



DELHI AVIATION FUEL FACILITY PRIVATE LIMITED

**DELHI AVIATION FUEL FACILITY PRIVATE LIMITED
AVIATION FUELLING STATION
SHAHBHAD MOHAMMADPUR
IGI AIRPORT
NEW DELHI-110061**



TENDER NO: DAFFPL/MOD/FF/2015-16/07

**INVITING TENDER FOR SUPPLY, FABRICATION & ERECTION,
INSTALLATION & CALIBRATION OF HORIZONTAL UNDER
GROUND MILD STEEL STORAGE TANK OF 45 M³**

BID DUE DATE & TIME: 1500 Hrs. IST on August 07th, 2015

OPENING OF TECHNICAL BIDS: 1100 Hrs. IST on August 10th, 2015



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PRICE BID FORMAT

NOTE: BIDDERS ARE REQUESTED TO SIGN AND STAMP ALL THE PAGES OF THE TENDER DOCUMENT AND SEND THE SAME BACK IN THEIR OFFER AS A TOKEN OF UNCONDITIONAL ACCEPTANCE OF TENDER FIRMS.

THE DEVIATIONS, IF ANY, SHOULD BE MENTIONED SEPARATELY ON BIDDER’S LETTER HEAD IN TECHNICAL BID. THE DEVIATIONS MENTIONED ANYWHERE ELSE SHALL NOT BE CONSIDERED. IN ABSENCE OF DEVIATION SHEET IT WOULD BE CONCLUDED THAT BIDDER HAS ACCEPTED THE TENDER TERMS WITHOUT ANY DEVIATIONS. CORRECTIONS IN TENDER DOCUMENT WILL NOT BE ACCEPTED.



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TENDER NOTICE DELHI AVIATION FUEL FACILITY PRIVATE LIMITED

INVITING EPC TENDER FOR SUPPLY, FABRICATION & ERECTION, INSTALLATION & CALIBRATION OF HORIZONTAL UNDER GROUND MILD STEEL STORAGE TANK OF 45 M³ CAPACITY AS PER SPECIFICATIONS AS REQUIRED

TENDER NO: DAFFPL/MOD/FF/2015-16/07

Delhi Aviation Fuel Facility (P) Ltd (DAFFPL) invites sealed bids under single stage two bid system from eligible bidders for EPC of 45 M³ MS horizontal cylindrical underground tank

Brief Scope of work:

We intends to provide 45 M³ MS horizontal cylindrical underground tank as per specification as required. Scope of supply includes SUPPLY, FABRICATION & ERECTION, and INSTALLATION & CALIBRATION OF HORIZONTAL UNDER GROUND MILD STEEL STORAGE TANK at our DAFFPL office.

| | |
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| Bid Security (EMD): | As mentioned in the Tender document |
| Date, Time & Venue for Voluntary Pre-bid Meeting: | July 22 nd , 2015; 14:30 HRS (IST) at DAFFPL, Aviation Fuelling Station, Shahabad Mohammadpur, New Delhi-110061 |
| Bid Due Date, Time & Place of Submission: | Upto 15:00 HRS (IST) on August 07 th , 2015 at the office of the Chief Executive Officer, DAFFPL, Aviation Fuelling Station, Shahabad Mohammadpur, |

Detailed Invitation for Bids (IFB) along with Pre-qualification Criteria, Bid Document Corrigenda can be viewed and downloaded from DAFFPL's website: <http://www.daffpl.in>

Chief Executive Officer
DAFFPL, New Delhi
8826120066



DELHI AVIATION FUEL FACILITY PRIVATE LIMITED

CHAPTER 1: INTRODUCTION (COVERING NOTE)

Delhi Aviation Fuel Facility Private Limited (DAFFPL) is a Joint Venture comprising Indian Oil Corporation Ltd. (IOCL), Bharat Petroleum Corporation Ltd. (BPCL), and Delhi International Airport (P.) Ltd. (DIAL). We provides the infrastructure aimed at ensuring an uninterrupted flow of Aviation Turbine Fuel (ATF) to all type of aircrafts at the Indira Gandhi International Airport, New Delhi (IGI Airport) as per international benchmarking.

The bidder/ contractor shall refer to various sections of this tender document for detailed scope of work. It is contractor's responsibility to execute the job in all respects as per detailed drawings, documents / specification furnished by consultant / owner and as per applicable codes, standards & in line of statutory requirements.

The field circumstances shall also be taken into consideration and methods suitable to the site conditions shall be adopted with concurrence of the Engineer-in-charge and in line with manuals, instructions of respective equipment and specified codes and standards. The successful accomplishment of the project is greatly influenced by the team work, workmanship of the workers and supervisors.

The Contractor shall employ only such workers and supervisors who have considerable experience of similar work and who can work, temperamentally in good harmony and co-operation.

Delhi Aviation Fuel Facility Private Limited (DAFFPL) invites sealed tenders in prescribed tender form under two-bid system. For viewing details including EMD, BID QUALIFICATION CRITERIA etc. please visit our web site www.daffpl.in and go to tender section by clicking the link "Tenders". Tender documents are available on our website.

The bid documents can also be collected from our office and the bids are to be submitted in Physical form in the Tender Box kept at the office of the **Delhi Aviation Fuel Facility Private Limited (DAFFPL)** at Shahabad Mohammadpur, New Delhi-110061, India.



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1. The Tender is floated in Two Bid system consisting of Technical Bids (Bid Qualification Criteria - BQC, Technical plus Commercial) and Price Bids.

Part-I : Bid Security / EMD in accordance with tender document.
Part-II : BQC (Bid qualification criteria), Technical & commercial Bid, duly filled in & along with all supporting as requested to be submitted in Physical form in the Tender Box.
Part –III : Price Bid.

2. The bidder should be able to fabricate & supply the entire size/type/quantity bidded by them. Bidders cannot bid for part items or part quantity.
3. Firstly the Technical bid (BQC & Techno commercial bids) shall be opened. The Bids shall be initially scrutinized by a team as per tender requirements of BQC (Bid qualification criteria). Technical cum commercial bids of only those vendors who qualify the BQC will be processed further. The price bids of only techno-commercially qualified bidders will be opened, evaluated and shortlisted for Placement of Work Order.
4. Each page of bid documents is to be duly signed & stamped by the bidder before submitting the Tender.
5. The bids submitted should be valid for **four months** from the due date of bid submission for Owners acceptance. Once accepted it will remain firm till completion of contracts/orders.
6. We request the bidder to carefully go through all tender documents before submitting the offer. Please note that any exceptions or deviations to the tender document are necessarily to be recorded in the attached deviation statement only. Any exceptions/deviations brought out elsewhere in the bid shall not be considered.
7. The bidders may be invited for a presentation to DAFFPL during Techno-commercial evaluation before price bid opening.
8. The bidders to provide their bank details/ PAN / Sales Tax /WCT Registration numbers/Service Tax Registration No. / VAT registration No., as applicable for updating vendor master file. You are also requested to keep us informed of any change in address / status of your business / contact details including email address etc.
9. Party can quote with the deviations as referred in Point No.6 above. Please refer query end date / time in tender calendar after which no query posted by bidder



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shall be considered. However DAFFPL reserves the right to respond the queries after cutoff date / time mentioned in tender calendar.

10. Please note that queries related to scope of job, tender specifications, terms & conditions etc., should be submitted by means of letter/E mail to reach the owner's office not later than one week before the meeting .It may not be practicable to answer queries received late, but queries and responses/clarifications will be posted in the form letter, E-mail within one week from the date of Pre Bid Meeting. Any modification in the bid document that may become necessary as a result of the Pre Bid meeting shall be made by the owner exclusively through the issues of corrigendum/ addendum posted at web site and not through the minutes of the pre bid meeting.
11. **UNSOLICITED POST BID MODIFICATION**
Bidders are advised to quote strictly as per terms and conditions of the Bidding Document. After tender submission due date & time/ extended due date & time (as the case may be) the bidders shall not make any subsequent price changes, whether resulting or arising out of any technical / commercial clarifications sought/allowed on any deviations or exceptions mentioned in the bid unless discussed and agreed by DAFFPL in writing.
12. EMD & Techno Commercial bid shall be opened on **August 10th, 2015 at 11:00 Hrs (IST)** in the presence of authorized representative of bidders (Restricted to one [1] person per bidder only) at the office of DAFFPL. Price Bid of only those bidders whose offer is found meeting both PQC & techno-commercially acceptable, shall be opened on a later date as per convenience of DAFFPL after intimation to the qualified bidders.
13. DAFFPL reserves the right to accept any tender in whole or in part or reject any or all tenders without assigning any reason. DAFFPL reserves right to accept any or more tenders in part. Decision of DAFFPL in this regard shall be final and binding on the bidder.

QUERIES AND CLARIFICATIONS: Any query or clarification with regard to this tender may please be referred to below address & phone nos. on any working day during office working hours

| | |
|--|---|
| Mr M Vishnu Vardhan Project Officer Vishnu.vardhan@daffpl.in , bksingh@daffpl.in 8826000228 | Mr V S Thakur (Consultant) Project Manager Virender.Thakur@mottmac.com 91-120-3992308 9313834546 |
|--|---|

14. **GOVERNING LAWS:** The laws of Union of India shall govern all matters concerning the tender. Any issue arising related to the tender or the selection process shall be adjudged by the courts in Delhi alone.



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15. A Pre-bid meeting is scheduled for **22/07/2015 at 14:30 Hrs IST** at the office of DAFFPL, New Delhi. All prospective bidders can participate in the same. Any clarification with regard to tender shall be sorted out during the pre-bid meeting.
- The purpose of the pre-bid meeting is to clarify any doubts of the BIDDER on the interpretation of the provisions of tender.
 - Bidder(s) are requested to submit their queries, mentioning form name, clause no. & clause, by a letter / e-mail to our office as per schedule in order to have fruitful discussions during the meeting.
 - All the Bidder(s) are requested to attend the pre-bid meeting to be held at DAFFPL Office as per schedule.
16. **Tender document can be purchased from our office located at Shahabad Mohammadpur at a cost of Rs 1000/- and also can be downloaded from our website www.daffpl.in.**
- A bidder who downloads the document from website has to submit a separate DD for an amount of Rs.1000/- along with the EMD document.**
 - Bidders who purchase the document from our office have to submit a DD for an amount of Rs.1000/- at the time of purchase.**
17. **Earnest Money Deposit (EMD) (also referred to as Bid Security):** Bidder shall be required to submit the Earnest Money Deposit (EMD), either in the form of Bank guarantee as per format (provided as Annexure) or PAY ORDER or BANK DRAFT (in favour of Delhi Aviation Fuel Facility Private Limited, payable at New Delhi) at our office. The EMD in either form has to be submitted on or before the due date & due time of bid submission of this tender with a covering note mentioning the tender no.
- The bidders not submitting EMD by due time & date shall be rejected & their bids shall not be evaluated further.
 - The EMD amount shall be 6.0 Lakhs INR**
 - Firms registered with National Small scale Industries (NSIC)/MSME of India are exempted from submission of bid security .Central Public Sector Enterprises of India and Firms registered with Nation Small Scale Industries Corporation (NSIC) of India are exempted from submission of Bid Security. Central Public Sector Enterprises are requested to give a self-declaration on their letter head to this effect. Bidders registered with NSIC of India are also requested to submit self-declaration on their letter head to this effect along with a copy of their Valid Registration certificate, specifying limit of volume and other details which should be submitted.



