

दूरभाष :
TELEPHONE :
तार : बार्क-मुंबई, चेम्बुर.
TELEGRAMS: BARC-MUMBAI, CHEMBUR.
टेलिक्स : ०११-६१०१७/०११-६१०२२ बार्क ईन
TELEX: 011-61017/011-61022 BARC IN
फेक्स संख्या : ११ - २२ - ५५० ५१५१
FAX NUMBER: 91-22- 5505151



सत्यमेव जयते

भारत सरकार
GOVERNMENT OF INDIA

भाभा परमाणु अनुसंधान केन्द्र
BHABHA ATOMIC RESEARCH CENTRE
RESEARCH REACTOR MAINTENANCE DIVISION
Mechanical Maintenance Section, Dhruva

Ref: RRMD/ TR-1/TN-551/2017

October 27, 2017

To,
The Relevant party

Sub: Proposal for Supply, Fabrication, Replacement and commissioning of Waste Disposal pipelines in MOS pump house.

Sir,

Sealed quotation is invited for Supply, Fabrication and Replacement and commissioning of Waste Disposal pipelines in MOS pump house as per the description and scope of work given below. Sealed quotation, subscribing the tender notice no. with name of work over the envelope, shall be sent to Administrative Officer - III, Reactor Group Office, Dhruva, BARC, Trombay, Mumbai-400085 so as to reach on **or before 13.11.2017**.

The quotation shall be sent through registered post/speed post through Indian postal services only. Quotation delivered by person or through courier will not be accepted and not considered for bidding process.

1.	Name of work	Supply, Fabrication and Replacement and commissioning of Waste Disposal pipelines in MOS pump house.
2.	Earnest Money Deposit (EMD)	Rs.45,000/- (Rupees Thirty Five Thousand only) Refer clause 11.0
3.	Time of completion	Ninety days
4.	Offer validity	90 days from due date of opening the tender

The EMD & financial bid should be sealed by the bidder in separate covers duly super scribed and both these sealed covers are to be put in a bigger cover which should be sealed and duly super scribed with the name of the work and tender notice reference and submitted on or before the due date by registered post/ speed post only. Refer section 11.0 for details.

The quotation shall be in the format of attached schedule-B and shall show the basic cost and GST separately, if applicable and shall include the tender ref. no., PAN and GSTIN of the firm.

1.0 INTRODUCTION:

The existing pipeline inside MOS pump house has developed leakages in the Carbon steel segment. These segment of CS pipe will be removed and replaced with new SS-316L material pipe and pipe fittings at the same location on the existing supports.

2.0 SCOPE OF WORK

The brief scope of work is given below:

General (Applicable to all the work items)

- 2.1 Detailed study of piping layout and verification of the routing of the pipelines as per actual site conditions before purchase of material and commencement of the work.
- 2.2 Preparation of site layout sketch based on actual site conditions and obtaining approval for the same from Engineer-in-charge.
- 2.3 Procurement, supply and testing of materials like pipes, fittings, flanges as listed in schedule 'B'.
- 2.4 Supply of materials for piping fabrication & erection like welding consumables, fasteners, gaskets, clamps etc. that may not be specifically counted but are necessary for completion of the job.
- 2.5 Issue of free issue material as per schedule 'A' and approved bill of material from RG stores, if any. Safe storage & proper accounting of Free issue material.
- 2.6 Preparation of job schedule & procedure and obtaining the approval of Engineer-in-charge.
- 2.7 Preparation and carrying out welding procedure qualification and welder's qualification as per ASME Section IX.
- 2.8 The general guidelines for welding are given in **Appendix - A**: "Welding requirements for fabrication of piping". All the electrodes shall be of Ador/Advani-Orlikon/Esab make.
- 2.9 The general guideline for examination of weld joints and acceptance criteria for welding defects are given in **Appendix - B**: "Welding examination requirement and methods".
- 2.10 Erection of scaffolding as and where required to facilitate working at high elevation locations specifically for site welding, erection of pipelines and anchoring of pipe supports on existing concrete foundation.
- 2.11 Repair and replacement of parts damaged during erection.
- 2.12 Field alteration as required due to design changes or to correct errors in detailing of fabrication.
- 2.13 Handling and proper storage of materials procured by the contractor. The contractor shall be provided a temporary storage place for the safe storage of the materials including pipes and pipe-fittings at a place identified by the Engineer-in-charge.
- 2.14 Cutting of old piping & structure generated in this contract into suitable pieces and packed into drums provided by BARC and disposal within complex as per Engineer-In-Charge.
- 2.15 Quality control, inspection and testing of the work.
- 2.16 Submission of reports concerning the quality of work, progress of work etc.
- 2.17 Any other work not specifically mentioned above but is required for efficient execution of work.

Detail scope of work.

- 2.18 Erection of scaffolding as and where required to facilitate working at high elevation locations specifically for site welding, erection of pipelines and anchoring of pipe supports on existing concrete foundation.
- 2.19 Removal of old piping part by part as permitted & isolated time to time.
- 2.20 Edge preparation, welding, fabrication & erection of piping as per site layout for the removed portion of piping.

- 2.21 Welding shall be carried out by the qualified welders and method shall be GTAW welding with appropriate electrode / filler wire.
- 2.22 Liquid Penetrant Testing (LPT) of root and final passes of all the weld joints as per ASTM E-165. The general guideline for examination of weld joints to know the weld surface defects, if any, are given in **Appendix - C**: "Liquid Penetrant Examination and Method".
- 2.23 Radiographic test (RT) of at least 10% of weld joints as per ASTM E-94. The general guideline for examination of weld joints to know the volumetric weld defects, if any, defects are given in **Appendix - D**: "Radiographic Examination and Method".
- 2.24 Fabrication and erection of pipe supports if required, made of rolled structural sections supplied by department.
- 2.25 Hydrostatic pressure testing of the entire fabricated pipe sections along with its branch connections, after erection at standard test pressure and held for at least ½ an hour. Contractor has to arrange all the required material for testing e.g. required blind flanges, pressurizing pump, pressure tubing connections, gauges etc.
- 2.26 Painting of newly erected supports.

3.0 VARIATION OF SCOPE OF WORK

The quantity of items in schedule B is as per estimate. If in course of work there is a reduction in quantity due to site changes, the contractor shall be ready to execute lesser quantity also.

4.0 SCOPE OF CONTRACTOR'S SUPPLY

In execution of the above work, the scope of the contractor's supply comprises of the following:

- 4.1 Supply of all the material, pipes, fittings, flanges etc. as per Schedule-'B' and as per site measurements. The pipes shall be procured from the reputed Indian manufacturers only. The material shall also accompany its original relevant test certificates of the manufacturers.
- 4.2 Supply of all welding consumables, gaskets, fasteners etc. required for assembly & erection of pipelines as per actual site condition, material for Liquid Penetrant testing, arrangement of tools & tackles for Radiographic test etc.
- 4.3 Providing all the equipments including grinding machine, pipe bending machine, welding generator and other welding equipments, required tools, tackles for hoisting facilities, etc. required to carry out the work.
- 4.4 Arrangement for hydrostatic testing like hand pumps, gauges, tubing, blind flanges etc.
- 4.5 All the consumables e.g. nut-bolts, gaskets, electrodes, etc should be procured only from reputed manufacturers, conforming to applicable standards and of good quality. All the material shall accompany its relevant test certificates of the manufacturers.

5.0 SUPERINTENDENCE AND LABOUR

The contractor shall provide supervision of erection which, shall include without limitation:

- 5.1 A competent Supervisor who shall be regularly at site and shall give his whole time to the superintendence of the erection of the works and whose duties shall include the supervision

of welding, assembly and installation, etc. repair and replacement of any damaged components and find alterations required to correct errors, in detailing of fabrication.

- 5.2 The employment of sufficient number of competent assistants to the Supervisor to complete the work within the time period specified.
- 5.4 The contractor shall employ only such persons who are skilled and experienced in their trades.
- 5.5 All workers shall be medically fit and shall submit a medical certificate in the approved format.

6.0 TECHNICAL SPECIFICATION

6.1 General

The piping & Structural system shall conform in all respect to the latest applicable Indian / American standards and safety codes. The detailed technical specifications on cleaning, fabrication, welding, DP testing, erection, pressure testing of pipelines is mentioned in the Appendices attached to this tender document.

