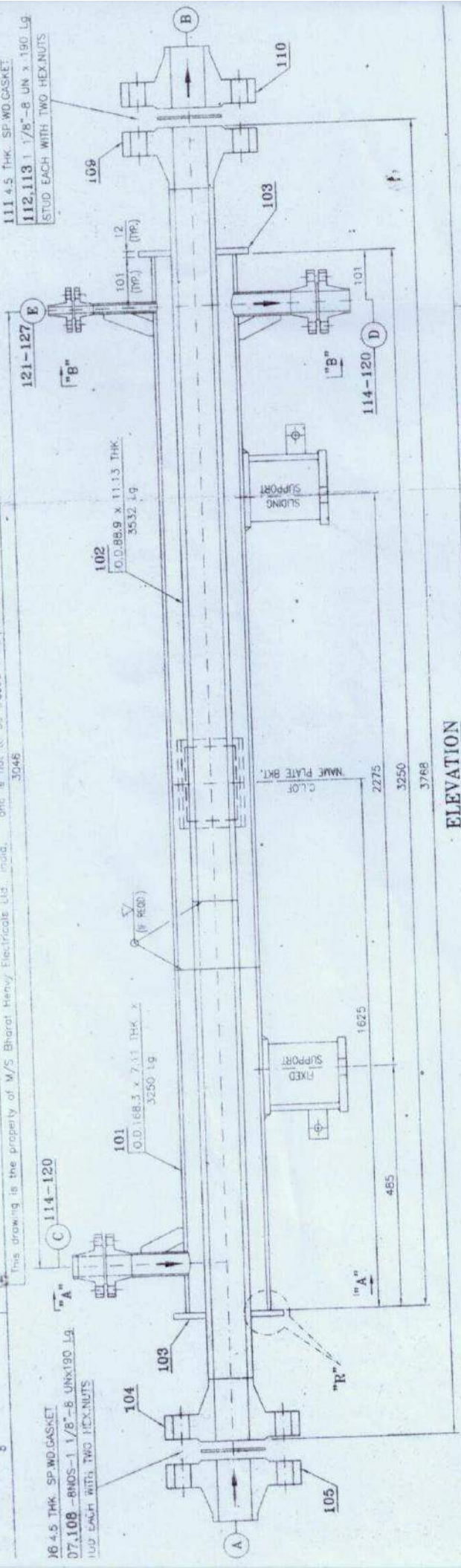


VIEW-A
ORIENTATION OF NOZZLES &
LIFTING LUGS OF CHANNEL ASSLY.

AMMONIA CONDENSER (B-3701)

ONLY FOR TENDER PURPOSE

DRAW 3
 7
 8
 4
 5
 6
 1



111 4.5 THK. SP.WD.GASKET
 112,113 1 1/8"-8 UN x 190 Lg
 STUD EACH WITH TWO HEX.NUTS

106 4.5 THK. SP.WD.GASKET
 07,108 -8NOS- 1 1/8"-8 UNx190 Lg
 STUD EACH WITH TWO HEX.NUTS

101
 O.D.168.3 x 7.11 THK x
 5350 Lg

102
 O.D.88.9 x 11.13 THK.
 3532 Lg

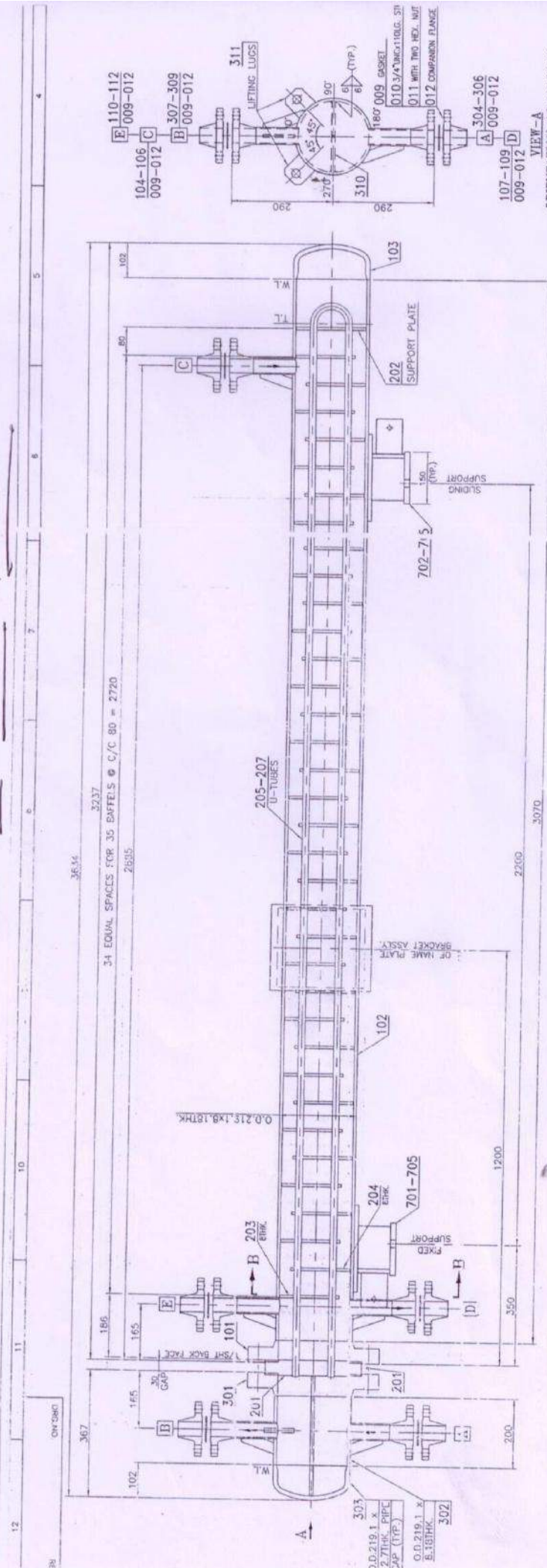
123 4.5 THK. SP.WD.GASKET
 124,125 4 Nos- 1/2"-UNC x 65 Lg
 STUD EACH WITH TWO HEX.NUTS