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THE FORMS /ATTACHMENTS TO THIS TENDER ARE AS UNDER:

1. Covering Note – CHAPTER: 1
2. Instructions To Bidders - CHAPTER: 2
3. Bid-Qualification Criteria - CHAPTER: 3
4. BQC –List of Documents – CHAPTER: 4
5. General Purchase Conditions- CHAPTER: 5
6. Technical Specification Documents - **(Attached separately as Annexure I)**
7. Annexure attached are as follows:
 - Annexure II – DEVIATION SHEET
 - Annexure III – DECLARATION SHEET
 - Annexure IV – FORMAT FOR DRAFT BANK GUARANTEE IN LIEU OF BID SECURITY (EMD)
 - Annexure V - FORMAT DRAFT COMPOSITE BANK GUARANTEE FOR SECURITY DEPOSIT/PERFORMANCE GUARANTEE
 - Annexure VI – FORM OF LETTER OF UNDERTAKING
 - Annexure VII – DECLARATION TO BE SUBMITTED ALONGWITH Technical BID
 - Price Bid

Thanking you,
Yours faithfully,
For DELHI AVIATION FUEL FACILITY (P) LTD.

Chief Executive Officer
DAFFPL, New Delhi



CHAPTER 2: INSTRUCTIONS TO BIDDERS

1. The bidder shall bear all costs associated with the preparation and submission of the bid and Owner will in no case be responsible or liable for these costs, regardless of the conduct or outcome of the bidding process.
2. Vendor is requested to submit their bids taking full notice of all the technical specifications, terms and conditions, forms & attachments to this tender. Bids must be submitted in Physical form only.
3. Owner reserves the right to accept / reject any or all bid qualification documents at their sole discretion without assigning any reason whatsoever.
4. Owner is not responsible for any delays from bidder end.
5. Owner reserves the right to make any changes in terms and conditions of purchase before due date of bid submission and to reject any or all bids received incomplete.
6. Undertaking by the bidder:
 - a. I/we hereby undertake that the statements made herein/information given in the bids through Physical Tendering system/annexure/forms referred are true in all respects and that in the event of any such statement or information being found to be incorrect in any particular, the same may be construed to be a misrepresentation entitling DAFFPL to avoid any resultant contract.
 - b. I/we further undertake as and when called upon by DAFFPL to produce, for its inspection, original(s) of the document(s) of which copies have been annexed hereto.
7. Owner, at its discretion reserves the right to verify information submitted by the bidders.
8. Bidder to submit documents/information to satisfy the bid qualification criteria. Bidders should also be in a position to produce further information as and when required by DAFFPL with in a time limit of 15 days.
9. DAFFPL reserves their right to negotiate the quoted prices with lowest bidder.
10. Bidders would be qualified based on data and documents submitted by them.
11. Owner's decision on any matter regarding short listing of vendors shall be final and no corresponding in this regards will be entertained.
12. The vendors who are on IOCL/BPCL/DIAL holiday list or delisted will not be



considered.

13. The bidder is expected to examine all instructions, forms, attachments, terms and specifications in the tender document. The entire tender document together with all its attachments thereto, shall be considered to be read, understood and accepted by the bidder, unless deviations are specifically stated seriatim by the bidder. Failure to furnish all information required in the tender document or submission of a bid not substantially responsive to the tender documents in every respect will be at bidder risk and may result in the rejection of his bid. The bidder scope of supplies as specified in the material requisition shall be in strict compliance with the scope detailed therein and in the bid document.
14. Bidders in their own interest shall ensure that they submit their bid, complete in all respects, well within the specified bid due date and time. No relaxation shall be given for delay due to any unforeseen event in submission of bid.
15. At any time prior to the bid due date, we may, for any reason, whether at its own initiative or in response to a clarification requested by a prospective bidder, modify the bid document. The amendment will be notified through our portal www.daffpl.in to all prospective bidders and will be binding on them. In order to afford prospective bidder, reasonable time in which to take the amendment into account in preparing their bids, we may, at our discretion, extend the bid due date.
16. The bid prepared by the bidder and all correspondence/ drawings and documents relating to the bid exchanged by bidder and the owner shall be written in ENGLISH language, provided that any printed literature furnished by the bidder may be written in another language so long as accompanied by an ENGLISH translation, in which case, for the purpose of interpretation of the bid, the ENGLISH translation shall govern.
17. Declaration with the bid qualification criteria that bidder has not been banned or delisted by any Government or quasi Government agencies or Public Sector Undertaking (PSU) as per declaration format (provided as annexure) of the tender document should be submitted along with the bid.
18. Bidders are advised to submit bids based strictly on the terms & conditions and specifications contained in the tender document and not to stipulate any deviations. Each Bidder shall submit only one bid. A Bidder who submits more than one bid will be rejected. Alternative bids will not be accepted.
19. The Owner may, at its discretion, extend the bid due date, in which case all rights and obligations of the Owner and the Bidders, previously subject to the bid due date, shall thereafter be subject to the new bid due date as extended. The same will be hosted in the web site.



20. Bids shall be kept valid for 4 months from the bid due date. A bid valid for a shorter period shall be considered as non-responsive and rejected by the Owner. Notwithstanding above, the Owner may solicit the Bidder consent to an extension of the period of bid validity. The request and the responses thereto shall be made in writing. The EMD (bid security) shall also be accordingly extended.
21. Telex/ Telegraphic/ Telefax / E-mail offers will not be considered and shall be rejected.
22. No bid shall be modified subsequent to the due date & time or extension, if any, for submission of bids. Bidder(s) to note that Price changes after submission of bid shall not be allowed. In case any bidder gives revised prices/price implication, his bid shall be rejected. No bid shall be allowed to be withdrawn in the interval between the deadline for submission of bids and the expiration of the period of bid validity specified by the Bidder. Withdrawal of a bid during this interval shall result in the forfeiture of Bidder s EMD.
23. Bids that do not meet the Bid qualification criteria as specified in the bid document shall be rejected. A bid with incomplete scope of work and/or which does not meet the technical requirements as specified in the bid document, shall be considered as non-responsive and rejected. Conditional bids will be liable for rejection.
24. The Owner will examine the bids to determine whether they are complete, whether any computational errors have been made, whether the documents have been properly signed and whether the bids are generally in order.
25. The bids without requisite EMD and/or not in the prescribed Performa and the time limit will not be considered and bids of such bidder Bidder(s) shall be rejected.
26. PRICE EVALUATION CRITERIA: As award is on overall landed lowest basis, part offers will be rejected. Bidder has to quote for all items in a lot for us to consider them.
27. Prior to the expiration of period of bid validity, the owner will notify the successful bidder in writing or by e-mail, that his bid has been accepted. The Notification of Award will constitute the formation of the Contract. Delivery Period shall be counted from the date of notification of award (Letter/Fax/e-mail of Intent).
28. Any efforts by a bidder to influence the owner/ in the owner bid evaluation, bid comparison or contract award decisions may result in the rejection of their bid.
29. ISSUE OF CONTRACT/ PURCHASE ORDER: After the successful bidder has been



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notified that his bid has been accepted, DAFFPL will send to such bidder a detailed contract/purchase order incorporating all the terms and conditions agreed between the parties. Within 15 days of receipt of the detailed purchase order, the bidder shall sign and return to the owner the duplicate copy of the order as a token of their acknowledgement.

30. Vigil Mechanism: DAFFPL has developed the Vigil Mechanism to deal with references/ grievances, if any, that is received from bidders who participated / intends to participate in the tender. The details of the same are available on our website www.daffpl.in

31. VERIFICATION BY OWNER: All statements submitted by bidder regarding experience, manpower availability, equipment and machinery availability etc., are subject to verification by the owner either before placement of order or after placement of order. If any data submitted by the bidder at the bid stage is found to be incorrect, the offer is liable to be rejected or the contract/order is liable to be terminated.

32. SEALING & MARKING OF BIDS

A. Bids shall be submitted separately in THREE SECTIONS in sealed envelopes superscribed with the Bid Document number, bid due date and time, item and nature of bid as under:

- **SECTION - I (Envelope No. 1): Bid Security / EMD:**
Bid security in accordance with tender document.
- **SECTION - II (Envelope No. 2): Technical Bid:**
 - a. Information and documentary evidence establishing bidder's claim for meeting qualification criteria as stipulated in IFB. This section/envelope should necessarily contain all the required back-up documents for Bid Qualification.
 - b. Technical bid complete with all technical and commercial details, covering letter and un-priced copy of price Schedule with prices substituted with 'QUOTED' or 'NOT QUOTED' or 'NOT APPLICABLE'. **Deviation sheet duly filled with deviations, if any, shall form part of technical bid.**
- **SECTION - III (Envelope No. 3): Price Bid:**
 - a. PRICE BID WITH FULL PRICE DETAILS. The price bid shall contain prices only in the prescribed price schedule formats, without any technical and commercial details. Technical specifications or commercial terms given in unpriced schedule will only be evaluated