6.2 Material specification

- 6.2.1 All the stainless steel seamless piping and pipe fittings shall be of reputed make conforming to ASTM A-312 TP 316L & ASME B36.19M and ASTM A-182 TP 316L & ASME B16.9 respectively, Weld neck raise face flanges (WNRF) of class#150, forged stainless steel, conforming to ASTM A-182 TP 316L & ASME B-16.5. The piping including fittings shall be butt weld, seamless Schedule- 40S as mentioned in the Schedule- 'B'.
- 6.2.2 The Bolt and nuts of the equipments, piping and support work shall be conforming to SA 193 Grade B7 & SA 194 Grade 2H.
- 6.2.3 Pipe 'U' clamps suitable for 2" NB, 3" NB & 4" NB pipe sizes shall be conforming to Cadmium/Chromium plated SA 193 Grade B7 & SA 194 Grade 2H.
- 6.2.4 All the electrodes shall be of Advani-Oerlicon make.
- 6.2.5 Gaskets shall be neoprene with Hardness 65 shore A. Gaskets shall be new with ash content less than 5%.

6.3 Codes and Standards

The fabrication, erection and testing of the piping system covered in this specification shall comply/conform in all respect to the currently applicable statutes, regulations and safety codes in the locality of plant site. The piping system shall conform in all respect, to the latest editions of the following Indian / American Standards. In the event of any conflict between any standard with technical specification, the governing requirement shall be as per technical specification.

ANSI Standards

ANSI	B.36.19	Stainless Steel pipe
	B.16.5	Steel pipe flanges and flanged fittings
	B.16.11	Forged steel fitting socket welding and threading
	B.16.9	Wrought steel butt welding fittings
	B.16.25	Butt welding ends
	B.31.7	Nuclear Power piping code.

ASTM Standards

ASTM	A-182	Forged or Rolled alloy steel pipe flanges, forged fittings.
	A-193/194	Stainless steel fastener.
	A-312	Seamless and Welded Austenitic S.S. pipe.
	A-371	Corrosion resisting Cr & Cr.Ni. steel welding rods and bars electrodes
	A-403	Wrought austenitic stainless steel piping fittings
	B-297	Specification for Tungsten arc welding electrodes.
	E-94	Recommended practice for radiographic testing (RT)
	E-165	Liquid Penetrant Testing (LPT)

ASME Standard

ASME	Boiler and Pressure Vessel code
Section II	Material specification
Section III	Design, fabrication, inspection, testing of nuclear grade Component
Section V	Non-destructive Examination
Section IX	Welding and Brazing qualifications.

6.4 Design and construction features

6.4.1 General.

Material and standard for parts which are not specifically mentioned herein and which are necessary for the fulfillment of this specification shall be of good quality and in accordance with good practice in the fabrication and erection of Structures & piping. Workmanship shall be in accordance with the best Engineering practice adequate to ensure satisfactory and safe erection of structures and piping in accordance with the provision of this specification.

6.4.2 Piping

6.4.2.1 Fabrication

All the piping, bends, welded joints, fittings shall be in strict accordance with the specifications and shall be fabricated as per the approved layout and the tests specified therein shall be abided with. Detailed guidance for fabrication of pipeline is given in **Appendix-E.**

6.4.2.2 Tolerances

All piping shall be erected, welded, utilising materials in accordance with the drawings approved by the Engineer-in-charge. Unless otherwise specified in the drawing, tolerance on any linear dimension shall be within ± 3 mm and tolerance shall not be cumulative. The bolt holes of flanges in the vertical plane shall straddle the vertical center line of the pipe in

the erected position. The deviation measuring any direction on flange face alignment shall be within 0.5mm. Maximum deviation from center lines of bolt hole location shall be ± 1.5 mm.

6.4.2.3 Tightening of bolts

In bolting of gasketed flanged joints, the gaskets shall be of specified ratings, the contact faces of the flanges shall bear uniformly on the gasket, and the gasket shall be properly compressed in accordance with the design principles applicable to the type of gasket used. The bolt stress in all flanged joints shall be uniform.

6.4.2.4 Piping

Piping shall be made with the minimum number of joints feasible. The contractor shall shop fabricate sub assembly of piping to the maximum extent possible under properly controlled cleanliness requirements. All machined surfaces shall be protected from dust and mechanical damage. The contractor shall visually examine all materials to be erected or being used in the fabrication and shall report any defects to the Engineer-in-charge. Any repair of material shall be as per Engineer-in-charge's instructions.

The contractor, on award of the contract, shall prepare detailed working sketch, showing the cross section, longitudinal section, details of fittings, locations of pressure indication etc.

The piping shall be properly supported. The Supports shall be fabricated and anchored by the Contractor.

All the screwed pipe fittings shall be accurately cut to the required size and threaded as per relevant code. The burrs etc. shall be removed before laying.

Open ends of the piping shall be covered during installation, to avoid entrance of foreign matter.

Lines requiring drainage shall have a minimum slope of 1/16"/foot unless otherwise noted on the drawings.

The piping system shall be fabricated and installed in workmanship manner.

6.4.2.5 Cleaning

All the Piping& fittings shall be neatly and properly finished. All the metal surfaces shall be smooth and free from burrs. Finished surface shall be protected against mechanical damage.

6.4.2.5 Welding

All welding has to be carried out by qualified welders and as per qualified welding procedures. Welding shall meet the design, fabrication and inspection and testing requirements given in codes and standards indicated in Appendix.

7.0 MATERIAL TESTING & INSPECTION

- 7.1 All the items / materials supplied by the contractor as per Schedule-B shall be inspected and tested as per relevant standards and codes.
- 7.2 All the items like pipes, fittings, flanges etc. shall be tested for their mechanical & chemical & metallurgical properties. Sample pieces shall be selected randomly and tested for tensile, chemical, bending/ flattening, elongation and macro-etching testing at M/s TCR or any other BARC approved laboratory in the presence of BARC representative. Few sample fittings and flanges have to be destroyed to carry out testing. The contractor has to arrange all the testing and has to bear the testing charges including destroyed sample items.
- 7.3 LPT, RT & Hydrostatic testing of all pipes shall be done by the contractor. The contractor shall provide all necessary equipment, materials e.g. testing pump, blind flanges, fittings, pressure gauges etc. and services & labour for carrying out the test. The contractor shall perform the test to meet the specification.
- 7.4 Piping repaired, if any, subsequently to the above test(s) shall be re-tested again in the same manner.
- 7.5 The Engineer-in-charge shall be notified well in advance by the contractor before any inspection & testing and all testing as well as sample selection shall be witnessed by Engineer-in-charge or his authorized representative.

8.0 QUALITY CONTROL AND INSPECTION

- 8.1 The contractor shall be responsible for and shall provide for and perform all the inspection and testing required by the Engineer-in-charge's Specifications.
- 8.2 Contractor shall submit for approval a Quality control plan together with the qualifications of the inspection and test personnel.
- 8.3 A Quality Surveyor shall be designated by the Engineer-in-charge. The Quality Surveyor and his designated staff will be responsible for checking the quality of work to the extent necessary to assess compliance with the provisions of the specifications. His surveillance shall not be limited to examination of the end product, and he shall have complete access to the work and the right to intervene where bad (non-standard) practices are detected. He shall also have the right to conduct or ask the contractor to perform, any additional inspection or testing he feels necessary. If any unacceptable defects are noted by such tests, the contractor shall repair the defects free of charge.

8.4 The surveillance provided by the Engineer-in-charge or the approval by the Quality Surveyor of finished work shall not relieve the contractor of any of his responsibilities under this specification.

8.5 The Contractor shall maintain quality control records, which shall record fully all the quality control operations that were performed. The Quality Surveyor shall have the right to witness any or all such operations.

9.0 GUARANTEE

The contractor shall guarantee satisfactory performance of the entire work executed by him including the materials, equipments supplied by him against defects and improper/ bad workmanship for a period of 12 months from the date of commissioning or 18 months from the date of completion of all works whichever is earlier.

10.0 COMMISSIONING OF PIPING

The commissioning of the erected pipeline shall be carried out as per commissioning procedure issued by the Engineer-in-charge. In case of any leak observed during commissioning from the pipes and pipe-fittings, the same shall be rectified as per procedure. All manpower and tools required for this shall be supplied by the contractor at no extra cost.

11.0 Commercial Terms & conditions:

EMD clause:

11.1 The EMD & financial bid should be sealed by the bidder in separate covers duly super scribed and both these sealed covers are to be put in a bigger cover which should be sealed and duly super scribed with the name of the work and tender notice reference. Price bid cover shall only be opened after confirming the submission of EMD in the specified form. The tender will be rejected if the EMD is not submitted along with the bid. EMD should be issued in favour of Accounts Officer, BARC, in any of the forms viz. (a) Receipted Treasury Challan, or (b) Deposit at Call receipt/Fixed Deposit Receipt/DD of a Scheduled Bank.

11.2 The tender shall remain open for acceptance for a period of ninety days from the date of opening of tenders. If any tenderer withdraws his tender before the said period or make any modifications in the terms and conditions of the tender which are not acceptable to the Department, then the Government shall, without prejudice to any other right or remedy, be at liberty to forfeit 50% of the said earnest money absolutely. If the successful tenderer, fails to commence work within 20 days of issue of work order, the President of India or his successors in office shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the said earnest money and close the contract.

