

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery		
	CLIENT		INDIAN OIL CORPORATION LIMITED		
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WELDING & NDE SPECIFICATION FOR FABRICATION OF PIPING

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1. GENERAL

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

The welded pipe joints shall include the following:

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

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

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

2. ABBREVIATIONS & DEFINITIONS:

“OWNER or IOCL” shall mean INDIAN OIL CORPORATION LIMITED

“CONSULTANT or PMC” shall mean TECHNIP INDIA LIMITED

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

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

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

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

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

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

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

3. APPLICABLE CODES & STANDARDS

All welding work, equipment for welding, heat treatment, other auxiliary functions and the welding personnel shall meet the requirements of the latest editions of the following accepted standards and procedures unless otherwise specified in the Welding Specification Chart and the Technical Notes attached thereof. In the case of conflicting requirements, the requirements mentioned in Welding Specification Chart/Technical Notes shall be applicable.

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

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

p. Licensers specifications.

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

4. ORDER OF PRECEDENCE

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

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

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

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

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

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

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

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

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5.4 Special requirement for CS with PWHT

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

Hardness should be limited to the following after PWHT:

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

5.5 Ferrite

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

6. BASE METAL

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

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

7. WELDING CONSUMABLES

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

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

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

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

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

Carbon / Low alloy /Ferritic steels

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

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

Austenitic Stainless Steel

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

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

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

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Austenitic/Ferritic Stainless Steel (DUPLEX)

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

7.11 Consumable Storage

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

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

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

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

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

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

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

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

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

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issue

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

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

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

8. SHIELDING & PURGING GAS

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

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

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

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

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

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

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

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9. EQUIPMENTS & ACCESSORIES

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

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

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

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

10. WELDING PROCESS

10.1 General

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

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

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

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

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

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

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

10.2 Requirement for specific welding process

10.2.1 Flux Cored Arc Welding (FCAW)

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

Flux cored welding shall not be used for wet H₂S services

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

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

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

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

10.2.2 Submerged Arc Welding Process (SAW)

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

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

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

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

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

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

10.2.3 Tungsten Arc Welding (GTAW)

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

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

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

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

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

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

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

10.2.4 Shielded Metal Arc Welding (SMAW)

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

10.2.5 Gas Metal Arc Welding (GMAW)

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

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

11. EDGE PREPARATION

11.1 General

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

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

Carbon Steel

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

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

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

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

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

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

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

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

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11.2 Cleaning

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

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

12 ALIGNMENT & SPACING

Components to be welded shall be aligned and spaced as per the requirements laid down in applicable code. Special care must be taken to ensure proper fitting and alignment when the welding is performed by GTAW process. Flame heating for adjustment and correction of ends is not permitted unless specifically approved by the Engineer-in-Charge.

A wire spacer of suitable diameter may be used for maintaining the weld root opening while tacking, but it must be removed after tack welding and before laying the root bead.

For pipes of wall thickness 5 mm and above, the ends to be welded shall be secured in position with the aid of couplers, yokes and 'C' clamps, to maintain perfect alignment. Yokes shall be detached after the completion of weld, without causing any surface irregularity. Any irregularity caused on the pipe surface must be suitably repaired to the satisfaction of the Engineer-in-Charge.

Tack welds, for maintaining the alignment, of pipe joints shall be made only by qualified welders using approved WPS. Since the tack welds become part of the final weldment they shall be executed carefully and shall be free from defects. Defective tack welds must be removed prior to the actual welding of the joints

Tacks should be equally spaced. Minimum number of tacks shall be:

- 3 tacks - for 2 1/2" and smaller dia. pipes.
- 4 tacks -for 3" to 12" dia. pipes.
- 6 tacks -for 14" and larger dia. pipes

Welding shall commence only after approval of fit-up by the Engineer-In-Charge.

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13. WEATHER CONDITIONS

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

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

14. WELDING TECHNIQUE

14.1 Root Pass

Root pass shall be made with electrodes/filler wires recommended in the welding specification chart. For fillet welding, root welding shall be done with consumables recommended for filler passes. The preferred size of the electrodes is 2.5 mm diameter (12 S WG) but in any case, not greater than 3.25 mm (10 S WG).

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

The root pass of butt joints should be executed so as to achieve full penetration with complete fusion of the root edges. Weld projection inside the pipe shall be as per applicable code. It shall be limited 3mm max. when the applicable code does not place any restriction.