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- and the same will be binding on the Bidder. The bids shall be sealed and kept in a single envelope with marking as Section - III (Price Bid) / Envelope No. 3 : "Original"
- b. The bidder shall quote the final prices (including taxes, Cess, duties and other levies etc) in the 'PRICE SCHEDULE FORMAT' of bid document ONLY. Prices quoted in any other format shall not be considered for evaluation.
 - c. The Price bid shall be kept in a larger envelope duly sealed and shall bear the name and address of the bidder.
- B. The envelopes containing Section -I, Section -II, Section -III of bid shall be enclosed in a larger envelope duly sealed and pasted and shall bear the name and address of the bidder.
- C. Bidder to note that if bid security / EMD (in the Proforma attached with these documents) in original and/or bid document fee (if the bid document is downloaded) is kept in any other envelope and not found in envelope no. 1, the offer of the bidder(s) will be REJECTED during opening.
- D. Bidder to note that prices are to be quoted in the format provided in the price schedule formats provided along with the tender without any conditions. Price bids submitted in any other format and conditional price bids will be liable to be rejected. Price bids received in open condition (not in sealed envelope) or kept in any other Section of the bid (i. e, Section - I or II) will also be liable for rejection.
- E. If the outer envelope is not sealed and not marked as required, then DAFFPL will assume no responsibility for the bid's misplacement or premature opening.
- F. Bidders in their own interest shall ensure that they send their bid complete in all respects well in time to reach the specified office within the specified bid due date and time. No relaxation shall be given for delay due to any unforeseen event in submission of bid.
- G. Central Public Sector Enterprises and Firms registered with NSIC are exempted from submission of Bid Security. Central Public Sector Enterprises are requested to give a self declaration on their letter head to this effect, which should be submitted in a sealed envelope marked as Bid Security.
- H. Bidders registered with NSIC are also requested to submit self declaration on their letter head to this effect along with a copy of their Valid Registration certificate, specifying limit of volume and other details which should be submitted in a separate sealed envelope no. 1 marked as Bid security.
- I. Bid Security strictly in the Proforma attached with these documents shall be submitted in Original along with the Bid. Bids received without original bid security, shall not be opened for evaluation.
- J. Tender document complete in all respects must be submitted in the tender



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box provided at the DAFFPL office before due date and time

33. DOCUMENTS COMPRISING THE BIDS

The bid prepared by the Bidder shall comprise the following components:

- I. **ORIGINAL BID SECURITY (Section - I):** Bidders are advised to instruct their banks not to post Bid Security directly to Owner as the same has to accompany with the bid.
- II. **TECHNICAL BID (Section -II):**
 - Documentary evidence establishing Bidder's claim for meeting qualification criteria as stipulated in the Bid Document.
 - Notarized Audited Annual Report of previous three financial years.
 - Documentary evidence establishing Bidder's eligibility to bid and that the offered Goods conform to the Bid Document.
 - Price Schedule (with Price figures blanked) completed in accordance with the requirements specified in the bid document.
 - Agreed Terms & Conditions duly filled-in.
 - Deviation Sheet, if any.
 - Declaration with the bid qualification criteria that bidder has not been banned or delisted by any Government or quasi Government agencies or PSU's.
 - Any other information/details/documents/data required as per Bid Document.
 - Parent Company Guarantee, if applicable
- III. **PRICE BID (Section -III):** Bid Form and Price Schedule (Both given along with tender) duly filled in.

34. BID FORM & PRICE SCHEDULE

The bidders shall complete the Bid Form and appropriate Price schedule furnished of Bid Document, indicating the required information for all quoted items.

35. FORMAT AND SIGNING OF BID

- a. The Bidder shall prepare required number of copies of the bid, clearly marking each 'Original Bid' and 'Copy of Bid' as appropriate. In the event of any discrepancy between them, the 'Original Bid' shall govern.
- b. The original and all copies of the bid shall be typed or written in indelible ink and shall be signed by the Bidder or a person or persons duly authorized to sign on behalf of the bidder on all pages of the bid. Such authorization shall be indicated by written Power of Attorney accompanying the bid. The name and position held by each person signing must be typed or printed below the signature. The person or persons signing the bid shall initial all pages of the



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bid, except for unamended printed literature.

- c. The complete bid shall be without alterations, interlineations or erasures, except as may be necessary to correct errors made by the Bidder, in which case such corrections shall be rewritten & initialed by the person or persons signing the bid.
- d. All the pages of the price bid shall be signed by the authorized signatory. In case all the pages of the price bid are not signed, the bid shall be rejected.

36. OPENING OF BIDS

Bids will be opened by Owner at DAFFPL Office, New Delhi, in the presence of bidders/bidders authorized representatives available on the opening date and time (duly authorized by a competent person and having the letter of authority).

a. **BID SECURITY / EMD (SECTION-I) AND TECHNICAL BID (SECTION-II):**

- I. On the day and time of bid opening, Bid security (Envelope 1) and Technical Bid (Envelope 2) shall be opened in presence of bidders.
- II. The Bidder's representatives, who are present, shall sign a register/attendance sheet evidencing their attendance.
- III. The Bidder(s) names, presence or absence of requisite bid security will be announced at the opening.
- IV. Bidder (s), whose bids are not opened for any reason, including non receipt of original bid security, will not be allowed to be present during bid opening.

b. **PRICE BID OPENING (SECTION -III):**

- I. Only those bidders whose bids meet the qualification criteria and are technically/commercially acceptable shall be called for opening of Price bid (Envelope 3) at a later date, informed in advance.
- II. The Bidder's representatives, who are present, shall sign a register/attendance sheet evidencing their attendance.
- III. Bidder(s), whose bids are not opened for any reason, will not be allowed to be present during bid opening.

37. EVALUATION OF BIDS

- a. Qualification of Bidder: The experience details and financial & technical capabilities of the bidder(s) shall be examined to determine whether the bidder(s) meet the Bid Qualification Criteria mentioned in the INVITATION FOR BIDS (IFB).
- b. The Owner will examine the bids to determine whether they are complete, any computational errors have been made, whether the documents have been properly signed and whether the bids are generally in order.
- c. The bids without requisite Bid Security and/or not in the prescribed proforma will not be considered and bids of such bidder Bidder(s) shall be



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rejected.

- d. To assist in the examination, evaluation and comparison of technical bids, the owner/ may, at its discretion, ask the Bidder clarifications on the bid. The request for such clarifications and the response thereto shall be in writing.
- e. Prior to the evaluation and comparison of the bid, the owner will determine the substantial responsiveness of each bid to the bidding documents. For the purpose of this Article, a substantially responsive bid is one, which conforms to all the terms and conditions of the bidding document without material deviations or reservations. A material deviation or reservation is one which affects in any substantial way the scope, quality, or performance of the works or which limits in any substantial way, inconsistent with the bidding document, the DAFFPL's rights or Bidder's obligation under the contract and retention of which deviation or reservation would affect unfairly the competitive position of other bidders presenting substantially responsive bids. The owner's determination of bid responsiveness is to be based on the contents of the bid itself without recourse to the extrinsic evidence.
- f. A bid determined as substantially non-responsive will be rejected by the Owner and shall not subsequently be allowed by the Owner to be made responsive by the Bidder by correction of the non-conformity.
- g. The Pumpset shall be supplied from the same Manufacturing unit as specified in the Documents submitted by Bidder.

Note:

- 1) The Bid Shall be submitted in English Language Only**
- 2) For any Document submitted in any language other than English, the translation copy in English language shall be submitted.**



| BQC REQUIREMENT | BIDDER RESPONSE |
|---|-----------------|
| 1. ESTABLISHED MANUFACTURER | |
| Vendor shall be a regular manufacturer and supplier of the specified equipment/ package. Bidder to give complete details of their manufacturing unit/s & to submit necessary documents in support of same | |
| 2. OWN FACILITY FOR MANUFACTURING | |
| Supply of entire tendered quantity for Fire Water Pump Sets shall be from bidders own manufacturing facility | |
| 3. COMPLIANCE CERTIFICATE | |
| The quantity delivery criteria i.e. No. of Tanks/ fabrication of Structural Steel should be from Vendor(s) same manufacturing unit/ location | |
| 4. TWO YEARS PROVEN EXPERIENCE OF SUPPLY | |
| The vendor should be having minimum 5 years proven supply experience of specified equipment / package (2 years shall be reckoned prior to the due date of bid submission). | |
| 5. MINIMUM QUANTITY SUPPLIED IN THE PAST | |
| The vendor should have fabricated at least 50-nos. Steel tanks of capacity greater than or equal to 45-KL (including supply of Steel) OR Fabricated more than 300-MT of Structural Steel (including supply of steel) during any continuous 12-months period in the last 3-years from the due date of bid submission. | |
| 6.FINANCIAL CAPACITY | |
| The vendor or their group companies should have achieved a minimum average Annual financial turnover as per Audited Balance Sheet and Profit & Loss account, in the last three accounting years, ending March 2015 prior to due date of bid submission, as indicated below: Other than MSME: INR 1.0 Crore For MSME as per CTE Guidelines | |
| Vendor to submit their Audited Balance Sheets & Profit & Loss accounts for last 3 years, ending 31st march 2015 of the previous financial year prior to the due date of bid submission. | |



OTHER INFORMATION OF PQC

1. Parties who are affiliates of one another can decide which Affiliate will make a bid. Only one affiliate may submit a bid. Two or more affiliates are not permitted to make separate bids directly or indirectly. If 2 or more affiliates submit a bid, then any one or all of them are liable for disqualification. However up to 3 affiliates may make a joint bid as a consortium, and in which case the conditions applicable to a consortium shall apply to them.
“Affiliate” of a Party shall mean any company or legal entity which:
 - a. Controls either directly or indirectly a Party, or
 - b. Which is controlled directly or indirectly by a Party; or
 - c. Is directly or indirectly controlled by a company, legal entity or Partnership which directly or indirectly controls a Party. “Control” means actual control or ownership of at least a 50% voting or other controlling interest that gives the power to direct, or cause the direction of, the management and material business decisions of the controlled entity.
2. Bids may be submitted by:
 - a. A single person/ entity (called sole bidder);
 - b. A newly formed incorporated joint venture (JV) which has not completed 3 financial years from the date of commencement of business;
 - c. A consortium (including an unincorporated JV) having a maximum of 3 (three) members;
 - d. An Indian arm of a foreign company.
3. Fulfillment of Eligibility criteria and certain additional conditions in respect of each of the above 4 types of bidders are stated below, respectively:
 - a. The sole bidder (including an incorporated JV which has completed 3 financial years after date of commencement of business) shall fulfill each eligibility criteria.
 - b. In case the bidder is a newly formed and incorporated joint venture and which has not completed three financial years from the date of commencement of business, then either the said JV shall fulfill each eligibility criteria or any one constituent member/ promoter of such a JV shall fulfill each eligibility criteria. If the bid is received with the proposal that one constituent member/ promoter fulfils each eligibility criteria, then this member/promoter shall be clearly identified and he/it shall assume all obligations under the contract and provide such comfort letter/guarantees as may be required by Owner. The guarantees shall cover inter alia the commitment of the member/ promoter to complete the entire work in all respects and in a timely fashion, being bound by all the obligations under the contract, an undertaking to provide all necessary technical and financial support to the JV to ensure completion of the contract when awarded, an undertaking not to withdraw from the JV till completion of the work, etc.