11.3 In the event of a tender being accepted, a receipt for the earnest money forwarded therewith shall thereupon be given to the contractor. No interest will be paid to the vendors participating in the tender. On acceptance of order by successful bidder the EMD shall be converted to Security deposit and will be returned to the vendor on completion of job. In the event of a tender being rejected, the earnest money shall thereupon be returned to the contractor with no interest.

11.4 In case the work cannot be started due to reasons not within the control of the contractor, either party may close the contract. In such eventuality, the Earnest Money Deposit shall

be refunded, but no payment on account of interest, loss of profit or damages etc. shall be payable at all.

Note: Cheques and Bank Guarantees for Earnest Money Deposit will not be accepted. Tender not accompanied by the earnest money deposit are liable to be rejected.

12.0 Payment terms and conditions:

12.1 No advance or part payment is admissible. The full and final payment will be made **within 45 days** after delivery of the material and production of the following documents whichever is later:

- a) Original Bill in duplicate (GST should be shown separately, PAN & GSTIN should be reflected on the bill).
- b) Advance stamped receipt
- c) Guarantee Certificate for at-least 12 months from the date of completion in all respect.

12.2 GSTIN and PAN number to be indicated in the stamped invoice.

12.3 BARC is the final consumer of the goods/services procured and does not intend to make any outward supply. BARC will not avail the benefits of Input Tax Credit and hence, the goods can be supplied without quoting the GSTIN of BARC, Mumbai on the invoice. The invoices taxed under GST, as per rates applicable under the GST Schedule of Rates, shall be admitted for payment.

12.4 Payment will be made **only** through ECS/Core Banking System. Hence, please furnish the bank details such as Bank's name & address, A/c No. and IFSC code in the invoice.

12.5 Income tax @ 2% will be deducted from your bill.

12.6 Vendor shall quote their formal quotation/rate clearly in the enclosed format and GST, if any quote separately.

12.7 The prices quoted by the vendor shall be valid for **at least 90 days** from the date of opening of the tender.

12.8 Please indicate whether any of your relatives are employed in BARC or you or any of your employed in BARC or any other unit of DAE.

13.0 Confidentiality Clauses -

i) Confidentiality: No party shall disclose any information to any third party concerning the matters under this contract generally. In particular, any information identified as "Proprietary" in nature by the disclosing party shall be kept strictly confidential by the receiving party and shall not be disclosed to any third party without the prior written consent of the original disclosing party.

This clause shall apply to the sub-contractors, consultants, advisers or the employees engaged by a party with equal force.

ii) **"Restricted information" categories under section 18 of the atomic energy act, 1962 and "Official Secrets" under section 5 of the official secrets act, 1923 :-**

Any contravention of the above mentioned provisions by any contractor, sub-contractor, consultant, adviser or the employees of a contractor will invite penal consequences under the aforesaid legislation.

- iii) **Prohibition against use of BARC's name without permission for publicity purposes** :
The contractor or sub-contractor, consultant, adviser or the employees engaged by the contractor shall not use BARC's name for any publicity purpose through any public media like Press, Radio, T.V. or Internet without the prior written approval of BARC.

14.0 MATERIALS & SERVICES TO BE PROVIDED BY THE DEPARTMENT

- 14.1 **Schedule 'A'** lists the items and quantities of free issue materials, which will be supplied to the contractor.

Schedule showing the materials to be supplied to the extent available by Bhabha Atomic Research Centre for work contracted to be executed.

Serial no.	Particulars	Quantity	Unit	Amount
1.	Electricity (415 V, 3 ph)	At one point	-	Free of cost
2.	Compressed air (100 psig)	NA.	-	NA.
3.	Water (80 psig)	At one point	-	-do-

15.0 **General information to vendor** :

- (i) The desirous bidders can contact with Shri S. K. Banerjee (Tel.: 022-25594643) for any clarifications.
- (ii) The bidder Vendor shall quote their formal quotation/rate clearly in the enclosed format and GST, if any quote separately.
- (iii) The quotation shall be inclusive of all the charges including the transportation, mobilization, testing etc.
- iv) Vendor shall execute the entire work within a period of 4 months from the date of acceptance of work order.
- v) The prices quoted by the vendor shall valid at least 90 days from the date of opening of the tender.

Encl: i) Format for Quotation
ii) Appendix-A, B, C, D & E

-S/d-
(S. Bhattacharya)
Associate Director, Reactor Group
For & On behalf of President of India

APPENDIX - A

WELDING REQUIREMENTS FOR THE FABRICATION OF PIPING

1.0 **Scope**

- 1.1 This specification defines the requirement concerning welding of piping for the Dhruva reactor, Trombay, Mumbai-400 085. It is applicable to shop welding at site or elsewhere.
- 1.2 The requirements stipulated are based on review of piping systems and materials specified for the construction at the time of writing this specification. Any subsequent design changes or authorised materials substitutions will require review of the appropriate sections of this specification and the issue of amendments, if required.
- 1.3 Wherever the term Quality Surveyor appears in this specification, it shall be taken to mean the Engineer's agent unless otherwise stated.

2.0 **Welding Processes**

- 2.1 All piping shall be welded using the GTAW process. Any other welding process, if proposed by the Contractor, shall require specific approval of the Engineer.
- 2.2 Preparation and carrying out welding procedure qualification and welder's qualification as per ASME Section IX.
- 2.3 Welding & fabrication of pipelines/pipefitting shall be done after proper cleaning & edge preparation. Welding shall be carried out by the qualified welders as per ASME Sec.-IX and welding process shall be GTAW. Filler wire ER-316 shall be used for GTAW process. Pure Argon gas shall be used as shielding as well as purging for GTAW process. Filler wire of Advani-Orlikon make shall be used.
- 2.4 For welding of all grades of stainless steel by the GTAW process, a 2% Thoriated Tungsten electrode conforming to AWS A 5.12-30 EWTH-2 classification shall be used.
- 2.5 The brands & make of electrodes / filler wires to be used shall be submitted for approval by the Engineer. For each batch of approved brand, certificates showing compliance. With the specification shall be secured and shall be submitted to the Quality Surveyor before being released for use on piping welding. Delta ferrite content on austenitic stainless steel welding consumables and weld deposits shall be a maximum of 4-9 percent (4-9 FN) as per clause NE 2433.1 of ASME Sec. III.
- 2.6 All weld joint fit-ups shall be made to comply with the tolerances specified.
- 2.7 Welder shall ensure the cleanliness, proper argon purging, argon flow, AC / DC with polarity, current, filler wire etc. before start of actual welding of joint.
- 2.8 The welding technique and manipulation shall be controlled to ensure Full penetration, Full fusion into the base metal without undercutting along the sides of the weld, Full fusion into the preceding bead or layer and Uniformity of surface in both single run passes and beaded layers. The butt weld profile shall be full penetration and the weld thickness shall exceed the minimum wall requirements of the pipe. The external surface of the weld shall be free from undercuts, overlaps and abrupt ridges or valleys. The weld metal reinforcement of the outside surface of the pipe shall not exceed the following limits.
- 2.9 All tack welds shall be removed after completion of weld, which will be used for joint fit-up or other purpose.

3.0 **Welding Procedures**

- 3.1 The qualification of welding procedures shall be in accordance with the Section IX of ASME Boiler and Pressure Vessel Code / ISI 2825.
- 3.2 The welding procedure tests shall demonstrate that all details are satisfactory the welds are free from unacceptable defects and that they have the necessary mechanical properties.
- 3.3 The procedure specification form shall describe the following in detail :
- a) Application i.e. for which particular work the procedure is qualified.
 - b) Welding process employed.
 - c) Specification and processed condition of base metal.
 - d) Thickness of base metal.
 - e) Joint Design, (Sketch)
 - f) Power source (AC or DC) and polarity of D.C.
 - g) Classification and size of filler metals and electrodes (Consumable and non-consumable) and drying requirements for electrodes.
 - h) Current and voltage ranges
 - i) Position
 - j) Progression (upward and downward in vertical welding)
 - k) Number of passes
 - l) Preheat and interpass temperature control
 - m) Post weld heat treatment
 - n) Surface condition before welding
 - o) Shielding and backing gas requirements
 - p) Welding technique and arc manipulation
 - q) Inspection requirements
 - r) Results or welding procedure qualification test (one form indicated in Section IX of ASME Boiler and Pressure Vessel Code).
- 3.4 Procedure qualification tests shall be performed at site and the qualifying authority shall be Quality Surveyor appointed by the Engineer.
- 3.5 No work shall start on prefabrication or installation of piping until the procedure qualification tests for the particular type of welding have been accepted by the Quality Surveyor and the procedures have been distributed to the parties concerned.
- 3.6 The Contractor shall deposit with the Engineer ten copies of each qualified and accepted procedure for the use the retention.
- 3.7 All test specimens shall be properly tagged and preserved for the duration of the construction. The disposition of test specimens shall be directed by the Engineer.
- 3.8 The cost of performing the procedure and performance qualification tests described in 4.0 shall be borne by the Contractor except that the pipe, filler metals and other consumables shall be supplied as described in the contract documents.