116 4.5 THK. SP.WD.GASKET
 117,118 4 Nos- 1/2"-UNC x 75 Lg
 STUD EACH WITH TWO HEX.NUTS

ELEVATION

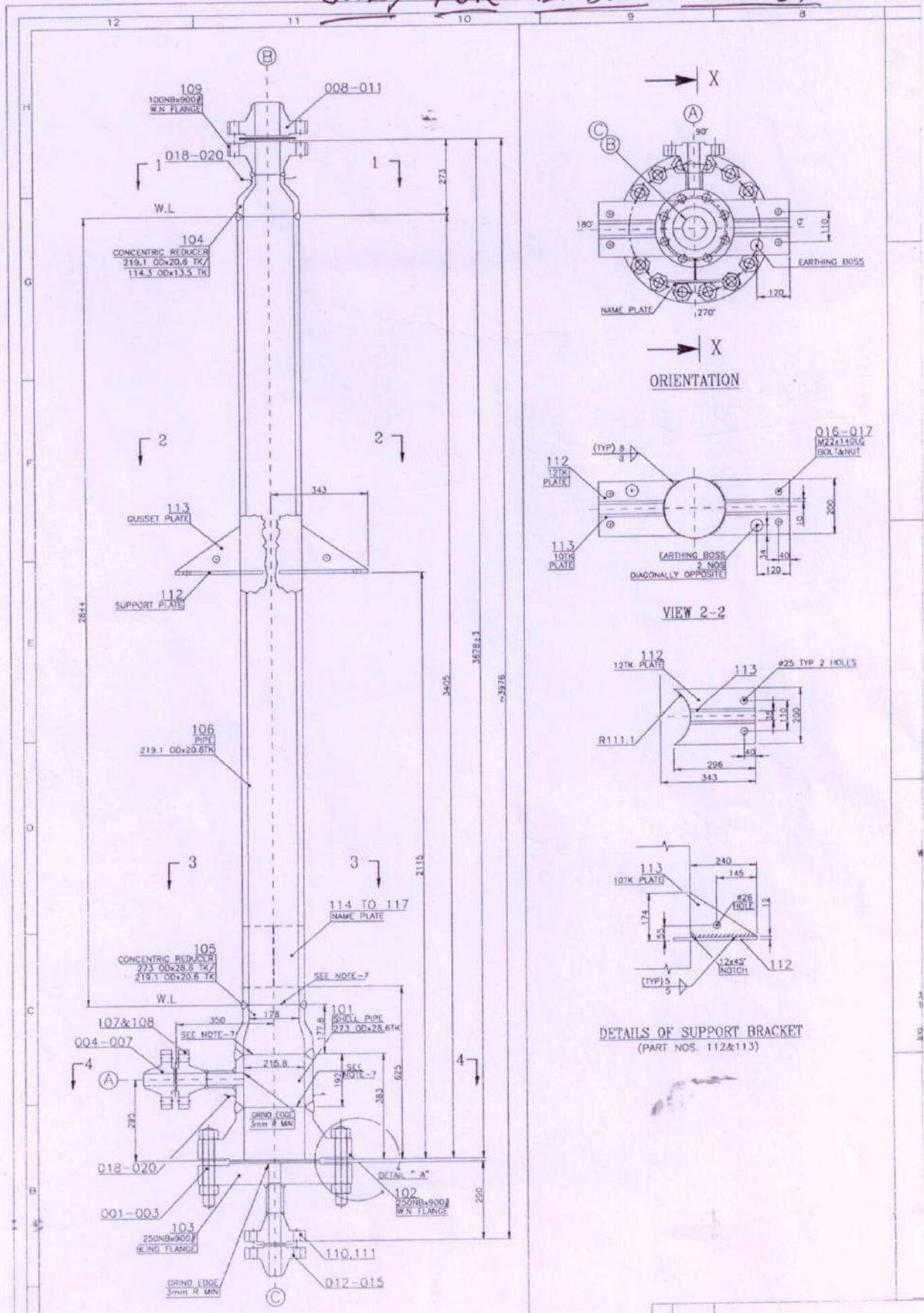
FEED HEATER (E-3704)

ONLY FOR TENDER PURPOSE



STRIPPER FEED HEAT EXCHANGER (E-3701)

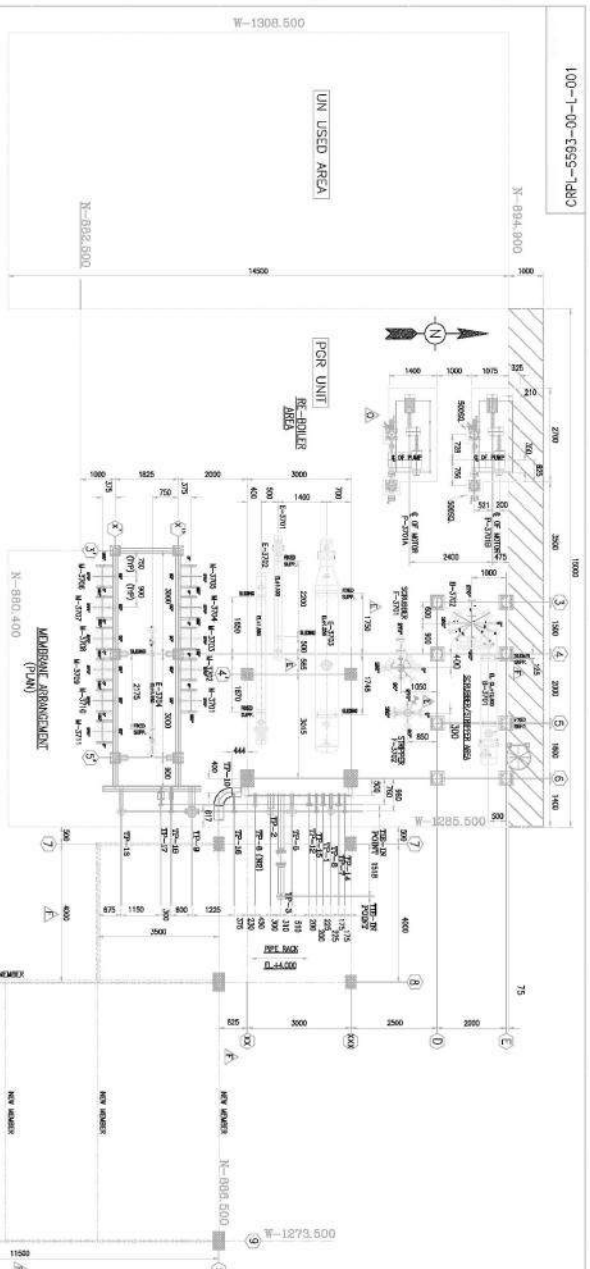
ONLY FOR TENDER PURPOSE



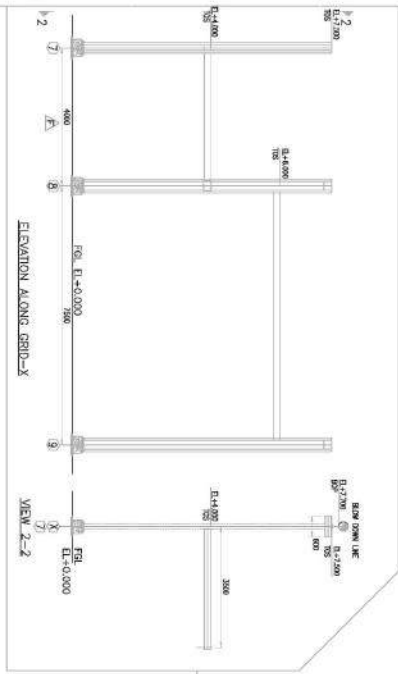
SECTION 'X-X'

HOUSING FOR MEMBRANCE MODULES (M-3701 TO M-3711)

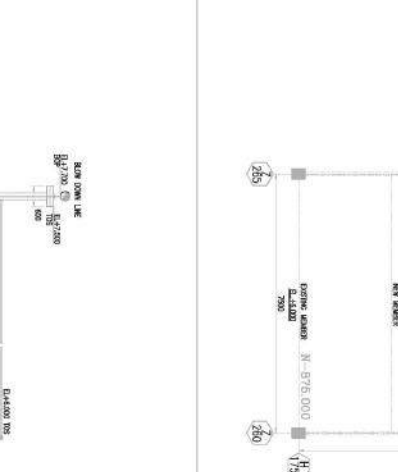
PART No.	DESCRIPTION	QTY.	REF. DRG. No.	REV. No.	REV. No.	ZONE	BREF. RECORD OF REVISIONS
1-3 DRAWING IS THE PROPERTY OF M/S. BHARAT HEAVY ELECTRICALS LTD.							
12	11	10	9				