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- c. In case the bidder(s) is/are a consortium (including an unincorporated JV), then the following conditions shall apply:
- I. Each member in a consortium may only be a legal entity and not an individual person;
 - II. The Bid shall specifically identify and describe each member of the consortium;
 - III. the consortium member descriptions shall indicate what type of legal entity the member is and its jurisdiction of incorporation (or of establishment as a legal entity other than as a corporation) and provide evidence by a copy of the articles of incorporation (or equivalent documents);
 - IV. One participant member of the consortium shall be identified as the "Prime member" and contracting entity for the consortium;
 - V. This prime member shall be solely responsible for all aspects of the Bid/ Proposal including the execution of all tasks and performance of all consortium obligations;
 - VI. The prime member shall fulfill each eligibility criteria;
 - VII. a commitment shall be given from each of the consortium members in the form of a letter signed by a duly authorized officer clearly identifying the role of the member in the Bid and the member's commitment to perform all relevant tasks and obligations in support of the
 - VIII. Prime/lead member of the Consortium and a commitment not to withdraw from the consortium;
 - IX. No change shall be permitted in the number, nature or share holding pattern of the Consortium members after pre-qualification, without the prior written permission of the Owner.
 - X. No change in project plans, timetables or pricing will be permitted as a consequence of any withdrawal or failure to perform by a consortium member;
 - XI. No consortium member shall hold less than 25% stake in a consortium;
 - XII. Entities which are affiliates of one another are allowed to bid either as a sole bidder or as a consortium only;
 - XIII. Any person or entity can bid either singly or as a member of only one consortium.
- d. In case the bidder is an Indian arm (subsidiary, authorized agent, branch office or affiliate) of a foreign bidder, then the foreign bidder shall have to full fill each eligibility criteria. If such foreign company desires that the contract be entered into with the Indian arm, then a proper back to back continuing (parent company) guarantee shall be provided by the foreign company clearly stating that in case of any failure of any supply or performance of the equipment, machinery, material or plant or completion



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of the work in all respects and as per the warranties/ guarantees that may have been given, then the foreign company shall assume all obligations under the contract. Towards this purpose, it shall provide such comfort letter/guarantees as may be required by Owner. The guarantees shall cover inter alia the commitment of the foreign company to complete the entire work in all respects and in a timely fashion, being bound by all the obligations under the contract, an undertaking to provide all necessary technical and financial support to the Indian arm or to render the same themselves so as to ensure completion of the contract when awarded, an undertaking not to withdraw from the contract till completion of the work, etc.



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CHAPTER 4: BQC DOCUMENTS BY VENDORS

| LIST OF DOCUMENTS FOR BID-QUALIFICATION OF VENDORS | | |
|--|--|--|
| 1 | Copy of approvals from any statutory body or equivalent, if applicable | |
| 2 | Details of the Manufacturing Facility | |
| 3 | Details of testing facilities available | |
| 4 | Certified list giving supply quantity details to meet minimum quantity supplied in the past criteria along with copies of Excise / VAT Invoices / Custom documents and the related purchase orders | |
| 5 | Audited Balance Sheets & Profit and Loss accounts for the previous 3 accounting years prior to the due date of bid submission | |
| 6 | Bank Guarantee in lieu of EMD / Demand Draft / Pay Order | |
| 7 | Declaration documents as per attached Annexure of the Tender | |
| 8 | Satisfactory Performance certificates from minimum 3 Installations / Terminals in India | |
| 9 | Relevant authorization from foreign Manufacturer for their Indian representative if applicable | |
| 10 | Details of the agency / company in India who will be providing maintenance & service support OR declaration to set up Service centre in India on being awarded the order, as applicable | |
| 11 | Other Supporting Documents, if any | |

Every page of attachments to be duly signed stamped before submitting the Tender.



CHAPTER 5: GENERAL TERMS & CONDITIONS OF PURCHASE:

1. General:

The materials and workmanship shall satisfy the relevant Indian Standards, the job specifications contained herein & codes referred to. Where the job specifications stipulate requirements in addition to those contained in the standard codes and specifications, these additional requirements shall also be satisfied.

In the absence of any standard / specification / codes of practice for detailed specifications covering any part of the work covered in this tender document, the instruction / direction of consultant engineer will be binding on the contractor.

Wherever it is stated in this tender document that a particular supply is to be effected or that a particular work is to be carried out, it shall be understood that the same shall be effected / carried out by the contractor at his cost, unless a different intention is specifically and expressly stated herein or otherwise explicit from the context.

2. Construction Program:

A detailed bar chart showing various activities shall be prepared by the tenderers. The work shall be executed strictly as per the agreed time schedule. The period of completion shall include, the time required for mobilization and testing as well as rectification, if any, testing & completion in all respects to the entire satisfaction of the consultant.

A joint programme of execution programme shall be prepared by the contractor.

Monthly / weekly construction programme shall be made by the contractor. The contractor shall scrupulously adhere to these targets / programme by deploying adequate personal and construction tools and tackles. He shall also supply all materials in his scope of supply in time to achieve the targets set out in the weekly and the monthly programme.

The contractor shall give every day, a report on labour and equipment deployed along with the progress of the work done on previous day, for each category of work.

3. Construction Water and Power:

Construction Water and Power will be arranged by the contractor. The rates quoted shall be inclusive of the same.

4. Safety Rules and Regulations:

All Safety rules and regulations of the terminal operator have to be followed by the contractor without fail. If any damage occurs due to negligence of safety, contractor



will be held for the same.

5. Tests and Inspection:

The contractor shall carry out the various tests as enumerated in the technical specifications of this tender document and the technical documents that will be furnished to him during the performance of the work. No separate payment shall be made.

The contractor shall carry out at his cost, all the tests either on the field or through external institutions / laboratories, concerning the execution of the work and supply of materials by the contractor.

Any work not conforming to the execution drawings, specifications or codes shall be rejected forthwith and the contractor shall carry out the rectification at this own cost. Results of all inspection & tests shall be recorded in the inspection reports, test reports, etc., which will be approved by the Engineer-in-charge. These reports shall form part of the completion documents.

Inspection & Acceptance of works shall not relieve the contractor from any of his responsibilities under this contract.

6. Site Cleaning:

The contractor shall take care to clean the working site from time to time for easy access to work site and for safety. Working site should be always kept cleared to the entire satisfaction of DAFFPL.

Before handing over any work to the owner, the contractor in addition to other formalities to be observed as detailed in the document shall clear the site to the entire satisfaction of DAFFPL.

7. Coordination with other Agencies:

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

8. DAFFPL reserves the right to accept any tender in whole and reject any or all tenders without assigning any reason. DAFFPL also reserves the right to allow public enterprises (Central/State) Price / purchase /contract / service preference as admissible under the Indian Government Policy.

9. BID PRICES:

- a) Prices shall be furnished strictly in the Price Bid format of the tender



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document.

- b) Bidder should quote their lowest and best offered price. Prices so quoted will remain firm till satisfactory completion of order. The price will not be subjected to escalation for any reason whatsoever.
- c) Bidders quoted prices shall be deemed to include entire Specification of item and all obligations and responsibilities to be carried out / executed by the Bidder as per terms of tender document. It is clearly understood by the Vendor that it is for the Vendor to ascertain and assess the applicable Acts/ Regulations/ Laws etc., entirely of their own. It is also for the Vendor to ascertain and assess the applicability of taxes, duties, levies etc. In case of any difference of opinion between Vendors proposal and interpretation by any tax/assessing (or similar) authorities, on the rate or terms and conditions related to taxes and duties etc., owners liability shall be strictly as per terms/provisions of the contract based on tender document and Vendors offer.
- d) No other charges accept those mentioned in the tender document will be payable to vendor.

10. The materials should be properly packed so as to withstand all transit hazards. Materials are required to be dispatched by the vendor to the locations, on freight paid DOOR- DELIVERY CONSIGNEE COPY ATTACHED basis along with copies of Inspection release note & internal test certificates & other documents as mentioned elsewhere in this tender document.

11. All shipment shall be under deck unless carriage on deck is unavoidable.

12. Bidder to note that Special Packaging Requirement as in technical specifications of this tender. The materials should be properly packed so as to withstand all transit hazards (both ocean & inland transit).

13. Indian agent Commission will not be paid by the owner.

14. TAXES & DUTIES:

- a) Bidder(s) quoted prices shall be inclusive of all taxes, duties, cess, levies etc.,
- b) The invoice should clearly mentioned that applicable Excise Duty, Education Cess or any other taxes charged and paid / payable on quoted item to enable the owner to claim MODVAT / Input credit.
- c) The statutory variation in Excise duty, Education Cess and Sales tax / VAT on finished goods and introduction of new tax, from bid due date till the contractual completion period shall be to owner account against submission of the documentary evidence. However, any increase in the rate of these taxes and duties beyond the contractual delivery period shall be to Seller account. Any decrease in the rate of these taxes and duties shall be passed on to the owner. Any additional excise duty due to increase in turn-over



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would be to seller account.

- d) It is for the Bidder to assess and ascertain the rate of excise duty, education Cess and sales tax/VAT applicable on quoted items. It is clearly understood that Owner will not have any additional liability towards payment of Excise Duty, Education Cess and Sales Tax/VAT which is based on Bidders wrong assessment / interpretation of applicability of such Excise Duty and/or education cess and / or Sales Tax/VAT.
- e) Successful bidder shall carry out its obligations towards services at site as mentioned in technical specifications without any extra charges.
- f) Octroi/Entry tax, if any, in the any state of India shall be directly paid by the vendor, if applicable.
- g) DAFFPL shall not be liable, in case the tax authorities assess the tax elements in a different way on account of any reason, whatsoever.
- h) Taxes and duties other than those specified in this document, if any, shall be included in the quoted prices and no separate reimbursement shall be made by DAFFPL.

15. Income Tax / Corporate Tax :

- a) As regards Income Tax, Surcharge on Income Tax or any other Corporate Tax payable by the Bidder for reason of the contract awarded, and / or on their expatriate personal, the Owner shall not bear any Tax liability whatsoever, irrespective of the mode of construction of contract / order. The Bidder shall be liable and responsible for payment of such tax, if attracted under the provision of Indian Income Tax Act.
- b) Bidder may note that if any tax is deductible at source as per Indian Income Tax Law, the same will be so deducted before releasing any payment to the Bidder and a TDS (Tax deducted at source) certificate will be furnished to the Bidder.
- c) Accordingly, Bidder shall have the responsibility to check and include such provision of taxes in the prices.
- d) In case of delay in delivery due to reasons attributable to Bidder, any new or additional taxes or duties levied by Statutory authorities during this period shall be borne by the Bidder.

16. DELIVERY PERIOD:

The items covered in this enquiry are required to be delivered as per Delivery Schedule stipulated below.