4.0 **Qualification and Performance record of welders**

- 4.1 All welders shall have passed the performance qualification test prescribed by Section IX of the ASME Boiler and Pressure Vessel Code/ISI 2825.
- 4.2 The qualification tests shall be performed at site and the qualifying authority shall be the Quality Surveyor appointed by the Engineer.

- 4.3 The Quality Surveyor shall have the right to call for further qualifications from time to time, from any welded who in the Quality Surveyor's opinion is not producing finished welds in accordance with his qualifications, or who has discontinued welding by the particular process for more than three months.
- 4.4 For each welded, a record card shall be maintained showing the procedure for which he is qualified. These cards shall show the date on which each procedure is used, the type of defects produced and their frequency. This record shall be reviewed once a week by the Quality Surveyor and those welders whose work requires a disproportionate amount of repair, shall be disqualified from welding on the permanent piping joints. Requalification of welders disqualified more than three times shall be entirely at the discretion of the Quality Surveyor.
- 4.5 When repairs are to be made, the welder whose work is defective shall have the nature of the defects explained to him. It is preferable if a welder can repair his own defective welds.
- 4.6 Each welder shall be assigned a letter, number or symbol. Each weld shall be clearly identified as to its welder either by marking on the pipe adjacent to the weld or by maintaining a chart on which every weld is detailed. Stamping and vibroetching are not permitted except that on pipe with over ¼ inch wall thickness. Low stress, round-nose continuous or round-nose interrupted dot die stamps may be used. Stainless steel may be marked by an electro etching method.

5.0 **General welding requirements**

- 5.1 No welding shall be done on surfaces which are wet or exposed to rain or excessive draft. Surfaces to be welded shall be free from pain, rust oil, grease, dust or any other contamination. Cloth used for cleaning shall be lint free with hemmed edges.
- 5.2 Welds shall be cleaned between passes to remove all tracks of slag and flux before successive beads or layers are deposited. Completed weldments shall be cleaned to the points of each individual bead shall be carefully examined and any defect shall be removed by grinding. Grinding wheels wire bushes chisels etc. for use on stainless steel shall not be used on any other material.
- 5.3 Peening shall not be permitted.
- 5.4 Inspection and Quality surveillance shall not be limited to examination of the finished weld. All aspects of the materials, fabrication procedures and examination procedures used, that could affect the quality of the finished weld, shall be subject to the approval of the Quality Surveyor. The equipment to be used shall be suitable for the quality of work specified and the technique employed shall be based on methods which are known to produce good results and which have been verified at site by actual demonstration.
- 5.5 The welding technique and manipulation shall be controlled to ensure the following -
- a) Full penetration.
 - b) Full fusion into the base metal without undercutting along the sides of the weld.
 - c) Full fusion into the preceding bead or layer.
 - d) Uniformity of surface in both single run passes and beaded layers.
 - e) Floating all slag, oxide and gases to the surface behind the advancing arc.
 - f) Delay in electrode travel until base metal fusion at the starting point is assured and until the crater is well filled at the completion of the weld.

- 5.6 Haphazard striking of the electrode on the base metal in establishing the arc shall not be permitted. The arc should be struck either in the joint where the metal surface will be used into the weld or on a starting tag. Starting tags shall be of the same material or a material compatible with the base metal being welded. When inadvertent arc strikes occur, the area affected shall be ground flush and then examined by the magnetic particle or liquid penetrant method. High frequency arc starting devices may be used for TIG welding.
- 5.7 Care must similarly be taken when stopping the arc to avoid unfilled crater and crater cracks. The following techniques are recommended for stopping the arc : The arc should be drawn off to the side of the joint and stopped on the beveled surface of the joint while extending the arc length rapidly.
- 5.8 When welding carbon steel with covered electrodes, the width of the deposited pass shall not exceed three times the nominal core wire diameter.
- 5.9 Vertical welds shall be made in an upward direction. On pipes over 300 mm (12") in diameter, welding shall be done whenever possible, by two welders working simultaneously on both sides of the pipes.

6.0 Joint Design

- 6.1 In all instances the end preparation for welding shall be as per the Engineer's drawings.
- 6.2 Where counter-boring or any other machining is done, the remaining wall thickness of pipes or fittings shall not be less than that shown on the joint design drawings.
- 6.3 All circular butt welded joints shall have their end preparations formed by machining, preferably on a lathe. Any machining equipment to be used for this purpose must achieve the accuracy specified for the particular end preparation. Joints of other geometry may be prepared by drilling and grinding and shall be checked with profile gauges.

7.0 Fit-up

- 7.1 All weld joint fit-ups shall comply with the tolerances specified on the design drawings.
- 7.2 Prior to starting fabrication, the relevant purchase specifications for materials (BARC or ASTM) shall be studied to establish the tolerance on supplied materials and their compatibility with specified fit-up tolerances.
- 7.3 Before fitting-up the weld joint, the profile and dimensions of the weld and preparation shall be checked. If the specified tolerances are exceeded this shall be corrected by grinding or machining.
- 7.4 All fit-ups shall be examined by the Quality Surveyor prior to welding the root pass.

8.0 Weld Profile

- 8.1 Butt welds shall be full penetration and the weld thickness shall exceed the minimum wall requirements of the pipe. The external surface of the weld shall be free from undercuts, overlaps and abrupt ridges or valleys. The weld metal reinforcement on the outside surface of the pipe shall not exceed the following limits.

Component Thickness (mm)	Maximum reinforcement (mm)
Up to (1/2") 13 mm	(1/16") 1.5 mm
Over (1/2") to (1")-13 mm to 25 mm	(3/32") 2.38 mm
Over (1") to (2")-25 mm to 50 mm	(1/8") 3.18 mm
Over (2") 50 mm	(5/32") 3.97 mm

- The reinforcement shall be crowned at the center and shall taper smoothly to the surface being joined.
- 8.2 The surface smoothness of the finished weld shall be suitable for proper interpretation of the non-destructive examination of the weld. If grinding is necessary the weld shall be blended into the present metal without gouging or thinning the parent metal in any way. Uneven or excessive grinding may cause rejection or re-work at the discretion of the Inspector.
- 8.3 When components of different outside diameters are welded together there shall be a gradual transition between the two surfaces. The length of the transitions shall be such that the length to offset ratio shall not be less than 3 to 1.
- 8.4 The root pass of butt welds made without inserts shall have less than 1/16 inch internal reinforcement. Defects such as 'icicle', burn-through and excessive "such-back", etc. shall be cause for rejection of the weld.
- 8.5 Fillet welds shall preferably be slightly convex and shall be free from undercutting and overlap at the toe of the weld. Convexity / concavity shall not exceed 1.5 mm (1/16²). Full penetration shall be obtained at the root of the fillet and in no case shall the leg length of the fillet be less than the nominal weld size stated in the drawings or specifications. The leg length shall not exceed the specified size by more than 1.5 mm (1/16²).
- 8.6 The profiles of welds on branch connections depend on the type of the attachments and shall be as per the detailed drawings issued by the Engineer.
- 9.0 **Attachment welds**
- 9.1 Attachments such as lugs, brackets, rings and other non-pressure parts that are welded to the pipe to form an integral and permanent attachment shall be in accordance with the details shown on the Engineer's drawings.
- 9.2 Temporary attachments, such as may be required to retain fit-up for welding, shall be of material compatible with the material to which it is attached.
- 9.3 All attachment welds shall be done by qualified welders and in accordance with qualified procedures. Welds shall be reheated and post weld heat-treated as called for in the appropriate welding procedure.
- 9.4 Temporary attachments shall be removed in a manner that will not damage the pipe. The removal can be done by grinding, chipping, sawing or in the case of heavy weldments by arc gouging or flame cutting. The attachment may be reduced to a very small cross-section and then the attachment "knock-off". "Knocking-off" of full size attachments welds or tacks is not permissible. When arc or flame gouging is used at least 3 mm (1/8²) of metal shall be left free of the pipe surface which will then be removed by grinding. Such gouging shall be done tangentially to the pipe surface and the pipe surface shall be suitably protected.
- 9.5 The areas from which temporary attachments have been removed shall be dressed smooth and be examined by the magnetic particle or liquid penetrant method. Defects shall be removed and material reinspected to ensure their removal. If weld repairs are necessary, they shall be made using qualified procedures and welders and shall again be examined by the magnetic particles or liquid penetrant method.