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

Welding shall be uninterrupted.

While the welding is in progress care should be taken to avoid any kind of movement of the components, shocks, vibrations and stresses to prevent occurrence of weld cracks.

Peening shall not be used.

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

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

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

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

14.2 Joint Completion

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

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

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

Each weld joint shall have a workmanship like finish. Weld identification work shall be stamped clearly at each joint, just adjacent to the weld. Metal stamping shall not be used on thin pipe having wall thickness less than 3.5mm. Suitable paint shall be used on thin wall pipes for identification.

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

14.3 Dissimilar Welds

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

Dissimilar metal welding shall be avoided in wet sour service

15. HEAT TREATMENT

15.1 Preheating

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

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

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

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

Preheating shall extend uniformly to at least three times the thickness of the joint, but not less than 50 mm, on both sides of the weld.

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

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

15.2 Post Heating

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

15.3 Post Weld Heat Treatment (PWHT)

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

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

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The CONTRACTOR / VENDOR shall submit for the approval of the Engineer-in-Charge, well before carrying out actual heat treatment, the details of the post weld heat treatment procedure as per Exhibit B attached, that he proposes to adopt for each of the materials/assembly/part involved.

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

While carrying out local post weld heat treatment, technique of application of heat must ensure uniform temperature attainment at all points of the portion being heat- treated. Care shall be taken to ensure that width of heated band over which specified post weld heat treatment temperature attained is at least that specified in the relevant applicable standards/codes. Control of temperature shall be done using microprocessor/computer controlled system. The desired time-temperature cycle shall be entered into the microprocessor/computer.

Throughout the cycle of heat treatment, the portion outside the heated band shall be suitably wrapped under insulation so as to avoid any harmful temperature gradient at the exposed surface of pipe. For this purpose temperature at the exposed surface should not be allowed to exceed 50% of the peak temperature.

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

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

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

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

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

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

16. CLEANING OF THE WELD JOINT

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

17. INSPECTION AND TESTING

17.1 General

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

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

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

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

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17.2 Welding Procedure Qualification

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

17.3 Brinell hardness tests

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

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

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

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

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

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

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17.4 Welder's Qualification

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

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

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

If a welder is found to perform a type of welding or in a position for which he is not qualified, he shall be debarred from doing any further work. All welds performed by an unqualified welder shall be cut and redone by a qualified welder at the expense of the CONTRACTOR / VENDOR

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

All Welders and welding operators shall be qualified at Site.

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

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

17.5 Welder Performance Registration.

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

This register should at least contain the following data:

- Welder's name and stamp.

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

18. NON-DESTRUCTIVE EXAMINATION

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

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

18.1 Visual Examination

Visual Examination of all welds shall be carried out as per the latest editions of the applicable codes and specifications. All finished welds shall be visually inspected for parallel and axial alignment of the work, excessive reinforcement, concavity of welds, shrinkage cracks, inadequate penetration, unrepaired burn-through, under cuts, dimensions of the weld, surface porosity and other surface defects. Undercutting adjacent to the completed weld shall not exceed the limits specified in the applicable standard/code.

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

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

18.2 Radiographic Examination

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

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

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

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

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

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

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

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

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

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

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

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

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

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

18.3 Check shots

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

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

18.4 Ultrasonic examination (UT)

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

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

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

The UT procedure shall include the following information as minimum:

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

18.5 Liquid Penetrant and Magnetic Particle Examination

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

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

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

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

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

The PT procedure shall include the following information as minimum:

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

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

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

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

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

The MT procedure shall include the following minimum information.

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

18.6 Hardness Test

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

18.7 Proof Tests

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

19. REPAIRS OF WELDS

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

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

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

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

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

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

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

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

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

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

Proposed Heat Treatment Procedure as per Exhibit-B.

Heat Treatment Charts.

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Weld joint hardness test results.

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

Welding Procedure Qualification records as per Exhibit-D.

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

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

Radiographic test Report along with Radiographs and other NDE reports.