- a) **COMPLETION PERIOD**
04 months from date of notification of award.
- b) Delivery Period shall be counted from the date of notification of award (Letter/Fax/e-mail of Intent) up to the Date of receipt of goods at defined locations.



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17. EMD / BID SECURITY

- a) The bidder shall furnish, as part of his bid, a bid security in original for the amount specified in the tender document by way of pay order, bank guarantee on Rs.100/-value non-judicial stamp paper or demand draft.
- b) The bid security is required to protect the Owner against the risk of Bidders conduct, which would warrant the security forfeiture.
- c) If bid Security / EMD is in the form of bank guarantee, it shall be in the form of irrevocable bank guarantee (in the format attached) issued by any Indian Scheduled Bank (other than Co-operative Bank) will be accepted.
- d) Bid Security / EMD shall be issued in favour of M/s Delhi Aviation Fuel Facility (P) Limited, New Delhi. .
- e) Unsuccessful bidders bid security without any interest will be discharged/ returned as promptly as possible, but not later than 60 days after the expiry of the period of bid validity prescribed by the Owner.
- f) The successful bidder bid security without any interest will be discharged, upon the Bidder accepting the Contract/ Purchase Order and furnishing the Contract performance bank guarantee to DAFFPL.
- g) The bid security may be forfeited:
 - i. If a bidder withdraws his bid during the period of bid validity or
 - ii. In the case of a successful bidder, if the bidder fails or refuses to:
 - Accept the Purchase Order in accordance with agreed terms and conditions.
 - Furnish Contract performance bank guarantee as per bid document/ Purchase Order.
 - iii. Detection of submission of false / forged documents and fraud.
- h) Bid Security / EMD should be in favour of “Delhi Aviation Fuel Facility Private Limited”, payable at New Delhi and submitted to the relevant office of DAFFPL as mentioned in covering note of the tender document. Covering letter to bid Security / EMD must indicate the tender number. This is essential to have proper co-relation at a later date. The bid security / EMD shall be strictly in the form provided in the bid document before the due date & time of bid submission.
- i) Central Public Sector Undertaking of Govt. Of India are exempted from furnishing the bid security. Firms registered with NSIC/ MSME are also exempted from furnishing bid security, provided they are registered for the tendered items and up to the monetary limit they intend to quote. Provided further that they submit a copy of the current and valid registration certificate for the quoted item and monetary value along with their bid(s). Owner reserves right to verify the registration certificate provided, with relevant authorities.



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18. CONTRACT PERFORMANCE BANK GUARANTEE [CPBG]

- a) As a Performance security, the successful Bidder, to whom the work is awarded by, shall be required to furnish within 30 days of notification of award of contract (Letter/ Fax/e-mail of Intent) a Performance Bank Guarantee on RS.100/- VALUE non-judicial stamp paper in favour of the Owner (M/S DAFFPL).
- b) The Bank Guarantee amount shall be equal to TEN PERCENT (10%) of the Total Order Value and it shall guarantee the faithful performance of the Order in accordance with the Terms and conditions specified in the documents and specifications.
- c) CPBG shall be in the form of an irrevocable Bank Guarantee (in the format attached) issued by any Indian Scheduled Bank (other than Co-operative Bank).
- d) The Bank Guarantee shall be valid for the entire period of the Contract, namely, till the end of the guarantee / warranty period. The guarantee amount shall be payable on demand to the Owner.
- e) In case, the Contract Performance Bank Guarantee stated above gets reduced/ deducted for reasons of non-fulfillment of any Contractual obligations upto the completion of guarantee period, the bidder shall immediately take action to increase the value of Bank Guarantee to TEN PERCENT (10%) of the Contract price, to cover his guarantee/warranty obligations.
- f) The Performance Guarantee will be returned to the bidder without any interest at the end of the warranty / guarantee period subject to fulfillment of all contractual obligations by the Bidder. The bank guarantee shall have a claim period of 3 months beyond the contractual guarantee period.
- g) The proceeds of performance security shall be appropriated by the owner as compensation for any loss resulting from vendor's failure to complete his obligations under the contract to the prejudice to any of the rights or remedies the owner may be entitled to as per terms and conditions of contract. The proceeds of this performance security shall also govern the successful performance of goods and services and vendors all obligations during the entire period of contractual warrantee / guarantee.

19. PRICE REDUCTION FOR DELAY IN DELIVERY:

- a) The delivery period quoted must be realistic & specific. The inability of successful bidder to execute orders in accordance with the agreed delivery schedule will entitle DAFFPL, at its options, to:
- b) Accept delayed delivery at prices reduced by a sum equivalent to half percent (0.5%) of the value of any goods not delivered for every week of delay or part thereof, limited to a maximum of 10% of the total order value. Date of receipt of materials at owners premises shall be considered for calculation of price reduction
- c) The price reduction clause shall become applicable for deliveries made



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beyond the schedule delivery period of six months.

20. INSURANCE

Supplier shall carry and maintain any and all statutory insurance(s) required under Indian Laws and Regulations, including Workmen compensation Act/ESI/Third party liabilities etc. and insurances for their personnel engaged in performance of the work at their own cost.

21. INSPECTION:

- a) Material shall be inspected by owner or its representative before dispatch of material from bidder works. Charges other than third party inspection, however, arranging & providing inspection facilities is entirely vendor responsibility and in no way should affect the delivery schedule.
- b) OWNER may, at its own expense, witness any test or inspection. In order to enable OWNER to witness the tests/inspections OWNER will advise the bidder in advance whether it intends to be present at any of the inspections.
- c) Even if the inspection and tests are fully carried out, the Vendor shall not be absolved from its responsibilities to ensure that the Material(s), raw materials, components and other inputs are supplied strictly to conform and comply with all the requirements of the Contract at all stages, whether during manufacture and fabrication, or at the time of Delivery as on arrival at site and after its erection or start up or consumption, and during the defect liability period. The inspections and tests are merely intended to prima-facie satisfy OWNER that the Material(s) and the parts and components comply with the requirements of the Contract. The Vendor s responsibility shall also not be anyway reduced or discharged because OWNER or OWNER s representative(s) or Inspector(s) shall have examined, commented on the Vendor s drawings or specifications or shall have witnessed the tests or required any chemical or physical or other tests or shall have stamped or approved or certified any Material(s).
- d) Although material approved by the Inspector(s), if on testing and inspection after receipt of the Material(s) at the location, any Material(s) are found not to be in strict conformity with the contractual requirements or specifications, OWNER shall have the right to reject the same and hold the Vendor liable for non-performance of the Contract.

22. UNLOADING & STACKING

Unloading & stacking will be arranged by consignee. However, advance information regarding expected date of delivery to Site In-charge must be given well in time for making unloading arrangements under advice to originator of ORDER.

23. PAYMENT TERMS

- a) Bidders to note that Advance Payment is not permissible in the contract.
- b) The following payment terms shall be applicable :



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| S No | Activity | Percentage (%) |
|------|--|----------------|
| 1 | On Submission of Fabrication Drawings (after DAFFPL Approval) | 10 % |
| 2 | Supply of 45 KL MS Tank as per Specifications & Execution of civil Works | 40% |
| 3 | Supply and Erection of all Electrical and Mechanical accessories as per approved drawing | 25% |
| 4 | Testing & Commissioning | 15% |
| 5 | After submission of all necessary Approval Certificates & Test Reports | 10% |

Payment will be released within 30th day from the receipt of invoice and acceptance of materials at site adjusting deductible if any.

24. GUARANTEE/WARRANTY:

- a) Materials shall be guaranteed against manufacturing defects, materials, workmanship and design for a period of 12 months from the date of commissioning or 24 months from the date of dispatch whichever is later. Warranty for replacement of material / accessories should be provided free of charges at our premises. The above guarantee/warranty will be without prejudice to the certificate of inspection or material receipt note issued by us in respect of the materials.
- b) All the materials including components and sub contracted items should be guaranteed by the vendor within the warranty period mentioned above. In the event of any defect in the material, the vendor will replace / repair the material at DAFFPL concerned location at vendor risk and cost on due notice.
- c) Alternatively, DAFFPL reserves the right to have the material repaired / replaced at the locations concerned, at the vendors risk, cost and responsibility, in case, vendor does not replace / repair the material.
- d) The Vendor shall provide similar warrantee on the parts, components, fittings, accessories etc. so repaired and / or replaced.
- e) Vendor shall guarantee that the performance of the EQUIPMENT supplied under the CONTRACT shall be strictly in conformity with the specifications and shall perform the duties specified under the CONTRACT.
- f) RISK PURCHASE CLAUSE: We reserve the right to curtail or cancel the order either in full or part thereof if bidder fails to comply with delivery schedule and other terms & conditions of the order. DAFFPL also reserves the right to procure same or similar materials/equipment through other sources at vendor's entire risk, cost and consequences.

25. TEST & PERFORMANCE CERTIFICATES: Bidder shall furnish Material test and Performance Certificates for the materials along with the challans and invoice.



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26. Only in the event of causes of Force Majeure occurring within the contractual delivery period and if they impede the performance of contract, the delivery dates shall be extended on receipt of application from the bidder / Owner without imposition of penalty. Only those causes which depend on natural calamities, civil wars, fire and national strikes which have duration of more than seven consecutive calendar days are considered the causes of force Majeure. The decision of Owner shall be final and binding on vendor.
27. The Vendor must advise the Owner by a registered letter duly certified by Local Chamber of Commerce or statutory authorities and Owner must advise the Vendor by a letter, the beginning and the end of the delay immediately, but in no case later than within 10 days of the beginning and end of such causes of Force Majeure condition as defined above. Provided further that if the performance in whole or part of any obligation under this contract is prevented or delayed by reason of any such event for period exceeding 60 days either party may at its option terminate the contract.
28. Repeat Order: DAFFPL reserves the right to place repeat order up to the order quantity within SIX MONTHS from the date of original order on mutual agreement basis.
29. Any reference to the Govt. Acts /Regulations etc. in the Bid Document is only indicative, and it is entirely for the bidder to ascertain the applicable Acts/Regulations.
30. Rejected material lying in Owner premises must be replaced within 60 days from date of final report on rejection of material.
31. RECOVERY OF SUMS DUE: Whenever, any claim against bidder for payment of a sum of money arises out of or under the contract or in any other form, the owner shall be entitled to recover such sums from any sum then due or when at any time thereafter may become due from the vendor under this or any other form and should this sum be not sufficient to cover the recoverable amount of claim(s), the vendor shall pay to DAFFPL on demand the balance remaining due.
32. PATENTS & ROYALTIES: The vendor shall fully indemnify owner and users of materials specified herein/supplied at all times, against any action, claim or demand, costs and expenses, arising from or incurred by reasons of any infringement or alleged infringement of any patent, registered design, trademark or name, copy right or any other protected rights in respect of any materials supplied or any arrangement, system or method of using, fixing or working used by the vendor. In the event of any claim or demand being made or action sought against Owner in respect of any of the aforesaid matter, the vendor shall be notified thereof



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immediately and the vendor shall at his/its own expense with (if necessary) the assistance of Owner (whose all expense shall be reimbursed by the vendor) conduct all negotiations for the settlement of the same and/or litigation which may arise thereof.