10.0 **Tack Welds**

- 10.1 All tack welds shall be made using a qualified procedure and qualified welders. Any preheat requirements specified in the welding procedure shall also apply to tack welds.
- 10.2 The number and size of the tack welds shall be kept as small as is consistent with adequate strength and joint alignment.
- 10.3 All tack welds shall be examined visually for defects and if found defective shall be completely removed.
- 10.4 As the welding proceeds, tack welds shall be either removed completely or shall be properly prepared by grinding or filling their stopping and starting ends so that they may be satisfactorily incorporated into the final weld.

11.0 **Repairs**

- 11.1 Any weld repairs shall be subject to the approval of the Quality Surveyor.
- 11.2 Unacceptable defects be removed by grinding, machining or chipping. Arc gouging or flame cutting are also permitted provided gouged surfaces are ground at least 1.5 mm (1/16") below the deepest indentation.
- 11.3 If preheat is specified in the appropriate welding procedure then the same preheat must be maintained during flame or arc gouging
- 11.4 Dye penetrant shall be used to check that the defect has been completely removed prior to weld repair. In the event of any doubt regarding complete removal of a defect, radiography may be required at the discretion of the Quality Surveyor.
- 11.5 Weld repairs shall be made using qualified procedures and welders. The preparation for the weld repair shall have the prior approval of the Quality Surveyor.
- 11.6 In the event of several unsuccessful repair attempts or if the Quality Surveyor feels that a satisfactory repair is not feasible the joints shall be completely remade. However, the number of weld repair attempts shall be restricted to 2 (two).
- 11.7 The rewelded are shall be re-examined by the methods specified for the original weld. Where radiography is required, a minimum amount of 50 mm (2") film overlap beyond the repair edges must be ensured.
- 11.8 Repairs of any base material utilized in fabrication of piping shall not be undertaken unless specifically permitted by the Quality Surveyor.

12.0 **Seal Welds**

- 12.1 Seal welding shall be done by qualified welders, and in accordance with approved procedures.
- 12.2 Threaded joints that are to be seal welded shall be made without the use of a thread lubricating compound.
- 12.3 The surfaces to be welded shall be clean, free from paint, grease, oil, rust, seal compound etc.
- 12.4 The threads shall be adequately prepared by grinding and entirely covered by the seal weld. The surface of the seal weld shall merge smoothly into the component surface and shall be suitable for the proper interpretation of non-destructive examination of the weld.
- 12.5 Seal welds shall not be considered as contributing to the strength of the joints. Backing off to correct alignment of screwed connections is not permitted.

13.0 **Filler metals / electrodes**

- 13.2 The brands of electrodes to be used shall be submitted for approval by the Engineer. For each batch of each approved band, certificates showing compliance with the specification shall be secured and shall be submitted to the Quality Surveyor before being released for use on project piping.
- 13.3 All electrodes shall be stored in their original sealed containers and under any conditions (50% maximum Relative Humidity). The electrodes shall remain identified until consumed.
- 13.4 All electrodes shall be dried before use in accordance with manufacturer's instructions. Drying ovens shall be provided in work areas for this purpose. Each lot of electrodes withdrawn from the oven shall be used within two hours. During periods of high humidity shorter periods may be required. Electrodes not used during this period shall be returned to ovens. Electrodes shall not be left at work locations whether in metal containers or otherwise. In the event that electrodes are left out for periods longer than two hours they shall be rebaked following the electrodes Supplier's rebaking procedure.
- 13.5 Electrodes which have been exposed to rain or which have been otherwise exposed to water however shall be discarded. No rebaking of such contaminated electrodes will be permitted.

APPENDIX – B

WELDING EXAMINATION REQUIREMENTS AND METHODS

- 1.0 The type and extent of weld examination shall be as per System Specification Sheets covered under the Appendix – A “Welding requirements for General Piping” of the contract document.
- 1.1 **General Requirements**
- 1.1.1 The type and extent of weld examination shall be as described in the Technical Specification.
- 1.1.2 All non-destructive examination shall be done to a detailed written procedure that has been qualified by actual demonstration as capable of detecting and locating discontinuities described in this specification as unacceptable or as required to be reported. The procedure shall comply with the requirements described in the relevant appendices of this specification covering the particular examination method. An adequate number of copies of the procedure shall be made readily available to all the concerned NDT personnel for their reference and use.
- 1.1.3 Radiographic examination of welds shall be performed after any bending or forming operation. Liquid penetrant examination of welds shall be performed after heat treatment, if any.
- 1.1.4 Following any non-destructive examination in which foreign material is applied to the surface, the surface shall be thoroughly cleaned in accordance with applicable material or

fabrication specification. Cleaning shall be done immediately after the Quality Surveyor's inspection of the test in question.

- 1.1.5 All personnel performing any NDT shall be competent and knowledgeable of the applicable examination requirements and shall be qualified in general technique and to specific procedure. The Quality Surveyor shall have the right to require requalification or change of any personnel, who in his opinion is not performing satisfactorily.
- 1.1.6 For non-destructive examination methods that consist of more than one operation or type, it is permissible to use personnel qualified to perform one or more operations. One person may be used who is qualified to conduct the examination and the may be used who is qualified to interpret and evaluate the examination results. The qualification certificate shall describe this in detail.

2.2 **Visual Examination**

2.2.1 Visual examination is of the first order of importance. Its purpose is to ensure the conformity of the welded joints with all provisions and requirements of the specifications and welding procedures. Visual examination is mandatory for all welded joints.

2.2.2 This method of examination shall extend to cover at least the following steps :

- a) Base metal identification w.r.to correlating mill test certificates.
- b) Base metal defects, if any, such as surface irregularities, cracks, or laminations.
- c) Filler metal identification and verification for any defects.
- d) Edge preparation.
- e) Joint fit-up.
- f) Cleanliness.
- g) Tacks.
- h) Jigs and braces.
- i) Purge provisions.
- j) Root pass and subsequent passes appearance.
- k) Cleaning between passes.
- l) Pre-heat, interpass temperature and heat treatment control.
- m) Appearance of completed welds, their conformity with drawings and specification and suitability for subsequent methods of examination.
- n) Condition of base metal in area adjoining to the weldment.
- o) Excessive or unexpected distortion due to welding.

2.2.3 Any deviations from the specifications and approved procedure shall be immediately reported to the Quality Surveyor and his approval shall be obtained prior to proceeding with the next step of work.

4.4 **Liquid Penetration Examination**

4.4.1 Liquid penetrant examination shall conform to the requirements of "Appendix B."

4.4.2 The penetrant, cleaner and developer shall be tested and certified as having acceptably low Halogen and Sulphur contents of each batch.

5.0 Acceptance Standards

5.1 Visual Examination

The acceptance standards for visual examination shall be as following:

Under cut maximum	:	0.3 mm
Arc pits maximum	:	0.3 mm
Lack of penetration	:	0.0 mm
Edge mismatch	:	$\frac{1}{4} t$ or 1.6mm whichever is minimum
Reinforcements	:	Upto 3mm thick - 2.0 mm 3 to 5mm thick - 2.5 mm Over 5 to 15 thick- 3.0 mm

5.2 Radiographic Examination

Weld defects observed in radiographic examination shall only be acceptable as per ND-5300. Welds that are shown by radiography to have any of the following types of discontinuities are unacceptable.

- a) Any type of crack or zone of incomplete fusion or penetration.
- b) Any other elongated indication which has a length greater than $\frac{1}{4}$ inch for t upto $\frac{3}{4}$ inch inclusive where t is the thickness of the thinner portion of the weld.
- c) Any group of indications in line that have on aggregate length greater than t in a length of $12 t$ except where the distance between the successive indication exceeds $6L$, where L is longest indication in the group.
- d) Porosity in excess of that shown as unacceptable by the porosity standards given in Appendix VI of Section III of ASME Code.

5.3 Liquid Penetrant Examination

Weld defects observed in Liquid Penetrant examination shall only be acceptable as per ND-5351. Following relevant indications are unacceptable

- a) Any cracks or linear indications.
- b) Rounded indication with dimensions greater than $\frac{3}{16}$ inch.
- c) Four or more rounded indication in a line separated by $\frac{1}{10}$ inch or less edge to edge.
- d) Ten or more rounded indications in any 6 Sq. inch of surface with the major dimension of this area not to exceed 6 inch with the area taken in the most unfavourable location.

6.0 Welding Quality Control Records

6.1 Welding quality control records shall comprise the following:

- a) Mill test certificates for base materials.

- b) Manufacturer's certificates for consumable supplies (filler metals, argon, liquid penetrant etc.) attesting compliance of the product with the specification issued by the Engineer-in-charge.
 - c) Welding procedures.
 - d) Welders for non-destructive examinations.
 - e) Procedures for non-destructive examinations.
 - f) Qualification certificates of the personnel performing non-destructive examination.
 - g) Procedure for heat treatment, if any.
 - h) The results of radiographic examination shall be recorded on a standard reporting form which shall be countersigned by the Quality Surveyor on completion of his examination.
 - i) For each joint there shall be a record attesting that work was completed, examined and found to comply with all the requirements of this specification.
- 6.2 The above records shall be submitted in quantities as described in the contract documents. Where only a single copy exists such as radiographs and heat treatment record charts, these shall become the property of Department of Atomic Energy on completion of the contract or earlier if so directed by Engineer-in-charge.