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

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EXHIBIT – B

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STRESS RELIEF HEAT TREATMENT PROCEDURE SPECIFICATION

Contractor : _____

Name of the Heat treater : _____

Name of the Project : _____ Specification _____

Reference No. _____

1. General Details Other Details

Name of the
Equipment : _____

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

Maximum Permissible Temp at
Uncovered Parent Metal _____

Width of heated band _____

Width of Insulation _____

Material : _____

No. of Thermo couples (dia wise)

Type of Thermo couples _____

3. Heat Treatment Cycle Details

Charging Temp °C _____

Rate of heating °C /Hr. _____

Soaking Temperature, °C _____

Soaking Time, Hrs. _____

Rate of Cooling °C /Hr. _____

Method of Cooling _____

4. Other details, if any _____

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
WELDING & NDE SPECIFICATION FOR FABRICATION OF PIPING	Project No. 080557C001	Document No. 080557C-000-PP-814	Rev. No. 3	Page 32 of 40

EXHIBIT - C
SHEET 1 OF 3

FORMAT FOR WELDING PROCEDURE SPECIFICATION (WPS)

Company Name _____ By _____

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

Revision No. _____ Date _____

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

JOINTS

Joint Design _____

Backing (Yes) _____ (No) _____

Backing Material (Type) _____

Sketches Production Drawings. Weld Symbols Written

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

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

BASE METALS

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

OR

Specification type and grade _____

to Specification type and grade _____

OR

Chem. Analysis and Mech. Prop. _____

to Chem. Analysis and Mech. Prop. _____

Thickness Range :

Base Metal : Groove _____ Fillet _____

Deposited Weld Metal : Groove _____ Fillet _____

Pipe Dia Range : Groove : _____ Fillet _____

Other _____

 	PROJECT	Standby SRU & Additional Tanks IOCL Paradip Refinery		
	CLIENT	INDIAN OIL CORPORATION LIMITED		
WELDING & NDE SPECIFICATION FOR FABRICATION OF PIPING	Project No. 080557C001	Document No. 080557C-000-PP-814	Rev. No. 3	Page 33 of 40

EXHIBIT - C
SHEET 2 OF 3

FILLER METALS

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

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

ELECTRICAL CHARACTERISTICS

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

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

TECHNIQUE

String or Weave Bead _____

Orifice or Gas Cup Size _____

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

Method of Back Gouging _____

Oscillation _____

Contact Tube to Work Distance _____

Multiple or Single Pass (per side) _____

Multiple or Single Electrodes _____

Travel Speed (Range) _____

Peening _____

Other _____

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

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

FORMAT FOR PROCEDURE QUALIFICATION RECORD (PQR)

RECORD ACTUAL CONDITIONS USED TO WELD TEST COUPON

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

JOINTS

Groove Design of Test Coupon

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

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

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

GUIDED BEND TESTS

Type of Figure No.	Result

TOUGHNESS TESTS

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

FILLET WELD TEST

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

Marco - Results _____

OTHER TESTS

Type of Test _____

Deposit Analysis _____

Other _____

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

Test Conducted by _____ Laboratory Test No. _____

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

Date _____

Manufacturer _____

By _____

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

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

SHEET 1 OF 2

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

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

Using WPS No. _____ Rev. _____

The above welder is qualified for the following ranges

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

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

Guided Bend Test Results

Type and Fig. No.	Result

Radiographic Test Results
For alternative qualification of groove welds by radiography

Radiographic Results _____

Fillet Weld Test Results

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

Length and Per Cent of Defects _____ inches _____ %

Macro Test - Fusion _____

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

Test Conducted by _____ Laboratory - Test No. _____

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

Date _____

Organization _____

By _____

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

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

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

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

(List of Approved Welding Electrodes
for IOCL Refineries)



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

REF: M&I/ IP/Welding/33

Updated in Dec'2017

Sub: List of Approved welding electrodes for IOCL Refineries

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

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

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

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

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

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

2. M/s Mailam India Ltd., Pondicherry

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

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

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

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

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

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

1. M/s. ADOR Welding Limited

2. M/s. ESSAB India Limited

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

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

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

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

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

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

6. M/s Mailam India Ltd. Pondicherry

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

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

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

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

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

9. M/s GEE Limited, Thane, Mumbai

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

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

10. M/s Modi Arc Electrode Co.

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

11. Royal Electrodes, Mumbai

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

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

1. M/s Modi Arc Electrode Co.

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

2. M/s D&H India, Indore

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

3. M/s GEE LIMITED

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

4. M/s Royal ARC Electrodes Limited



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



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



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



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



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

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

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

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

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

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

- Note 1

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

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

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

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

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

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

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

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

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

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