33. **LIABILITY CLAUSE:** In case where it is necessary for employees or representatives of the Vendor to go upon the premises of owner, vendor agrees to assume the responsibility for the proper conduct of such employees/representatives while on said premises and to comply with all applicable Workmen s Compensation Law and other applicable Government Regulations and Ordinances and all plant rules and regulations particularly in regard to safety precautions and fire hazards. If this order requires vendor to furnish labour at site, such vendors workmen or employees shall under NO circumstances be deemed to be in owner s employment and vendor shall hold himself responsible for any claim or claims which they or their heirs, dependent or personal representatives, may have or make, for damages or compensation for anything done or committed to be done, in the course of carrying out the work covered by the purchase order, whether arising at owner s premises or elsewhere and agrees to indemnify the owner against any such claims, if made against the owner and all costs of proceedings, suit or actions which owner may incur or sustain in respect of the same.
34. **COMPLIANCE OF REGULATIONS:** Vendor warrants that all goods/Materials covered by this order have been produced, sold, dispatched, delivered and furnished in strict compliance with all applicable laws, regulations, labour agreement, working condition and technical codes and statutory requirements as applicable from time to time. The vendor shall ensure compliance with the above and shall indemnify owner against any actions, damages, costs and expenses of any failure to comply as aforesaid.
35. **REJECTION, REMOVAL OF REJECTED GOODS AND REPLACEMENT:** In case the testing and inspection at any stage by inspectors reveal that the equipment, materials and workmanship do not comply with specification and requirements, the same shall be removed by the vendor at his/its own expense and risk, within the time allowed by the owner. The owner shall be at liberty to dispose off such rejected goods in such manner as he may think appropriate. In the event the vendor fails to remove the rejected goods within the period as aforesaid, all expenses incurred by the owner for such disposal shall be to the account of the vendor. The freight paid by the owner, if any, on the inward journey of the rejected materials shall be reimbursed by the vendor to the owner before the rejected materials are removed by the vendor. The vendor will have to proceed with the replacement of the equipment or part of equipment without claiming any extra payment if so required by the owner. The time taken for replacement in such event will not be added to the contractual delivery period.



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36. **NON-WAIVER** : Failure of the Owner to insist upon any of the terms or conditions incorporated in the Purchase Order or failure or delay to exercise any rights or remedies herein, or by law or failure to properly notify Vendor in the event of breach, or the acceptance of or payment of any goods hereunder or approval of design shall not release the Vendor and shall not be deemed a waiver of any right of the Owner to insist upon the strict performance thereof or of any of its or their rights or remedies as to any such goods regardless of when such goods are shipped, received or accepted nor shall any purported oral modification or revision of the order by DAFFPL act as waiver of the terms hereof. Any waiver to be effective must be in writing. Any lone incident of waiver of the any condition of this agreement by DAFFPL shall not be considered as a continuous waiver or waiver for other condition by DAFFPL.
37. **NEW & UNUSED MATERIAL**: All the material supplied by the vendor shall be branded new, unused and of recent manufacture.
38. **CANCELLATION**:
- a) DAFFPL reserves the right to cancel the contract/purchase order or any part thereof through a written notice to the vendor if –
 - i. The vendor fails to comply with the terms of this purchase order/contract.
 - ii. The vendor becomes bankrupt or goes into liquidation.
 - iii. The vendor fails to deliver the goods on time and/or replace the rejected goods promptly.
 - iv. The vendor makes a general assignment for the benefit of creditors.
 - v. A receiver is appointed for any of the property owned by the vendor.
 - vi. Any other conditions where owners commercial interest get affected.
 - b) Upon receipt of the said cancellation notice, the vendor shall discontinue all work on the purchase order matters connected with it. DAFFPL in that event will be entitled to procure the requirement in the open market and recover excess payment over the vendor s agreed price if any, from the vendor and also reserving to itself the right to forfeit the security deposit if any, made by the vendor against the contract. The vendor is aware that the said goods are required by DAFFPL for the ultimate purpose of materials production and that non-delivery may cause loss of production and consequently loss of profit to the DAFFPL. In this-event of DAFFPL exercising the option to claim damages for non delivery other than by way of difference between the market price and the contract price, the vendor shall pay to DAFFPL, fair compensation to be agreed upon between DAFFPL and the vendor. The provision of this clause shall not prejudice the right of DAFFPL from invoking the provisions of price reduction clause mentioned aforesaid.
39. **ANTI –COMPETITIVE AGREEMENTS/ABUSE OF DOMINANT POSITION** : The Competition Act, 2002 as amended by the Competition (Amendment) Act, 2007 (the Act), prohibits anti- competitive laws and aims at fostering competition and at



DELHI AVIATION FUEL FACILITY PRIVATE LIMITED

protecting Indian markets against anti- competitive practices by enterprises. The Act prohibits anti- competitive agreements, abuse of dominant position by enterprises, and regulates combinations (consisting of acquisition, acquiring of control and M&A) wherever such agreements, abuse or combination causes, or is likely to cause, appreciable adverse effect on competition in markets in India. DAFFPL reserves the right to approach the Competition Commission established under the Act of Parliament and file information relating to anti-competitive agreements and abuse of dominant position. If such a situation arises, then Vendors are bound by the decision of the Competitive Commission and also subject to penalty and other provisions of the Competition Act.

40. **ASSIGNMENT:** The Vendor can / does not have any right to assign his rights and obligations under these general purchase conditions without the prior written approval of DAFFPL.
41. **GOVERNING LAW:** These General Purchase Conditions shall be governed by the Laws of India.
42. **AMENDMENT:** Any amendment to these General Purchase Conditions can be made only in writing and with the mutual consent of the parties to these conditions.
43. The following expressions used in these terms and conditions and in the purchase order shall have the meaning indicated against each of these:
 - a) **OWNER,** Client, Purchaser, buyer : means DAFFPL
 - b) **VENDOR,** tenderer, Bidder, Contractor, Seller, Supplier, manufacturer stated anywhere in the tender document carry the same meaning: It means the person, firm or the Company / Corporation to bidding and shall include its successors and assigns.
 - c) **INSPECTOR/ TPIA:** Person/agency deputed by Owner for carrying out inspection, checking/testing of items ordered and for certifying the items conforming to the purchase order specifications..
 - d) **GOODS / MATERIALS:** means any of the articles, materials, machinery, equipments, supplies, drawing, data and other property and all services including but not limited to design, delivery, installation, inspection, testing and commissioning specified or required to complete the order.
 - e) **SITE / LOCATION:** means any Site where DAFFPL desires to receive materials anywhere in India as mentioned in tender
 - f) **CONTRACT,** Order or Purchase Order/CALL-OFF means the agreement for supply of goods/ materials for required quantity between Owner and Vendor, for a fixed period of time on mutually agreed terms and conditions.
 - g) The term MR means Material Requisition containing technical requirements and scope of work (technical), GPC means General Purchase Conditions containing commercial terms & conditions, PO means Purchase order issued after award of contract incorporating agreed deviations in MR, ATC means Agreed Terms &



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Conditions , RFQ means Request For Quotation.

- h) For the purpose of contract, the trade terms FOB, CFR and CIF, DAP shall have the meanings as assigned to them by INCOTERMS 2010 published by ICC, Paris.

44. REFERENCE FOR DOCUMENTATION :

The number and date of Collective Request for Quotation (CRFQ) must appear on all correspondence before finalization of Contract / Purchase Order.

After finalization of Contract / Purchase Order: The number and date of Contract /Purchase Order must appear on all correspondence, drawings, invoices, dispatch advices, (including shipping documents if applicable) packing list and on any documents or papers connected with this order.

45. ARBITRATION

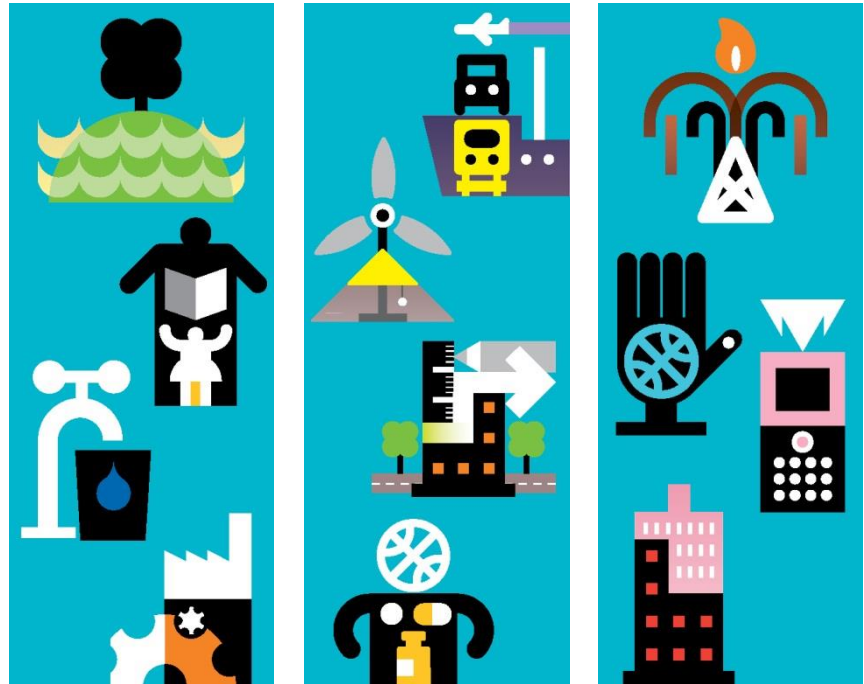
- a) Any 'dispute or difference of any nature whatsoever, any claim, cross-claim, counterclaim or set off of the Owner against the Consultant or regarding any right, liability, act, omission or account of any of the parties hereto arising out of or in relation to this agreement shall be referred to the Sole Arbitration of the nominated Director of the Owner or of some Officer of the Owner who may be nominated by the nominated Director. The consultant will not be entitled to raise any objection to any such arbitrator on the ground that the arbitrator is an officer of the Owner or that he has dealt with the matters to which the contract relates or that in the course of his duties as an Officer of the Owner, he had expressed view on all or any other matters in dispute or difference. In the event of the arbitrator to whom the matter is originally referred being transferred or vacating his office or being unable to act for any reason, the nominated Director as aforesaid at the time of such transfer, vacation of office or inability to act may in the discretion of the nominated Director designate another person to act as arbitrator in accordance with the terms of the agreement to the end and intent that the original Arbitrator shall be entitled to continue the arbitration proceedings notwithstanding his transfer or vacation of office as an officer of the Owner if the nominated Director does not designate another person to act as arbitrator on such transfer, vacation of office or inability of original arbitrator. Such person shall be entitled to proceed with the reference from the point at which it was left by his predecessor. It is also a term of this contract that no person other than the nominated Director of the Owner or a person nominated by such nominated Director as aforesaid shall act as arbitrator hereunder. The award of the arbitrator so appointed shall be final, conclusive and binding on all parties to the agreement subject to the provisions of the Arbitration & Conciliation Act,1996 or any statutory modification or reenactment thereof



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and the rules made there under for the time being in force shall apply to the arbitration proceedings under this clause.