APPENDIX - C

LIQUID PENETRANT EXAMINATION

The rules contained herein describe methods that shall be employed whenever Liquid Penetrant Examination is specified. The rules are substantially in accordance with articles of ASME Sec-V and generally conform to SE-165 "Standard Practice for Liquid Penetrant Inspection Method" and reference to this standard may be made for additional details to be included in written procedures required herein.

1.0 DESCRIPTION OF METHOD

Liquid penetrant examination is a method of non-destructive examination, which provide for the detection of discontinuities open to the surface in ferrous and non-ferrous materials, which are non-porous. Typical discontinuities detectable by this method are cracks, seams, laps, cold shuts and laminations. A liquid penetrant is applied to the surface to be examined and allowed to enter such openings. Then the excess penetrant is removed, the part is dried, and a developer is applied which is wetted or otherwise affected by the penetrant entrapped in the discontinuities. This increases the evidence of the discontinuities so that they may be seen.

2.0 APPROVED METHOD

Since the major use of liquid penetrant examination will be on field erected piping, only the visible dye penetrant-solvent removable method is specified. Other methods shall require the specific approval of the Quality Surveyor.

3.0 METHOD REQUIREMENTS

3.1 Surface Preparation:

3.1.1 In general satisfactory result may be obtained when the surface is in the as-welded, as-rolled, as-cast, or as forged condition. When surface irregularities mask the indication of defects, grinding or machining of the surface will be required.

3.1.2 Prior to liquid penetrant examination, the surface to be tested and any adjacent area within at least 25mm of the surface to be tested shall be dry and free of any dirt, grease, lint, scale, welding flux, spatter, oil or any extraneous matter that would obscure surface openings or otherwise interfere with the test.

3.1.3 Typical cleaning agents which may be used for removing contaminants are detergents, organic solvents, descaling solutions, and paint removers.

3.2 Drying:

Drying of the surface to be tested, after cleaning, can be accomplished by normal evaporation. A minimum period of time shall be established and included in the written procedure to assure that the cleaning solvents have evaporated prior to the application of the penetrant. When employing the non-volatile solvent, it is recommended that forced hot air be used to accelerate drying.

3.3 Penetrant application:

The penetrant shall be applied by dipping, brushing, or spraying. If the penetrant is applied by spraying using compressed air type apparatus, filters shall be placed at the air inlet to preclude contamination of the penetrant from oil, water and dirt sediment that may have collected in the lines. The temperature shall remain between 30° C to 50° C and penetration time shall be at least 15 minutes.

3.4 Excess penetrant removal:

Guidelines given in Para 6.5 of SE 165 shall be followed:

3.4.1 After the penetrant time specified in the procedure has elapsed, any penetrant remaining on the surface shall be removed.

3.4.2 Excess penetrant, in so far as possible, shall be removed by using clean, dry cloths or absorbent paper. The operation should be repeated until most traces of penetrant have been removed. A clean dry cloth or absorbent paper shall then be moistened, with solvent and the surface shall be wiped lightly until all remaining traces of excess penetrant have been removed. Care shall be employed not to use an excess of the solvent in order to avoid removing penetrant from the defects. Flushing the surface with solvent following the application of the penetrant and prior to developing is prohibited.

3.5 Developing:

3.5.1 The developer shall be applied as soon as possible after the penetrant removal operation and the interval shall not exceed the time established during procedure qualification.

3.5.2 The quality of the developer and the method of application in fine spray are important and shall be demonstrated to the satisfaction of the Quality Surveyor.

4.0 EXAMINATION

4.1 The true size and type of discontinuities are difficult to evaluate if the penetrant diffuses excessively in the developer. Consequently, it is good practice to observe the surface during the application of the developer in order to detect the nature of certain indications which might tend to bleed out profusely. Final interpretation, however, shall be made after allowing the penetrant to bleed out for a minimum of seven (7) minutes to a maximum of thirty (30) minutes. If the test surface is sufficiently large to preclude complete testing and examination within the prescribed times, the surface shall be tested and examined in suitable increments.

4.2 The developer should form a more or less uniform white coating. Surface discontinuities are indicated by bleeding out of the penetrant which is normally of a deep red colour. Indications which exhibit a light pink colour may indicate excessive or inadequate cleaning.

4.3 Illumination shall be provided which is adequate to ensure that there is no loss in the sensitivity of the test.

5.0 QUALIFICATION OF PROCEDURE

5.1 Required procedures shall be qualified on test pieces representative of the manufacturer's product with respect to material type and product form (weld, casting, wrought product etc.)

6.0 EVALUATION OF INDICATIONS

6.1 Defects which occur as mechanical discontinuities at the surface will be indicated by bleeding out of the penetrant, however, localized surface imperfections such as may occur from machining marks or surface conditions may produce similar indications which are not relevant to the detection of defects.

6.2 Any indication which is believed to be non-relevant shall be regarded as defect until the indication is either eliminated by surface conditioning or it is demonstrated to be non-relevant. Non-relevant indications and broad areas of pigmentation which would mask indications of defects are unacceptable.

6.3 Relevant indications are those which result from mechanical discontinuities. Linear indications are those indications in which the length is equal or more than three times the width. Rounded indications are indications which are circular or elliptical with the length less than three times the width.

7.0 REPAIR OF DEFECTS

All repairs shall be made in accordance with the requirements for the particular product form, including welds. Whenever a defect is removed and subsequent welding is not required, the affected area shall be blended into the surrounding surface so as to avoid sharp notches, crevices or corners.

APPENDIX – D

RADIOGRAPHIC EXAMINATION OF BUTT WELDED JOINTS

Radiographic examination shall meet requirements of ASME Section-III ND- 5000. The rules contained herein describe radiographic examination methods and shall be employed whenever radiographic examination is specified. The rules are generally in accordance with ASME standards SE-94 & Article-2 and reference to these standards shall be made for additional details to be included in written procedures required herein.

1.0 EQUIPMENT AND MATERIALS

1.1 Radiation Sources:

X-Ray equipment or Radioactive isotopes shall be used for radiography of weld joints.

1.2 Films:

The films shall conform to type 1 or 2 of ASME-SE-94. “Standard practice for Radiographic Testing.” Film characteristics are shown below :-

<i>Film Type</i>	<i>Speed</i>	<i>Contrast</i>	<i>Graininess</i>
1.	Low	Very High	Very Low
2.	Medium	High	Low

1.3 Screens:

1.3.1 Intensifying Screens may be used, except that fluorescent type screens shall not be used. Screens shall be at commercially availability types made of pure lead or any alloy of 6% antimony and 94% lead. (Provided the alloying element is uniformly distributed throughout the metal).

1.3.2 Screens shall be free from surface streaks of lower atomic number materials and from wrinkles, dirt, grease, lint and scratches. Screens showing evidence of physical damage shall be discarded.

1.3.3 Screens shall be in intimate contact with both sides of the film during exposure.

1.4 Filters:

Objectionable scatter-radiation shall be reduced by suitable filtration with lead foil screens or other high atomic number metals placed between the radiation source and the specimen and between the specimen and film.

1.5 Penetrameters:

1.5.1 Penetrameters for radiography of welds shall be fabricated from material that is radiographically similar to or radiographically less dense than the base material and / or the weld metal on which they are used. Radiographically similar material refers to

materials or alloys which have approximately the same radiation absorption as the material being radiographed. The identical alloy by chemical analysis is not usually required. For example, carbon and most alloy steels are considered to be radiographically similar materials but radiographically less dense than materials such as copper or nickel base alloys.

1.5.2 The selection, placement of identified by permanently attached lead numbers of Penetrameters / IQI shall be in accordance with ASME- Sec.-V Article 2. The radiographic quality shall be at least 2-4T as per ASME- Sec.-V Article 2.

1.6 Film Viewing Facilities:

Viewing facilities should be constructed as to provide subdued lighting and exclude background lighting of an intensity that may cause reflection of the radiographic film. Equipment used to view films for radiographic interpretation shall provide a high intensity light source such that the proper penetrameters and hole for the specified quality level shall be readily visible for the specified density range. The extraneous light from the illuminator shall be masked. Densitometry or comparison step wedge films shall be provided for assuring compliance with film density requirements. Calibration step wedge films shall be available for checking calibration if densitometers are used.

1.7 Processing Films and Viewing & Storing Radiographs:

All films shall be processed in accordance with part –III of ASME-SE-94.