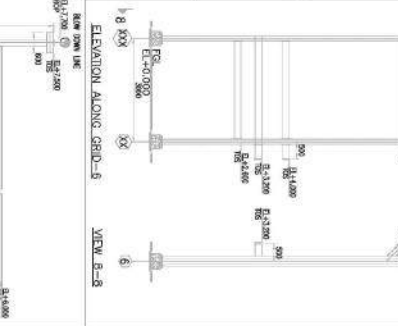
FOUNDATION PLAN AT EL.+0.000



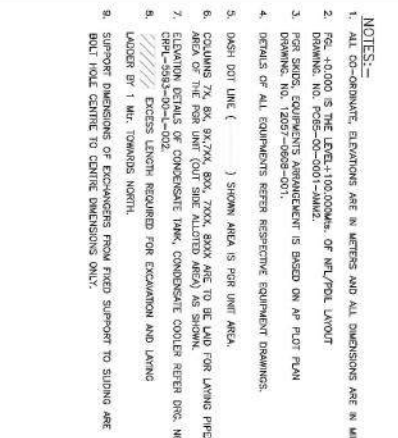
ELEVATION ALONG GRID-X
VIEW 2-2



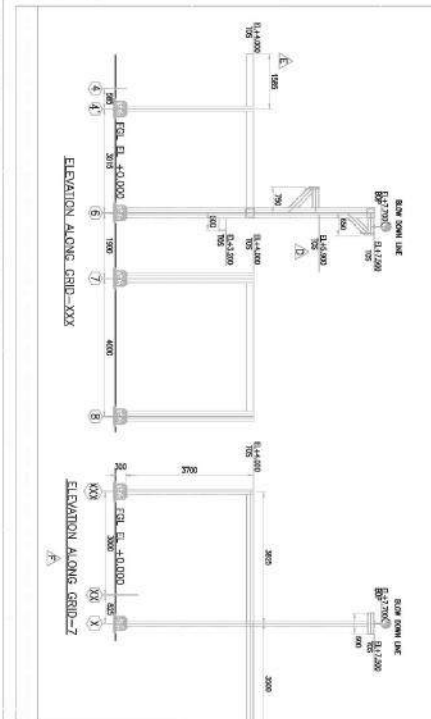
ELEVATION ALONG GRID-B
VIEW B-B



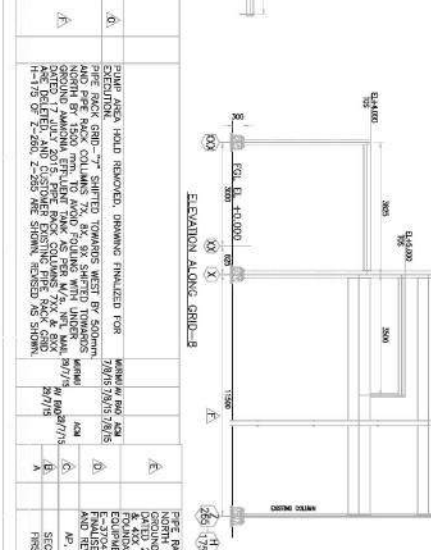
ELEVATION ALONG GRID-6
VIEW B-B



ELEVATION ALONG GRID-8
VIEW B-B



ELEVATION ALONG GRID-XXX



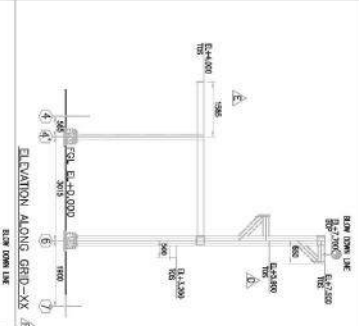
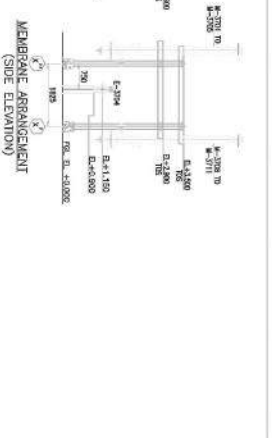
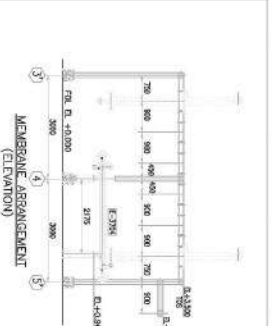
ELEVATION ALONG GRID-7



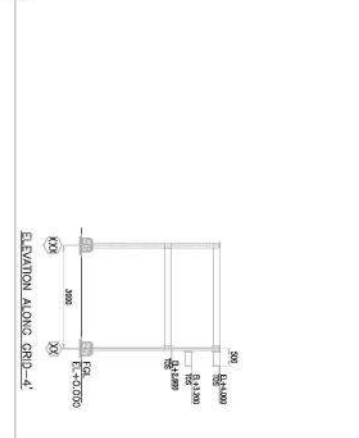
ELEVATION ALONG GRID-8



ELEVATION ALONG GRID-9



ELEVATION ALONG GRID-XX



ELEVATION ALONG GRID-4

NOTES:-

1. ALL CO-ORDINATE, ELEVATIONS ARE IN METERS AND ALL DIMENSIONS ARE IN MILLIMETERS
2. FGL +0.000 IS THE LEVEL+100.00MM. OF NPL/PDL LAYOUT
3. DRAWING NO. PDS-0-001-AMMZ.
4. FOR SIZES, EQUIPMENT'S ARRANGEMENT IS BASED ON AP PLOT PLAN DRAWING, NO. 12057-0002-001.
5. DETAILS OF ALL EQUIPMENTS REFER RESPECTIVE EQUIPMENT DRAWINGS.
6. DASH DOT LINE (---) SHOWN AREA IS FOR UNIT AREA.
7. FOUNDATION 7X 8X 9X 70X SHOWN ARE TO BE LAID FOR LAYING PRESS OUT SIDE AREA OF THE FOR UNIT (OUT SIDE ALLOTTED AREA) AS SHOWN.
8. ELEVATION DETAILS OF CONDENSATE PANK, CONDENSATE COOLER REFER DRA. NO. GRN-5593-01-1-002.
9. EXCESS LENGTH REQUIRED FOR EXCAVATION AND LAYING
10. LARGER BY 1 MM. TOWARDS NORTH.
11. SUPPORT DIMENSIONS OF EXCHANGERS FROM FIXED SUPPORT TO SLING ARE DOUT HOLE CENTRE TO CENTRE DIMENSIONS ONLY.