- b) The arbitrator shall have power to order and direct either of the parties to abide by, observe and perform all such directions as the arbitrator may think fit having regard to the matters in difference i.e. dispute, before him. The arbitrator shall have all summary powers and may take such evidence oral and/or documentary, as the arbitrator in his absolute discretion thinks fit and shall be entitled to exercise all powers under the Indian Arbitration & Conciliation Act 1996 including admission of any affidavit as evidence concerning the matter in difference i.e. dispute before him.
- c) The parties against whom the arbitration proceedings have been initiated, that is to say, the Respondents in the proceeding, shall be entitled to prefer a cross claim, counter claim or set off before the Arbitrator in respect of any matter in issue arising out of or in relation to the Agreement without seeking a formal reference of arbitration to the nominated Director/officer for such counter-claim, or set off and the Arbitrator shall be entitled to consider and deal with the same as if the matters arising therefore has been referred to him originally and deemed to form part of the reference made by the nominated Director/officer.
- d) The arbitrator shall be at liberty to appoint, if necessary any accountant or engineering or other technical person to assist him, and to act by the opinion so taken.
- e) The arbitrator shall have power to make one or more awards whether interim or otherwise in respect of the dispute and difference and in particular will be entitled to make separate awards in respect of claims of cross claims of the parties.
- f) The arbitrator shall be entitled to direct any one of parties to pay the costs to the other party in such manner and to such extent as the arbitrator may in his discretion determine and shall also be entitled to require one or both the parties to deposit funds in such proportion to meet the arbitrators expenses whenever called upon to do so.
- g) The parties hereby agree that the courts in the city of Delhi alone shall have jurisdiction to entertain any application or other proceedings in respect of anything arising under this agreement and any award or awards made by the Sole Arbitration hereunder shall be filed (if so required) in the concerned courts in the city of Delhi only.



EPC Tender for 45 M³ MS horizontal cylindrical underground oil tank

Modernization of existing Fuel farm facility

June 2015

Delhi Aviation Fuel Facility Pvt. Ltd.



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Modernization of existing Fuel farm facility

June 2015

Delhi Aviation Fuel Facility Pvt. Ltd.

Aviation Fuelling Station, Shabad, Muhammad Pur, IGI-Airport, New Delhi-110061

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1 General

1.1 Introduction

Modernization of facilities in Fuel Farm of Delhi Aviation Fuel Facility Pvt. Ltd. (DAFFPL), IGI Airport, New Delhi is envisaged and upgrade the same conforming to International Standards for Aviation Fuel Systems.

Jet A1 fuel shall be pumped in to the vertical cone roof tanks through underground pipe lines from IOCL and BPCL Oil Terminals at Bijwasan, New Delhi.

This document specifies the minimum acceptable parameters & requirements set by the Owner for the design, engineering, procurement, fabrication, assembly, inspection, testing and delivery to site of 45 M³ capacity, MS horizontal cylindrical oil storage tank for its underground installation in Fuel Farm of Delhi Aviation Fuel Facility Pvt. Ltd. (DAFFPL)

- For this proposed Fuel facility, complete EPC work are to be carried out as per described but not limited to the Scope of work, detailed specifications & in accordance to necessary Codes & standards at DAFFPL - New site.
- For this purpose the Technical bid and price bid should be submitted by contractor along with this entire tender document duly signed on every page confirming acceptance of Terms & Condition mentioned herein by due date.
- .Site Particulars

Table 1.1: Site Particulars

| Description | : | Data | Description | : | Data |
|------------------------|---|--|-------------------------|---|---------------------------|
| Nearest Airport | : | Indira Gandhi International Airport, New Delhi | Nearest Railway Station | : | New Delhi Railway Station |
| Avg. Max. and Min Temp | : | 48.4° C & -2.2° C | Design Temp | : | 50° C |
| Humidity Max. and Min | : | 100% & 25% | Rain fall: mm/hr. | : | 20-30 |
| Designed Wind Velocity | : | 47 m/s | Seismic Zone | : | Zone IV as per IS:1893 |
| Altitude | : | 237 m | Barometric Pressure | : | 0.98 bar |

2 Scope of Work

2.1 General

The bidder/ contractor shall refer to various sections of this tender document for detailed scope of work. It is contractor's responsibility to execute the job in all respects as per detailed drawings, documents / specification furnished by consultant / owner and as per applicable codes, standards & in line of statutory requirements.

The field circumstances shall also be taken into consideration and methods suitable to the site conditions shall be adopted with concurrence of the Engineer-in-charge and in line with manuals, instructions of respective equipment and specified codes and standards. The successful accomplishment of the project is greatly influenced by the team work, workmanship of the workers and supervisors.

The Contractor shall employ only such workers and supervisors who have considerable experience of similar work and who can work, temperamentally in good harmony and co-operation.

The scope of Contractor includes the following categories but not limited to them,

2.2 Civil

Delhi Airport Fuel Farm Private Limited (DAFFPL) is modernisation of existing tank farm of his fuelling set up. Scope of general civil work for 45 KL ATF tanks, including removing existing floor, excavation, Base foundation of Ms tank, concrete floor, buried the MS tank by sand filling and top of ground covered same as existing, as per detailed drawing and specifications.

2.3 Mechanical (Storage Tanks)

1. The scope of work of the bidder cover adequacy check of Owner supplied details, drawings (if any), any residual detailing, supply of materials, obtaining approvals of Engineer Quality in charge/owner, transportation, storage , fabrication, installation, erection, inspection, painting, coating, testing,, calibration, handling, commissioning and establishing the required parameters to the satisfaction of Consultant/Owner, of cylindrical horizontal storage tank as listed below inclusive of fabrication all Piping & fittings and other attachments there to and sub-assemblies wherever required as per data sheet/ specification, Client approved quality manual and instructions as per site circumstances for the project. The complete work shall be done in strict compliance with engineering drawings/datasheets, specifications and the cited standards and codes and approved quality assurance procedures / method statements. Stringent ref. and acceptance codes / standards shall be followed to achieve the best quality.

Table 2.1: Scope of Supply

| Tank farm | Tag No | Capacity in KL | MOC | Type | Tank size (IDxHT), m | Hot & Cold Insulation | Qty |
|-----------|--------|----------------|--------------|------------------------------------|----------------------|-----------------------|-----|
| ATF | UG-214 | 45 | IS 2062 Gr.B | Cylindrical Horizontal Underground | 3.00/ IDx 6.4 | NIL | 1 |

- a. All other materials, inclusive of but not limited to consumable like welding Rods/wire, flux, gases, D.M and potable water, gaskets, hardware, material handling equipment, pipe, flanges,

structural material, venting devices, paints, erection materials, scaffolding, bending and cutting machine, girth welding machines, oxygen, acetylene, grease, oils, tools, tackles, hoist/crane, jacks, instruments, etc.. required for satisfactory completion of the job, shall be supplied by the Contractor

- b. The intent of this specification is to establish Owner's minimum requirements only and not to deviate from the stipulations in relevant codes, but rather to supplement the minimum requirements of the applicable codes, Standards and specifications, manufacturer Recommendations etc. The equipment constructed shall conform to the highest standard of engineering, design and workmanship and shall be done in strict compliance with engineering drawings/ data sheets and specifications and quality assurance.
2. The scope of work of the bidder defined below, is in general and shall include the following but be not limited to the same. The bidder shall also carry out the jobs that are not listed here but required for completion of the job in all respects as per the specifications, standards, drawings, As built drgs, O&M manuals, erection, commissioning and testing methodology encodes ,quality assurance plan and instructions of Engineer and Quality in charge whether specifically mentioned in the drawing or not. The Contractor shall visit the site before quoting to get himself acquainted with site conditions, logistics, approach etc. No delay whatsoever shall be entertained on this account. Any approval by the Consultant/Owner shall not relieve the Contractor of his responsibilities to meet the requirements of the tender.
- a. Loading, handling and transportation of all materials from supply point / store of work site / Contractor's store. Stripping/Removal of vegetation for fabrication yard at Site shall also be in Contractor's scope. Reasonable levelling and ground preparation, if required for carrying out fabrication work, shall be under Contractor's scope. Proper shed for welding, surface preparation and painting shall be in EPC contractor scope.
 - b. Preparation of any residual engineering (if any) working drawings of the storage tank for approval by Consultant /Owner. Project drawings and documentation shall be in the English language and SI/MKS units.
 - c. Procurement and supply of materials and consumables as indicated in contractor's scope of supply. Appropriate storage facility shall be in EPC Contractor scope.
 - d. Any package or bought outs should be procured from client approved suppliers only.
 - e. EPC Contractor will submit detail categorisation quality plan for client approval including all items with inspection category.
 - f. Supply and fixing of all nozzles, manholes, gauge hatches with covers, inspection hatches, flanges, elbow, bends, dip pipes, goosenecks, Pipes and Pipe Fittings etc. as per Client approved specification drawings and data sheets. Only standard forged pipe fittings shall be used. However, wherever size does not permit fabricated nozzles butt-welded joints shall be subject to 100% RT After written approval from client engineering and Quality. Scope includes fabrication and erection of supports for pipes, instruments etc. on tank.
 - g. Fabrication and erection of anchor chairs with foundation bolts (washer & 2 nuts to be provided). Supply, fabrication & erection of handrails, platforms (if required), and instrumentation for temperature measurement are envisaged for all the storage tanks. Suitable installation provision and mounting arrangements shall be provided for the same as required by the instrument supplier.
 - h. Radiography, DP test, MP test and all other tests on tanks as per code and client approved QAP, drawings and testing procedures approved by DAFFPL apart from routine, visual and dimensional check. The Contractor shall arrange necessary tools and tackles for carrying out the tests. If Gamma ray source is required to be kept inside the location on a continuous basis, all safety and operational precautions as stipulated by BARC shall be strictly adhered to.