2.0 TECHNIQUE FOR RADIOGRAPHIC EXAMINATION OF FIELD JOINTS

2.1 Weld Surface Condition:

The weld ripples or welds surface irregularities, on both the inside and outside where accessible, shall be removed by any suitable mechanical process to such a degree that the resulting radiographic image due to any irregularities cannot mask or be confused with the image of any discontinuity.

2.2 Radiography Quality Level:

Radiography shall be performed with a technique of sufficient sensitivity to display the penetrameter and the specified hole, which are essential indications of the image quality of the radiograph. Radiograph shall also display the identifying nos. and letters. Essential hole size and thickness of penetrameters for piping shall be as per table ND-5111-1 of ASME.

2.3 Radiographic Technique:

2.3.1 Single Wall Technique:

In a single-wall technique the radiation passes through only one wall of the weld (material) which is viewed for acceptance on the radiograph. An adequate number of exposures shall demonstrate that the required coverage has been obtained.

2.3.2 Double Wall Technique:

When it is not practical to use a single wall technique, one of the following double wall techniques shall be used.

2.3.2.1 Single Wall Viewing

For materials and for welds in components, a technique may be used in which the radiation passes through two walls and only the weld (material) on the film side is viewed for acceptance, an adequate number of exposures shall be made to demonstrate that the required coverage has been obtained. When complete coverage is required for circumferential welds (materials), a minimum of three exposures taken 120 deg. to each other shall be made.

2.3.2.2 Double Wall Viewing

For materials and for welds in components 101.60 mm (3^{1/2}" NPS) or less in outside diameter a technique may be used in which the radiation passes through two walls and the weld (material) in both walls is viewed for acceptance on the same radiograph. The penetrameter shall be placed on the source side. Care should be exercised to ensure that the specified geometric unsharpness value is not exceeded. If the geometric unsharpness requirement cannot be met, then the single wall viewing shall be used.

- a) For Welds the radiation beam may be offset from the plane of the weld at an angle sufficient to separate the images of the source side and film side portion of the weld so that there is no overlap of the areas to be interpreted. When complete coverage is required, a minimum of two exposures taken 90° to each other shall be made for each joint.
- b) For pipes 8 mm (1/4") NPS the weld may be radiographed with the radiation beam positioned so that the image of both walls are superimposed. When complete coverage is required a minimum of two exposures taken at 90 deg. to each other shall be made for each joint.

2.4 Penetrameter Application:

In addition to the requirements stated in sub-paragraphs 1.5 and 2.2 of this Appendix the following shall apply:

2.4.1 Penetrameter, designation, thickness, hole diameter and placement for welds shall be in accordance with guideline given in ASME Section-V of Boiler and Pressure vessel code.

2.4.2 The radiographic quality shall be at least 2-4T as per ASME- Sec.-V Article 2.

2.4.3 As a rule the penetrameter shall be placed on the side nearest the radiation source. Where it is physically impossible to do this, the penetrameter can be placed on the film side of the joint and a lead letter 'F' as high as penetrameter identification number shall be placed adjacent to or on the penetrameter, but shall not mask the essential hole.

2.4.4 At least one penetrameter shall be used for each exposure, to be placed so that the plane of the penetrameter is generally normal to the radiation beam. Additional penetrameters on circumferential welds shall be used whenever required.

- 2.4.5 Each penetrometer shall represent an area of essentially uniform radiographic density as judged by density comparison strips or a densitometer. If the film density through the weld varies by more than minus 15 or plus 30 percent from the density through the body of the penetrometer, then an additional penetrometer is required for each exceptional area or areas. If the requirements of subparagraph 2.2 are met by using more than one penetrometer, one shall be representative of the lightest area of a film, and the other of the darkest. The intervening densities on the film shall be considered acceptable. It is not necessary that these additional penetrometers be normal to the radiation source as their location.
- 2.4.6 The film density through acceptable weld metal shall be 1.8 minimum for single film viewing for radiography made with an X-ray source and 2.0 minimum for radiography made with a gamma-ray source. For composite viewing if multiple film exposures each radiograph of a composite set shall have a minimum density of 1.3. The maximum density shall be 4.0 for either single or composite viewing. A tolerance of 0.05 in density is allowed for variations between densitometer readings.
- 2.4.7 For welds, the penetrometer (S) may be placed adjacent to or on the weld. The identification number(s) and the lead letter "F", when used, shall not be in the area of interest. When geometric configuration makes it impractical to place the penetrometer(s) as mentioned above, or when the weld metal is not radiographically similar to the base material, the identification numbers and lead letter "F" may be placed in the area of interest.
- 2.4.8 A shim of material radiographically similar to the weld metal shall be placed under the penetrometer if needed, so that the radiographic density throughout the area of interest is no more than minus 15% from (lighter than the radiographic density through the penetrometer).
- 2.4.9 Where more than one film per exposure is used, a penetrometer image shall appear on each film except where the source is placed on the axis of the object and the complete circumference is radiographed with a single exposure in which case at least three uniformly spaced penetrometers shall be employed.
- 2.4.10 When radiation passes through one or two walls and it is impractical to place the penetrometer inside the pipe, the penetrometer may be placed on the film side and appropriate penetrometers from table A2/A3 shall be chosen.

2.5 Film Quality Requirements:

All radiographs shall be free from mechanical, chemical or other blemishes to the extent that they cannot mask or be confused with the image of any discontinuity in the area of interest of the object being radiographed. Such blemishes include but are not limited to :-

- a) Fogging
- b) Processing defects such as streaks, water marks or chemical stains.
- c) Scratches, finger marks, crimps, dirtiness, static marks, smudges or tears.

- d) Loss of detail due to poor screen to film contact.
- e) False indications due to defective screens or internal faults.

2.6 Location Markers:

2.6.1 Location markers, the images of which will appear on the film shall be placed adjacent to the weld on the part, not on the film or film holder, and their locations shall be marked on the surface near the weld in such a manner that a defect appearing on a radiograph may be accurately located and in such a manner that it is evident on the film that complete coverage of the weld has been obtained.

2.6.2 Location markers as indicated in ASME Section V Fig.-T-275 shall be employed.

2.6.3 Radiographs shall include all the information regarding the welded joint viz. line no., joint no. repair mark, penetrometer, welders symbol etc.

2.7 Source to film distance:

Geometric unsharpness of the radiograph shall not exceed 0.510mm.

2.8 Object to film distance:

The object to film distance shall be the minimum possible and when practical the film shall be shaped to the contour of the object.

3.0 PROCEDURE REQUIREMENTS

Radiographic examination shall be performed in accordance with a written procedure to the requirements listed below.

- a) The type of material to be radiographed.
- b) The material thickness ranges to be radiographed.
- c) The type of radiation source, maximum focal spot or source size, X-ray machine voltage rating and manufacturer.
- d) Film brand and type and number of films in cassette. For multiple film technique state whether viewing will be done with superimposed films.
- e) Type and thickness of intensifying screens and filters.
- f) Blocking or masking technique, if any
- g) Minimum source to film distance
- h) Exposure conditions, voltage, distance of film to object, geometric arrangements for the radiographs. (shooting sketch) Orientation of location markers.
- i) Description of the welding procedure or approved welding procedure (WPS) number.

4.0 REPORTS:

Written reports of radiographic examination shall be submitted for the approval of the Quality Surveyor in the form approved by the Engineer/Quality Surveyor. Prior to submitting above reports to the Engineer/Quality Surveyor, radiographs shall be examined and interpreted by the contractor and the written reports shall be accompanied by such review reports.

APPENDIX – E
PIPING FABRICATION, ERECTION AND PRESSURE TESTING

1.0 SCOPE

- 1.1 This specification describes the requirements for fabrication, erection and testing of Stainless Steel piping of effluent management system in MOS pump house, Dhruva.
- 1.2 In the event that certain technical requirements are not described in the technical specifications, the contractor person shall request the Engineer-in-Charge prior to starting any fabrication, to issue governing requirements.
- 1.3 The Engineer shall have the right to amend existing, and to issue additional specifications whenever the need shall arise. All specifications, whether in the form of specifications, drawings, instructions or procedures will be issued consistent with the provision of the contract documents.

2.0 QUALITY CONTROL AND INSPECTION

- 2.1 The contractor shall be responsible for and shall provide for and perform all the inspection and testing required by the technical specifications.
- 2.2 Contractor shall submit for approval a Quality Assurance Plan together with the qualifications experience of his quality control personnel. The Plan shall include all the steps to be followed for achieving the specified quality requirements.
- 2.3 A Quality Surveyor shall be designated by the Engineer. The Quality Surveyor and his designated staff will be responsible for checking the quality of work to the extent necessary to assess compliance with the provisions of the specifications. His surveillance shall not be limited to examination of the end product, and he shall have complete access to the work and the right to intervene where bad (non-standard) practices are detected. He shall also have the right to conduct or require the contractor to perform any additional inspection or testing he deems necessary. If any unacceptable defects are noted by such tests, the contractor shall repair the defects free of charge to the entire satisfaction of Engineer-in-Charge.
- 2.4 The surveillance provided by the Engineer or the approval by the Quality Surveyor of finished work shall not relieve the contractor of any of his responsibilities under this specification. The rejection of work not meeting this specification is possible at any time.
- 2.5 The Contractor shall maintain quality control records which shall record fully all the quality control operations that were performed. The Quality Surveyor shall have the right to witness any or all such operations.