SAC NO.	DESCRIPTION	EQPT. BT./CENTRE LINE ELEVATION
P-3701	CONDENSATE PANK	+12.000 M.
B-3702	CONDENSATE COOLER	+11.500 M.
C-3702	CONDENSATE COOLER	+11.500 M.
F-3702	CONDENSATE COOLER	+11.500 M.
M-3701	CONDENSATE PANK	+12.000 M.
M-3702	CONDENSATE COOLER	+11.500 M.
M-3703	CONDENSATE COOLER	+11.500 M.
M-3704	CONDENSATE COOLER	+11.500 M.
M-3705	CONDENSATE COOLER	+11.500 M.
M-3706	CONDENSATE COOLER	+11.500 M.
M-3707	CONDENSATE COOLER	+11.500 M.
M-3708	CONDENSATE COOLER	+11.500 M.
M-3709	CONDENSATE COOLER	+11.500 M.
M-3710	CONDENSATE COOLER	+11.500 M.
M-3711	CONDENSATE COOLER	+11.500 M.
M-3712	CONDENSATE COOLER	+11.500 M.
M-3713	CONDENSATE COOLER	+11.500 M.
M-3714	CONDENSATE COOLER	+11.500 M.
M-3715	CONDENSATE COOLER	+11.500 M.
M-3716	CONDENSATE COOLER	+11.500 M.
M-3717	CONDENSATE COOLER	+11.500 M.
M-3718	CONDENSATE COOLER	+11.500 M.
M-3719	CONDENSATE COOLER	+11.500 M.
M-3720	CONDENSATE COOLER	+11.500 M.
M-3721	CONDENSATE COOLER	+11.500 M.
M-3722	CONDENSATE COOLER	+11.500 M.
M-3723	CONDENSATE COOLER	+11.500 M.
M-3724	CONDENSATE COOLER	+11.500 M.
M-3725	CONDENSATE COOLER	+11.500 M.
M-3726	CONDENSATE COOLER	+11.500 M.
M-3727	CONDENSATE COOLER	+11.500 M.
M-3728	CONDENSATE COOLER	+11.500 M.
M-3729	CONDENSATE COOLER	+11.500 M.
M-3730	CONDENSATE COOLER	+11.500 M.
M-3731	CONDENSATE COOLER	+11.500 M.
M-3732	CONDENSATE COOLER	+11.500 M.
M-3733	CONDENSATE COOLER	+11.500 M.
M-3734	CONDENSATE COOLER	+11.500 M.
M-3735	CONDENSATE COOLER	+11.500 M.
M-3736	CONDENSATE COOLER	+11.500 M.
M-3737	CONDENSATE COOLER	+11.500 M.
M-3738	CONDENSATE COOLER	+11.500 M.
M-3739	CONDENSATE COOLER	+11.500 M.
M-3740	CONDENSATE COOLER	+11.500 M.
M-3741	CONDENSATE COOLER	+11.500 M.
M-3742	CONDENSATE COOLER	+11.500 M.
M-3743	CONDENSATE COOLER	+11.500 M.
M-3744	CONDENSATE COOLER	+11.500 M.
M-3745	CONDENSATE COOLER	+11.500 M.
M-3746	CONDENSATE COOLER	+11.500 M.
M-3747	CONDENSATE COOLER	+11.500 M.
M-3748	CONDENSATE COOLER	+11.500 M.
M-3749	CONDENSATE COOLER	+11.500 M.
M-3750	CONDENSATE COOLER	+11.500 M.
M-3751	CONDENSATE COOLER	+11.500 M.
M-3752	CONDENSATE COOLER	+11.500 M.
M-3753	CONDENSATE COOLER	+11.500 M.
M-3754	CONDENSATE COOLER	+11.500 M.
M-3755	CONDENSATE COOLER	+11.500 M.
M-3756	CONDENSATE COOLER	+11.500 M.
M-3757	CONDENSATE COOLER	+11.500 M.
M-3758	CONDENSATE COOLER	+11.500 M.
M-3759	CONDENSATE COOLER	+11.500 M.
M-3760	CONDENSATE COOLER	+11.500 M.
M-3761	CONDENSATE COOLER	+11.500 M.
M-3762	CONDENSATE COOLER	+11.500 M.
M-3763	CONDENSATE COOLER	+11.500 M.
M-3764	CONDENSATE COOLER	+11.500 M.
M-3765	CONDENSATE COOLER	+11.500 M.
M-3766	CONDENSATE COOLER	+11.500 M.
M-3767	CONDENSATE COOLER	+11.500 M.
M-3768	CONDENSATE COOLER	+11.500 M.
M-3769	CONDENSATE COOLER	+11.500 M.
M-3770	CONDENSATE COOLER	+11.500 M.
M-3771	CONDENSATE COOLER	+11.500 M.
M-3772	CONDENSATE COOLER	+11.500 M.
M-3773	CONDENSATE COOLER	+11.500 M.
M-3774	CONDENSATE COOLER	+11.500 M.
M-3775	CONDENSATE COOLER	+11.500 M.
M-3776	CONDENSATE COOLER	+11.500 M.
M-3777	CONDENSATE COOLER	+11.500 M.
M-3778	CONDENSATE COOLER	+11.500 M.
M-3779	CONDENSATE COOLER	+11.500 M.
M-3780	CONDENSATE COOLER	+11.500 M.
M-3781	CONDENSATE COOLER	+11.500 M.
M-3782	CONDENSATE COOLER	+11.500 M.
M-3783	CONDENSATE COOLER	+11.500 M.
M-3784	CONDENSATE COOLER	+11.500 M.
M-3785	CONDENSATE COOLER	+11.500 M.
M-3786	CONDENSATE COOLER	+11.500 M.
M-3787	CONDENSATE COOLER	+11.500 M.
M-3788	CONDENSATE COOLER	+11.500 M.
M-3789	CONDENSATE COOLER	+11.500 M.
M-3790	CONDENSATE COOLER	+11.500 M.
M-3791	CONDENSATE COOLER	+11.500 M.
M-3792	CONDENSATE COOLER	+11.500 M.
M-3793	CONDENSATE COOLER	+11.500 M.
M-3794	CONDENSATE COOLER	+11.500 M.
M-3795	CONDENSATE COOLER	+11.500 M.
M-3796	CONDENSATE COOLER	+11.500 M.
M-3797	CONDENSATE COOLER	+11.500 M.
M-3798	CONDENSATE COOLER	+11.500 M.
M-3799	CONDENSATE COOLER	+11.500 M.
M-3800	CONDENSATE COOLER	+11.500 M.

CONSULTANT: M/s. PROJECTS & DEVELOPMENT INDIA LTD.

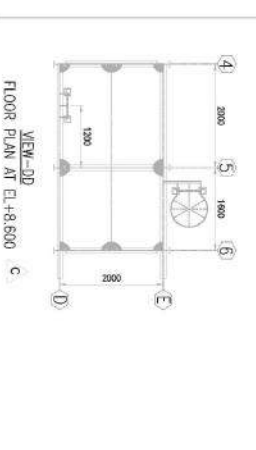
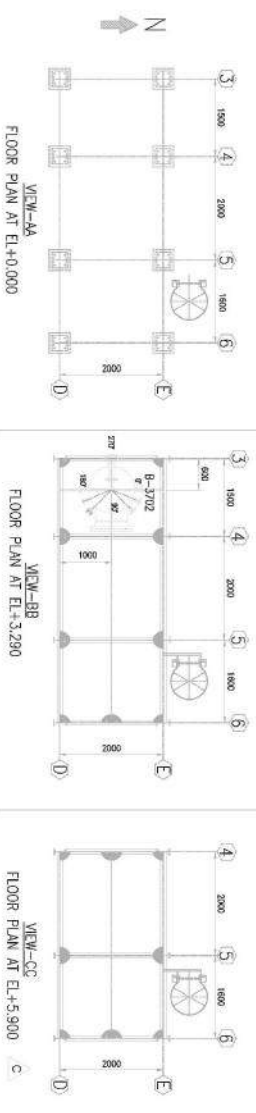
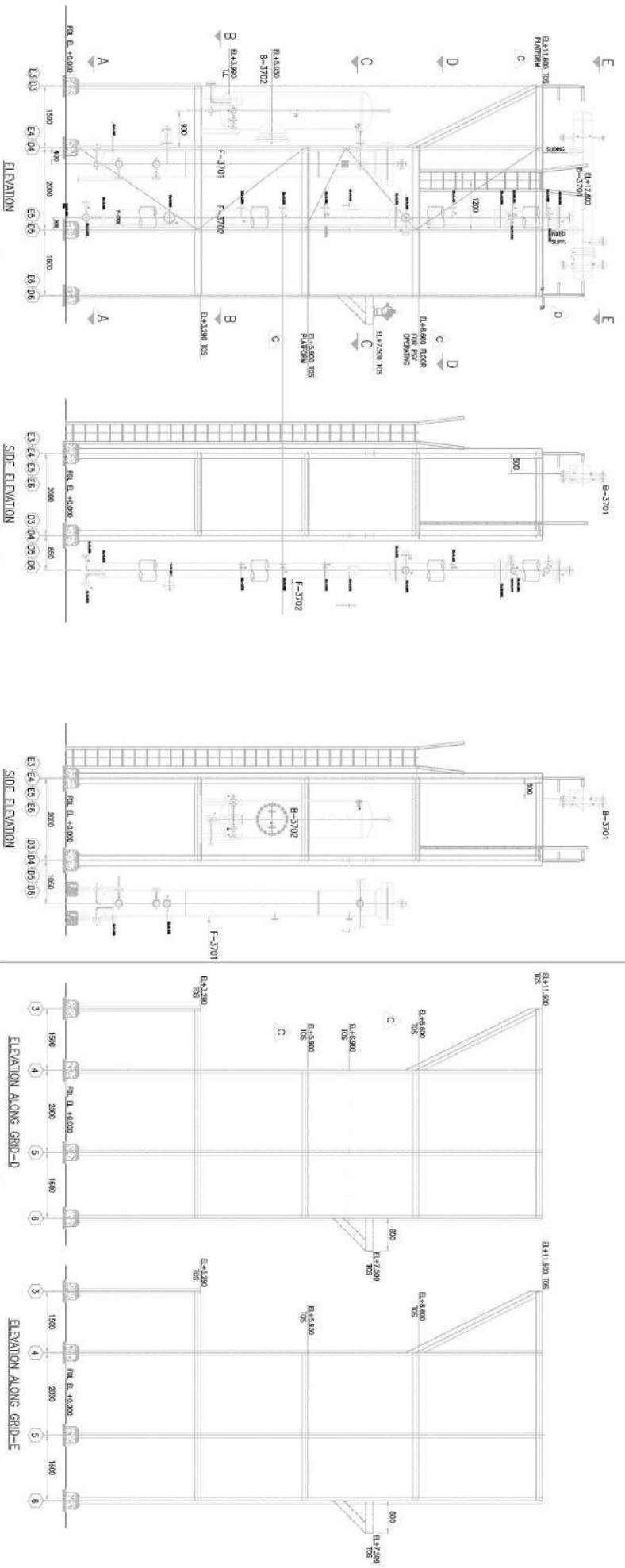


M/s. NATIONAL FERTILIZERS LTD.

PROJECT: M/s. NATIONAL FERTILIZERS LTD.

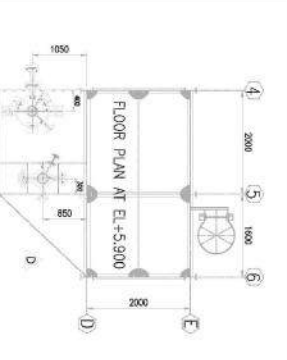
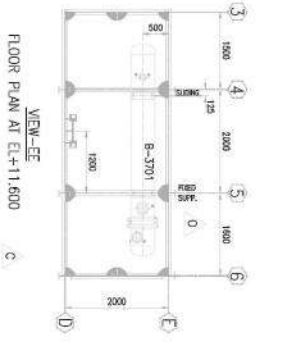
DATE: 2015

APP-5593-00-1-001 0



NOTES:-

1. ALL CO-ORDINATE ELEVATIONS ARE IN METERS AND ALL DIMENSIONS ARE IN MILLIMETERS
2. FOL +0.000 IS THE LEVEL+100.000MM. OF N/F/P/S/L LAYOUT DRAWING. NO. P/CS-00-001-1A402.
3. P/S/S/S. EQUIPMENTS ARRANGEMENT IS BASED ON AP FLOOR PLAN DRAWING. NO. 12057-6668-001.
4. LOCATION OF THIS Dwg. REFER LAYOUT Dwg. NO. CRP-5593-00-1-001.
5. 0. FROM INLET OF PP STRIPPERS PUMPS TO CONDENSATE TANK HORIZONTAL DISTANCE IS MAX. 3500 mm.