3.0 DISCREPANCIES AND FIELD CHANGES

- 3.1 Any discrepancies in or omission from drawings, specifications or other documents or any doubts arising as to the meaning or intent of any part thereof shall be referred to the Engineer-in-Charge. Written instruction or explanations will then be issued by the Engineer-in-Charge whose decision shall be final and binding.

3.2 Whenever the contractor is unable to comply with the Engineer's requirements, be it dimensional or technical, or whenever field changes are inevitable for any reason, the contractor must obtain the appropriate approval from the Engineer-in-Charge.

4.0 IDENTIFICATION OF MATERIAL

4.1 All materials to be used in piping installation shall conform to the specification issued by the Engineer-in-Charge. No substitution of equivalent materials is permissible unless approved by Engineer-in-Charge.

4.2 Material supplied by contractor shall be tested in BARC approved laboratories. Manufacturer's certificates attesting compliance of the material with the specification shall include identification details, a certified report of the results of all the required tests, examinations and repairs performed on the material. The certificates shall be submitted to the Engineer-in-charge for retention and record.

4.3 Each piece of pipe regardless of length and each fitting or other component part, except minor fasteners, shall be clearly identified by legible marking on the part.

4.4 The marking shall consist of the applicable specification number, grade / type and any non-destructive testing. In those cases where size or shape prohibits, a marking code shall be used that identifies the material with the certification report.

4.5 The materials shall be marked by any method that will not result in any harmful contamination or sharp discontinuities and which will identify the material until the system is completely installed. Material 6 mm and greater in thickness may be marked by a stamping. When stamping is used, it shall be done with round-nose continuous or round-nose interrupted dot low stress die stamps. Vibro-etching is permitted on all thickness provided minimum wall thickness requirements are met and marking is acceptable to Quality Surveyor.

4.6 Pipelines and sub-assemblies shall be identified in accordance with the code number assigned on the flow sheets.

5.0 PIPELINE ROUTING REQUIREMENTS

5.1 Normally piping is routed as per general guidance contained in relevant drawings.

5.1 Pipeline shall be routed in a manner that it is short and with minimum bends, in plumb when vertical, parallel to walls when horizontal, and also to avoid any interference with other piping, equipment and structure.

5.3 All valves and on-line equipments / instruments shall be located at the same place as in the original location after replacement of pipes.

6.0 HANDLING OF MATERIALS

6.1 The contractor shall take adequate precautions to ensure safety of all materials / components, issued to him by the Department, during their storage, handling and installation to avoid any pilferage, damage etc. In the event of such an instance, the

contractor shall replace free of cost all such materials of a quality acceptable to the Engineer-in-charge.

6.2 All materials arriving at site shall be immediately inspected, classified and directed to such storage as may be necessary for its protection.

6.3 Loading and unloading of materials and equipment shall be by hoisting and skidding so as to avoid any damage. Under no circumstances shall materials be dropped. Pipes handled on skid ways shall not be skidded or rolled against other pipes.

7.0 DIMENSIONAL TOLERANCES

Unless otherwise specified on the drawings, the following tolerances will apply and shall be achieved without springing into position.

7.1 Tolerances on dimensions shall not exceed ± 3 mm lengthwise and tolerances shall not be cumulative. Any deviations in excess of 3 mm from that required on the drawing shall be brought to the attention of the Engineer-in-Charge.

7.2 The bolt holes of flanges in the vertical plane shall straddle the vertical center line of the pipe in the erected position.

7.3 The maximum deviation, measured in any direction, on flange face alignment shall be $\frac{1}{2}$ degree or 0.8 mm whichever is less.

7.4 Maximum permissible parallel misalignment on flanged joints shall be 1.6 mm.

8.0 TIGHTENING OF BOLTS

8.1 All bolts shall be engaged so that there is visible evidence of complete threading through the nut or threaded attachment. At least two threads on bolt should project beyond nut.

8.2 In bolting of gasketed flanged joints, the contact faces of the flanges shall bear uniformly on the gasket, and the gasket shall be properly compressed in accordance with the design principles applicable to the type of gasket used. The hold stress in all flanged joints shall be uniform.

8.3 All threads of bolts and nuts shall be cleaned by suitable means so as to be free from any foreign material and suitable approved lubricant wherever specified, shall be used prior to tightening of bolts.

8.4 Torque wrenches shall be used for tightening of bolts to ensure controlled tightening and uniform torque on all bolts.

9.0 SUPPORTS AND HANGERS

9.1 The support shall be erected as per instruction of Engineer-in-charge, as per the given drawings and requirements at site. Stainless steel shims/flat shall be provided between SS pipes and MS support to prevent direct contact.

10.0 PIPELINE IDENTIFICATION MARKINGS

10.1 After a pipeline is installed and tested, the contractor shall write pipeline designation by paint on the outer surface of the pipeline in clear capital English letters or as desired by the Engineer-in-Charge.

11.0 TESTING

11.1 The hydrostatic leak testing of all piping systems and equipment as per approved procedure shall be carried out by the contractor apart from the DPT and radiography of the weld joints.

11.2 The contractor shall also provide all the necessary equipment, men and materials for carrying out the tests. He shall perform the test and carry out repairs as required meeting the specifications.

11.3 All the pipe lengths after welding and fabrication shall be hydrostatically pressure tested at 10 Kg/cm^2 with the flanged ends blanked. Pipes will be kept pressurized for sufficiently long period and no pressure drop will be acceptable.

Format for Quotation for Quantity and cost of proposal (Schedule-B)

Sr. No.	Name of items	Unit	Quantity (a)	cost/unit i.e. Rate (b)	Total cost (INR) C= a x b
1.0	Supply & testing of Stainless steel seamless pipes conforming to ASTM A 312, TP-316L of following sizes:				
1.1	50 mm NB, Sch.-40S	Mtr.	24		
1.2	80 mm NB, Sch.-40S	Mtr.	80		
1.3	100 mm NB, Sch.-40S	Mtr.	18		
2.0	Supply & testing of stainless steel seamless butt welded pipe fittings - 90° elbows, Equal / Unequal Tees & reducers conforming to ASTM A 403 TP-316L of following sizes:				
2.1	Elbow- 50mm NB, Sch.40S	Nos.	11		
2.2	Elbow- 80mm NB, Sch. 40S	Nos.	50		
2.3	Elbow- 100mm NB, Sch. 40S	Nos.	12		
2.4	Tee- 2" x 2" x 2", Sch. 40S	Nos.	7		
2.5	Tee- 3" x 3" x 3", Sch. 40S	Nos.	10		
2.6	Tee- 4" x 4" x 4", Sch. 40S	Nos.	6		
2.7	Tee- 4" x 4" x 3", Sch. 40S	Nos.	3		
2.8	Tee- 4" x 4" x 2", Sch. 40S	Nos.	2		
2.9	Reducer- 6" x 4", Sch. 40S	Nos.	1		
2.10	Reducer- 4" x 3", Sch. 40S	Nos.	3		
2.11	Reducer- 3" x 2", Sch. 40S	Nos.	14		
3.0	Supply & testing of stainless steel forged raised face weld neck Flanges (WNRF) of class-150 conforming to ASTM A 182 TP-316L of following sizes:.				

Sr. No.	Name of items	Unit	Quantity (a)	cost/unit i.e. Rate (b)	Total cost (INR) C= a x b
3.1	2 " NB	Nos.	22		
3.2	3 " NB	Nos.	40		
3.3	4 " NB	Nos.	10		
4.0	Cutting, Edge preparation, fit up and welding of pipe & pipe fittings by GTAW process with Ar purging by using suitable filler wire ER-316L, DP testing of root & final pass of weld joints as per tender specifications of following sizes.				
4.1	SS-316L Butt Weld Joints	Inch-Dia.	950		
5.0	Removal of existing pipelines and erection of pipelines and pipe fittings on the same lay-out, including supply of fasteners, supports and neoprene rubber gaskets, leveling, alignment, making flange joint by uniform predetermined torquing etc. as directed by Engineer-in-charge. As far as possible existing supports will be used.	Inch-dia.-Mtr.	360		
6.0	Breaking and remaking of 2' thick concrete wall to pass 4" NB pipe	Nos.	1		
	Basic Cost				
	GST @18%				
	Total Cost				

Signature of contractor
with rubber stamp