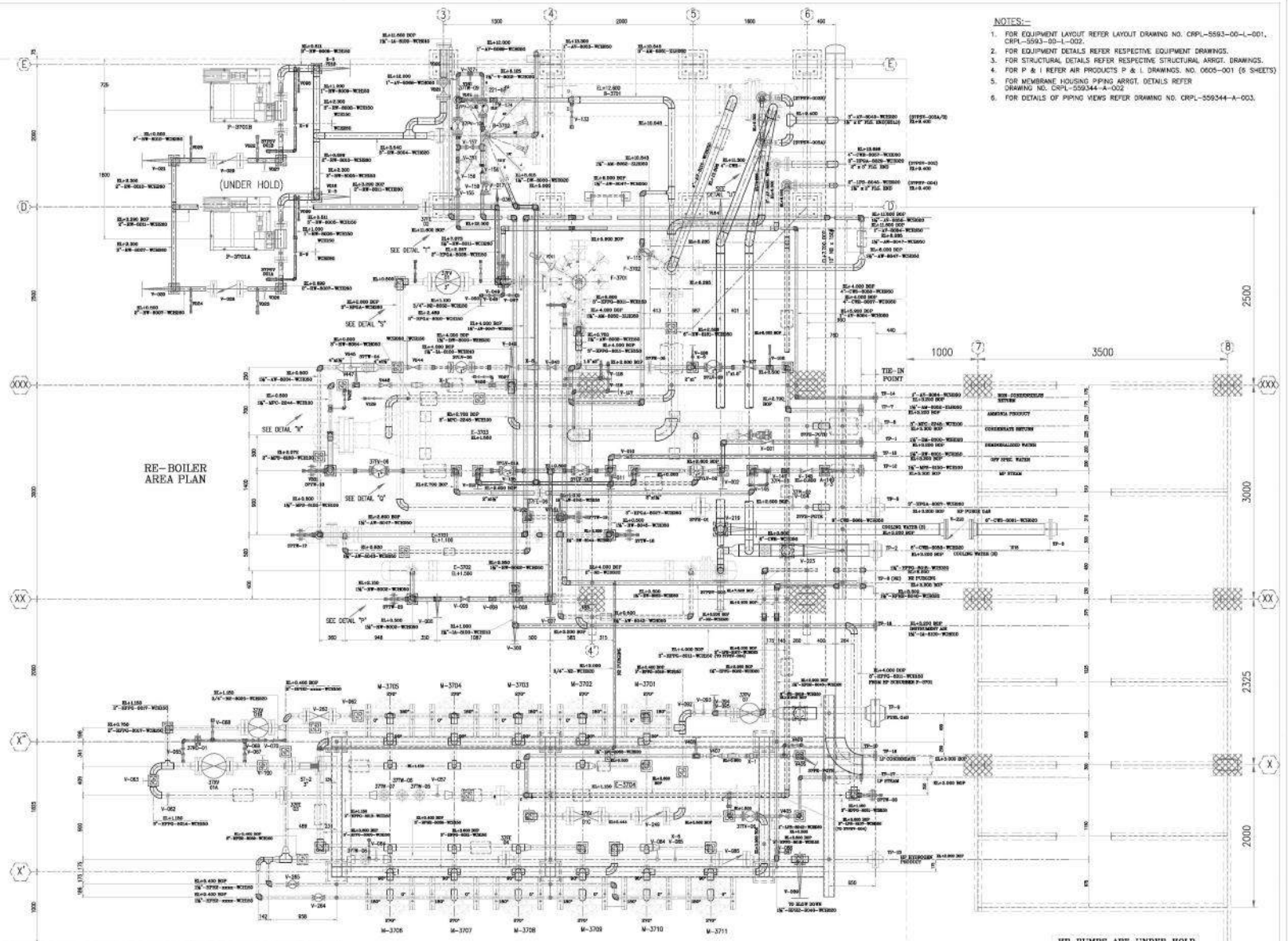


0	AMMONIA CONDENSER SHADE LOCATION REVISED AS PER SPC/MA DRAWING FINALIZED FOR EXECUTION.	7/8/15/8/15/8/15	MM/MA/MD/KAY
D	SPC/MA STRIPPER, F-3702 SUPPORTING ARRANGEMENT SPC/MA	8/7/15/8/15/8/15	MM/MA/MD/KAY
C	EQUIPMENTS B-3701, LOCATION FINALISED AND HOLD REWORKED, AND REVISED AS MARKED AP COMMENTS INCORPORATED	8/7/15/8/15/8/15	MM/MA/MD/KAY
B	AP COMMENTS INCORPORATED	8/7/15/8/15/8/15	MM/MA/MD/KAY
A	FIRST ISSUE	8/7/15/8/15/8/15	MM/MA/MD/KAY

CONSULTANT: M/s. PROJECTS & DEVELOPMENT INDIA LTD.

	शतलक्ष इंजीनियरिंग प्रिविटेड Shat Lakh Engineering Private Ltd. 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.	M/s. NATIONAL FERTILIZERS LTD. VIJAYPUR STRUCTURE FOR CONDENSATE TANK AND AMMONIA CONDENSER 6593	1:50 2015 CRP-5593-00-1-002 0
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N-894.900



- NOTES:-
1. FOR EQUIPMENT LAYOUT REFER LAYOUT DRAWING NO. CRPL-5593-00-L-001, CRPL-5593-00-L-002.
 2. FOR EQUIPMENT DETAILS REFER RESPECTIVE EQUIPMENT DRAWINGS.
 3. FOR STRUCTURAL DETAILS REFER RESPECTIVE STRUCTURAL DRAWINGS.
 4. FOR P & I REFER AIR PRODUCTS P & I DRAWINGS, NO. 0605-001 (6 SHEETS)
 5. FOR MEMBRANE HOUSING PIPING ARRGT. DETAILS REFER DRAWING NO. CRPL-559344-A-002
 6. FOR DETAILS OF PIPING VIEWS REFER DRAWING NO. CRPL-559344-A-003.

W-1308.500

N-882.500

N-880.400

MEMBRANE ARRANGEMENT

N-880.400

W-1285.500

HP PUMPS ARE UNDER HOLD

NO.	DESCRIPTION	EQUIP. QTY./CENTRE LINE ELEVATION
P-3701	1. P. 3701	1
P-3702	1. P. 3702	1
P-3703	1. P. 3703	1
P-3704	1. P. 3704	1
P-3705	1. P. 3705	1
P-3706	1. P. 3706	1
P-3707	1. P. 3707	1
P-3708	1. P. 3708	1
P-3709	1. P. 3709	1
P-3710	1. P. 3710	1
P-3711	1. P. 3711	1

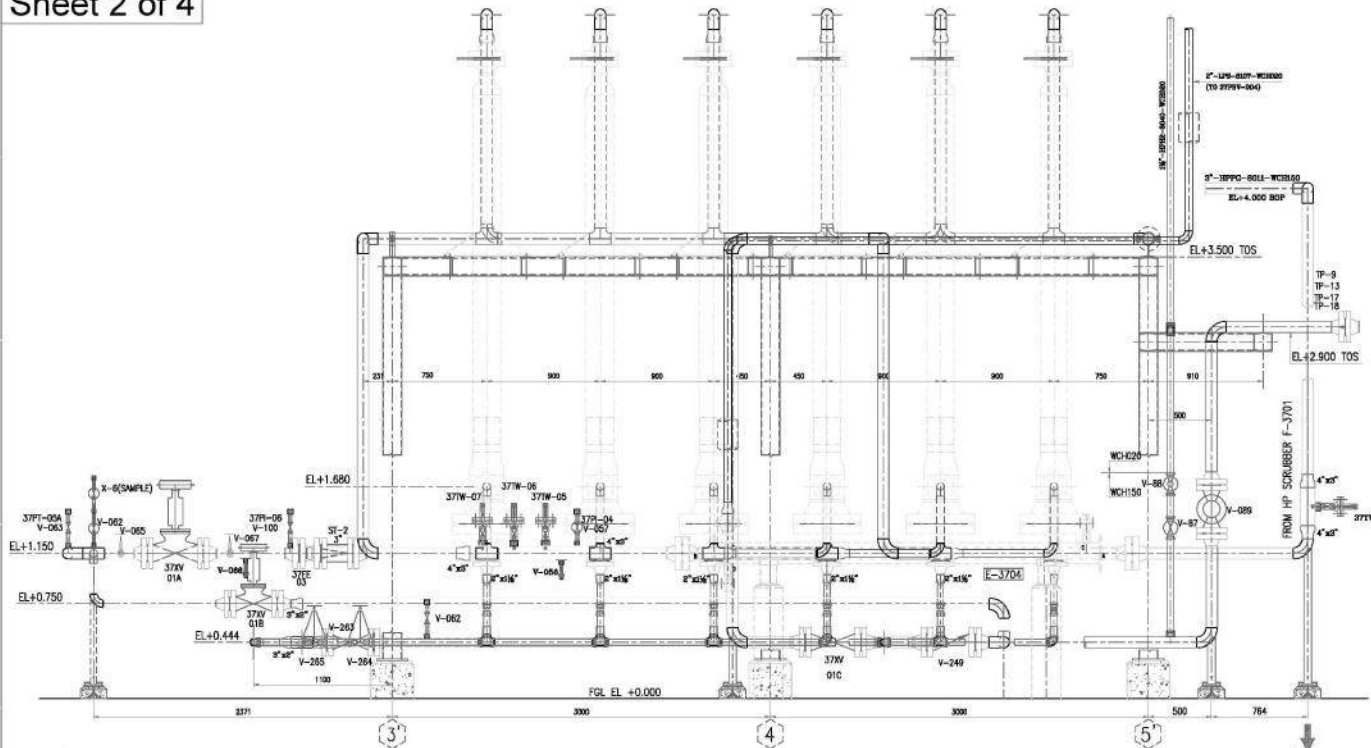
CONSULTANT: M/s. PROJECTS & DEVELOPMENT INDIA LTD.

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
 Bharat Heavy Electricals Ltd.
 100, Bypass Road, Ranchi - 834002, Jharkhand, India

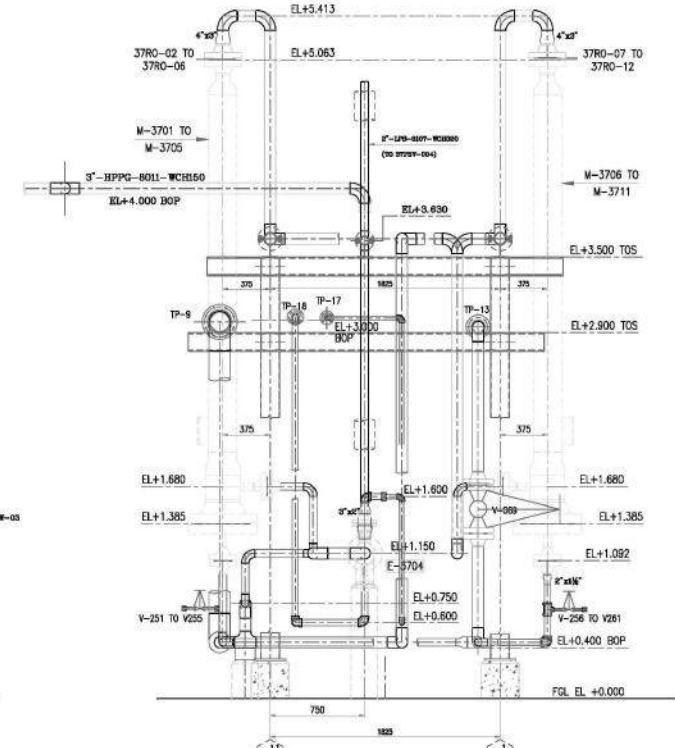
M/s. NATIONAL FERTILIZERS LTD.
 NHF
 PIPING GENERAL ARRANGEMENT
 PEGAS GAS RECOVERY UNIT

5593-44 ONE
 1:20 2015 CRPL-559344-A-001 A

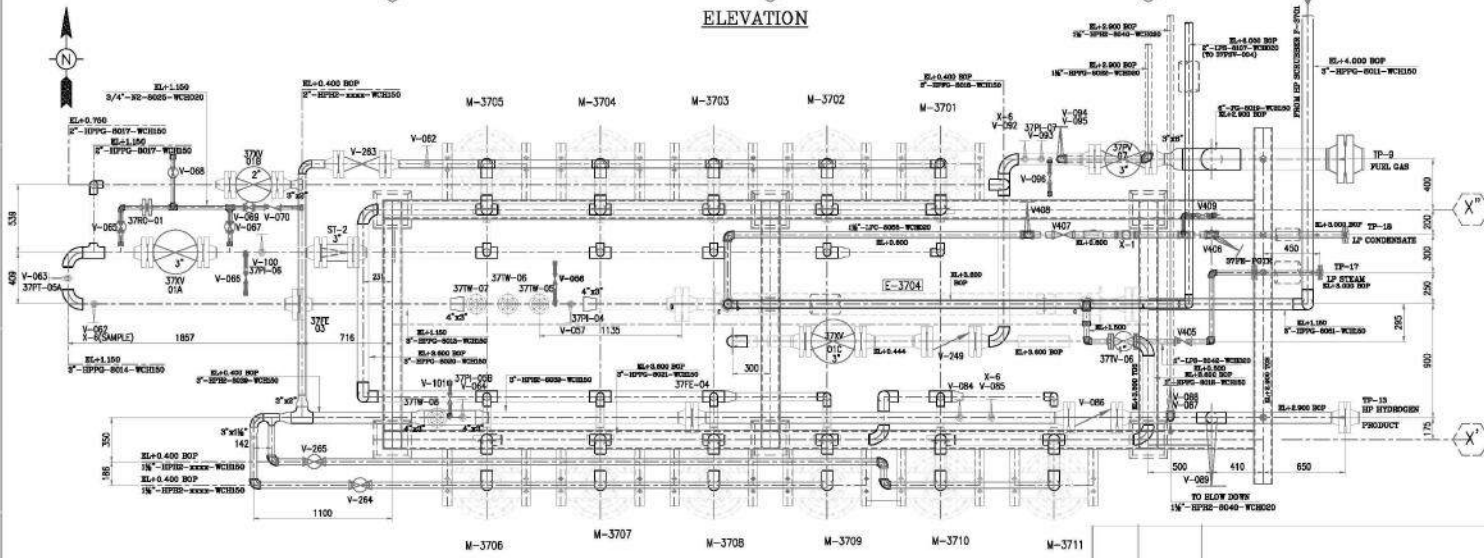
Only For Tender Purpose



ELEVATION



SIDE VIEW



MEMBRANE ARRANGEMENT

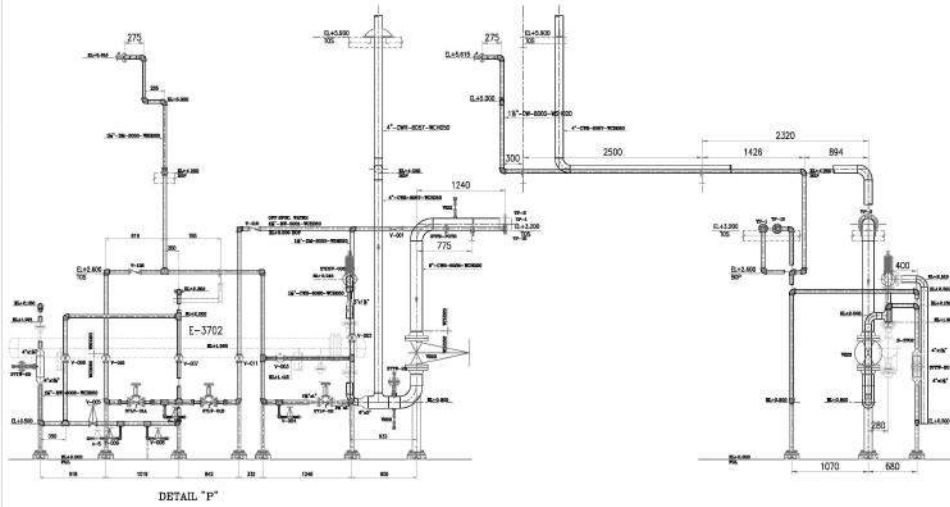
Only For Tender Purpose

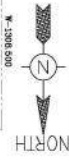
- NOTES:-
1. LOCATION OF THIS DRAWING REFER PIPING GENERAL ARRANGEMENT DRAWING NO. CRPL-559344-A-001.
 2. REFERENCE DRAWING NO :-
 - a) AIR PRODUCTS P & I 0805-001 SHEET 3 & 6
 - b) CRME-559304-A-000 G.A. OF HOUSING FOR MEMBRANE MODULES (M-3701 TO M-3711)
 - c) CRME-559303-A-000 G.A. OF FEED HEATER
 - d) CRPL-5593-00-L-001 EQUIPMENT LAYOUT.
 - e) CRST-559374-A-002 STRUCTURE FOR MEMBRANE HOUSING.

CONSULTANT: M/s. PROJECTS & DEVELOPMENT INDIA LTD.

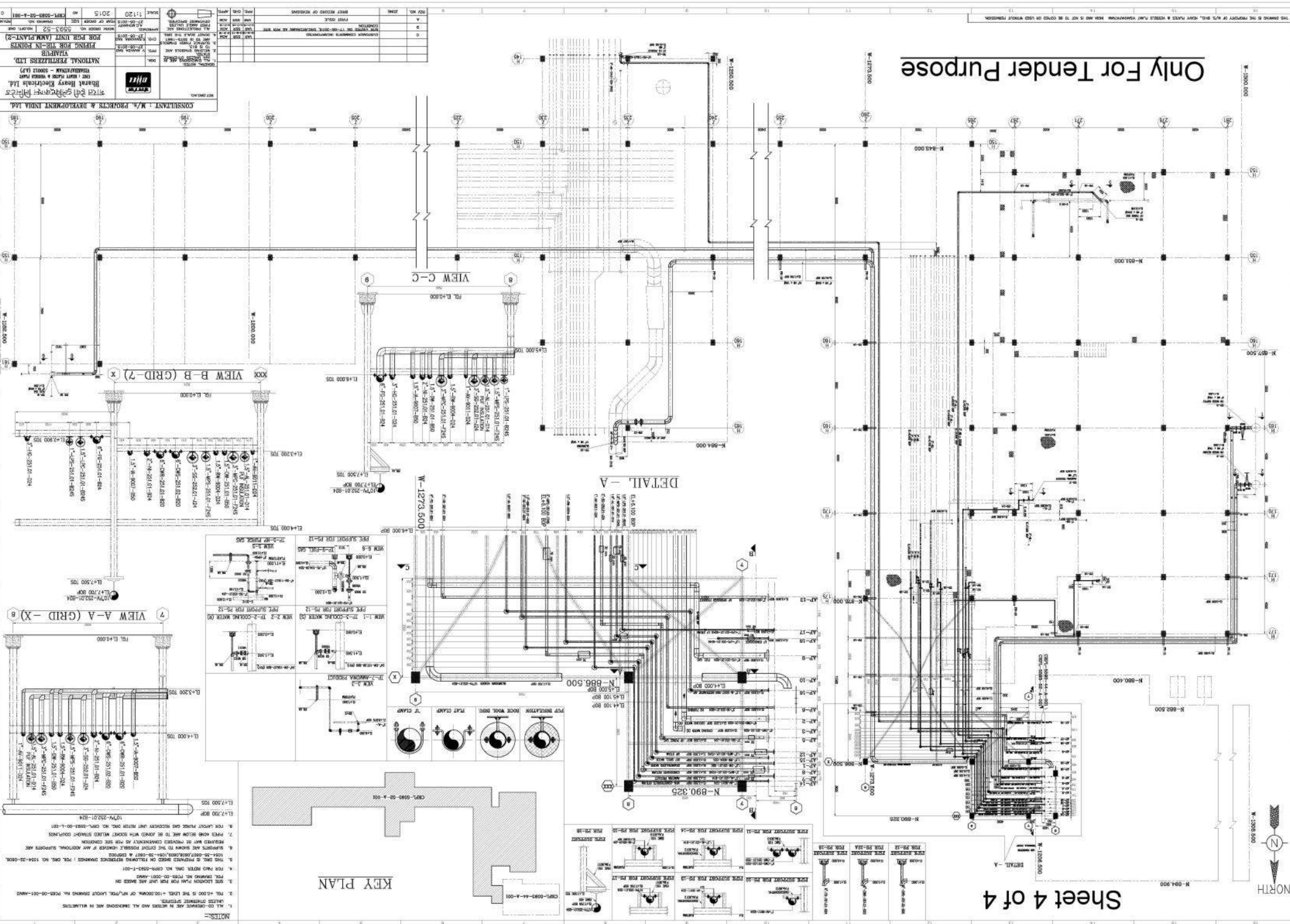
	भारत हेवी इलेक्ट्रिकल्स लिमिटेड Bharat Heavy Electricals Ltd. CHD - HEAVY PLATES & TUBES PLANT VARANASI (U.P.) - 221015 (I.P.)
	M/s. NATIONAL FERTILIZERS LTD. VILAIKUR ARRANGEMENT OF MEMBRANES HOUSING PURGE GAS RECOVERY UNIT 5593-44
MURNU 9/7/15 AV RAO 9/7/15	ONE
AC NOBARTY	1:20
2015	CRPL-559344-A-002 A

ISSUED FOR APPROVAL





Only For Tender Purpose



NOTES:
1. ALL DIMENSIONS ARE IN METERS AND ALL DIMENSIONS ARE IN MILLIMETERS (UNLESS OTHERWISE SPECIFIED).
2. TOL. ±0.000 IS THE EXACT ±100.000MM OR 1/32" TOL. UNLESS OTHERWISE SPECIFIED.
3. SITE LOCATOR MAP FOR REF. ARE SHOWN ON SHEET 01-001-001-001.
4. THE PWD WATER SUPPLY, PWD, NO. CWP-0001-001-001.
5. THE CW & CHW SYSTEMS ARE TO BE PROVIDED BY THE CLIENT.
6. SUPPORTS ARE SHOWN TO THE EXTENT POSSIBLE. HOWEVER, IF ANY ADDITIONAL SUPPORTS ARE REQUIRED FOR THE SYSTEMS, THE CONTRACTOR SHALL PROVIDE THE SAME.
7. PIPES SHALL BE INSTALLED AS SHOWN IN THE DRAWING UNLESS OTHERWISE SPECIFIED.
8. FOR LAYOUT PURPOSES ONLY. NO. CWP-0001-001-001.

VIEW A - A (GRID - X)
VIEW B - B (GRID - Y)
VIEW C - C
VIEW 1 - 1
VIEW 2 - 2
VIEW 3 - 3
VIEW 4 - 4
VIEW 5 - 5

PROJECT INFORMATION TABLE

NO.	2015
DATE	11/20/2015
SCALE	AS SHOWN
PROJECT	BHARAT HEAVY ELECTRICALS LTD. PLANT - 2
CLIENT	M/S. PROJECTS & DEVELOPMENT INDIA PVT. LTD.
DESIGNER	M/S. PROJECTS & DEVELOPMENT INDIA PVT. LTD.
CHECKER	M/S. PROJECTS & DEVELOPMENT INDIA PVT. LTD.
APPROVED	M/S. PROJECTS & DEVELOPMENT INDIA PVT. LTD.
DATE OF ISSUE	11/20/2015
NO. OF SHEETS	04
SHEET NO.	04