- i. Carrying out stage wise inspections as per approved Quality Assurance Plan as well as NDT procedures, hydrostatic, pneumatic, vacuum, and other test as specified in codes/standards using bidder's own equipment.
- j. Clearing job sites of all surplus material, debris, scrap, construction equipment etc. as per directions of Engineer-in-charge.
- k. Accomplishment of any other item of work required for making the storage tank ready for commissioning.
- l. Quantity of steel given is approximate. Payment shall be made for quantities of plates laid / erected duly certified by the Engineer at site, calculated on theoretical basis of 7850Kg/m³ for MS. Structural's shall be quantified as per standard tables.
- m. Supply of consumables for two year trouble free operation. Where various sizes are involved such as in gaskets, bolts, nuts, studs etc., quantity of spares shall be 10% but not less than 2 numbers for each size. Spares should be supplied in relevant unit and item wise.
- n. The fabrication and installation shall be in conformity with regulations of CCOE, OISD and other statutory bodies, if applicable.
- o. Work plan to be submitted by contractor and to getting the same to be approved by Engineer in Charge.
- p. Submission of all documentation as per the tender. CVs of the Personnel to be submitted.
- q. Calibration of tanks and getting approval from statutory authorities as per IS 2007 - 1974 and IS 2008 - 1961. Calculations and preparation of calibration charts and submitting to Consultant/Owner. All liaison work including arranging the visit and witnessing the strapping of work etc., with CPWD, Weights and Measure Department or other competent authorities. Preparation and getting the approval of the calibration charts shall be the responsibility of the Contractor. All applicable fees and other charges for getting the tanks calibrated and approved will be borne by the Contractor. However, PCDS shall be submitted by Bidder along with Offer.
- r. Painting as per client. Paint manufacturer technical specification shall be deploy full time at site for procedure establishment and inspection on day to day basis. Painting shall be procured from client approved Contractors only.
- s. Supply of necessary and required labour and supervision of all works at site.
- t. Rates quoted by bidder are deemed to include deployment of competent Quality control engineer's from start to completion for upkeep and maintenance of all QA/QC records in accordance with ITP/QAP as well as Consultant/Owner Quality System and requirement.
- u. Observance of all safety norms, rules, regulations, statutory requirement etc. Provide site safety Engineer on day to day basis for the safety of personnel and site.
- v. Assistance to Owner for commissioning of the tanks including supply of manpower, supervision, labour with all required tools and spares. This commissioning assistance shall extend upto 24 hrs. Beyond completion of first Pump-in of product into the tanks.

2.4 Scope of Work (Centrifugal Pump)

- This specification covers the minimum requirements for the design, selection, engineering, Obtaining approval from client/consultant, manufacturing, supply, guarantee, inspection, testing as per the approved Quality Assurance Plan at work, coating as applicable, packing, Transportation and delivery of pump sets to site in compliance with the mechanical data sheet, pacification and standards attached to these specifications along with all other associated Auxiliaries like motor, bearing base plate, coupling, foundation bolts, etc. and mountings. The scope also includes supervision during erection, testing and commissioning and providing performance guarantee.
- The Contractor shall provide electrically driven Centrifugal Pump set in accordance with this specification, the duties and conditions listed in the relevant data sheet, and the documents included in the bid documents.

- The Contractor should ensure technical feasibility of their tender offer, after inspecting the site. It must be understood that the Contractor shall be required to Supply & execute/s every such items of work which is considered necessary for satisfactory performance of the pump sets, though such items is required are not specified in the tender documents.

2.5 Piping

2.5.1 Category-I (Process & utility Equipment Erection)

It includes Design, Engineering, Procurement/Supply, Construction/ installation / erection & Commissioning of equipment on foundation, assembly of sub-assemblies &/or parts, positioning, levelling, and aligning the equipment &/or sub-assemblies &/or parts as per required specifications.

This category would include all the equipment static or rotary such as tanks / vessels, pump / blowers, compressor including Contractor package supply items as applicable. It shall be contractor's responsibility of dynamic balancing (alignment) of rotating Equipment.

It also comprises Testing, inspection, commissioning and handing over of complete work as per Drawings & Documents such as Equipment Layout, Piping drawings, P & I Diagrams, Specifications, As built drgs. etc.

All the equipment under this category shall be supplied by the Contractor unless specified. EPC Contractor will submit detail categorization quality plan for client approval including all items with inspection category.

2.5.2 Category-II (Process & utility Piping)

It includes Design, Engineering, Procurement/Supply, Construction/ installation / erection / Fabrication, Flushing, Blowing, carbon blasting Inspection & Testing, Painting, Coating, Wrapping, insulation (if required) and commissioning, N₂ Purging etc. of all CS piping work & Installation of valves including MOV's and all field instruments, special items like installation of strainers, special Tee's for pig removal, Pig launcher / receivers, loading Arm at TLF area, spectacle blinds etc. as per drawings, Documents & specifications furnished by owner / consultant or as required at site.

Fabrication & erection of Process, Cooling water, chilled water, Hot water, raw water, treated / soft water, Compressed Air, Gaseous Nitrogen, etc. piping work as necessary & as applicable.

The piping work also includes supply of materials apart from FIM (Free Issue Material) and any other components to complete the work in all respects.

The work also comprised of Installation of structural Pipe Rack, Structural frame for EOT at all manifolds, pipe support fabrication and erection including fixing of supports to concrete surfaces by anchor fasteners etc. as per piping drawings, support details and civil / structural details furnished by consultant / owner. In case of unavailability of any details or site construction, the contractor shall furnish the drawings / documents for approval before erection.

Painting as per specification provided in later chapters.

In addition to above mentioned but not limited to the scope of work also includes

- Supply and Transportation of all material from owners / contractor's storage to site, unloading at site, storage /safe custody at site.
- Flushing, Blowing, Drying and Testing of all Equipment & Piping Systems.
- Hydro test with potable water chloride content less than 100 ppm shall be used. DP test, Radiography etc., as per specifications.
- Fabrication, testing and erection of any special from pipe required at site including mitre bends, reducers & branch connections from plates / pipes & pipe supports as per drawings and specifications.
- The contractor shall carry out all modifications and provide additional cleats, if required.
- Any additional test like radiography, DP test etc. shall also be carried out, if required by Engineer in charge / tender specifications.
- The contractor shall make provision of labour, tools and tackles for preparation of equipment for trial runs and to assist during commissioning.
- The contractor shall bear the cost of repair, changes, replacement etc. caused due to noncompliance with the standards codes or due to disregard of instructions given by Engineer in charge / tender specifications.
- The contractor shall make provision of lying, coating and wrapping for underground piping work (if required).

2.6 Electrical

The scope of work under this scheme includes supply, transportation, unloading, erection and commissioning of the following items. It is contractor's responsibility to execute the job in all respect as per the detailed drawings / specifications supplied by the consultant / owner.

Any other equipment/services which are not explicitly mentioned above or in the price bid but deemed necessary for the successful operation of the system complete in all respects shall be in contractor's scope.

It is assumed that, as required in the Tender Documents, before tendering, the Contractor visited and examined the Site and satisfied himself as to the nature of the existing roads or other means of communication and the character of the soil and of the excavations, the correct dimensions of the work and the facilities for obtaining any special articles called for in the Contract Documents and shall have obtained generally his own information on all matters affecting the Site and local conditions. Installation and commissioning in Contractor's scope for the followings items

2.6.1 Detail Scope of work

DAFFPL will provide single point supply from Nearest Bore well area and Bidder to provide single starter control panel with adequate rating of MPCB, Contractor and motor protection relay with required auxiliary contacts and terminal block. From Starter Panel to pump motor proper cable rating to be selected suitable for motor rating and control cable for local control station.

Supply and installation part of Starter panel, Local Control panel, power and control cable are in the scope of bidder. Adequate rating of earthing strip and its connection for tank and motor to be executed by bidder with all respect as per standard and standard engineering practices.

2.6.1.1 Category – I (Work excluding supply)

- a) Single point supply shall be provided by Customer.

2.6.1.2 Category – II (Work including supply)

- a) Flameproof motor as per specification and Datasheet.
- b) Local push button station with start-stop pushbutton and on-trip indication lamp.
- c) Power cable for pump motor and control cable for LCS.
- d) Earthing Work.
- e) Modification in the existing panel. (If Required)
- f) Single starter control panel with motor protection.
- g) Cable tray (as per requirement)

2.6.1.3 Category – II (General)

- a) Statutory approval including submission of electrical drawings from Electrical Inspector for the scope of work.
- b) Statutory approval from Fire Inspector for the scope of supply
- c) Making of earth pits required as per relevant IS/ international standard for entire scope of work as per enclosed layout. Necessary soil work shall be included.
- d) Cable identification tags for all cables at either ends and on ground for all underground cables.
Others.

2.7 Instrumentation

This specification together with the data & follow sheets attached herewith form the minimum requirement for design, materials, packing, supply, inspection, installation, testing, commissioning, guarantee of Pressure Gauges and thermal safety relief valve including accessories for the Modernization of Fuel Farm of DAFFPL, IGI Airport, New Delhi.

2.7.1 Contractor Quality Control

- Unless accepted otherwise by the “Owner / Owner Representative”, “Contractor” shall employ a Quality Management System complying with the program described in ISO 9001-2008.
- Work which, in the opinion of the “Owner / Owner Representative” is not in accordance with the Specifications shall be rejected. Any delay caused by such rejection shall not in any way relieve the “Contractor” of his obligations under the Contract

2.7.2 Guarantee

“Contractor” shall guarantee the Performance of all equipment and system supplied under his scope in accordance with the approved design and specification and shall also guarantee the equipment and system against any manufacturing, material or design defects for the period of 12 months from the date of commissioning of the project or 18 months from the date of despatch of the entire system, whichever is earlier.

2.8 Deviation

All deviation in the specification shall be categorically stated and the same shall be taken to be a complying case and no deviation whatsoever shall be accepted at a later date. Hence it is in the interest of the "Contractor's" that they highlight the deviations in a separate document titled "Deviations to Specifications".

Any offer which does not highlight deviations and if deviations are detected during the course of evaluation is liable to be summarily rejected.

2.9 Changes in Scope of Work

Owner shall be free to alter, add to or delete any part of the job without any compensation to the Contractor, in case the Contractor fails to provide sufficient labour / materials under his scope for the execution and completion of the work on schedule as per Owner's assessment.

3 Scope of Supply

3.1 Civil

All materials required for above scope of work, like cement, sand, aggregates, filling materials, portable water required for construction, in scope of EPC Contractor.

3.2 Mechanical (Storage Tank)

Steel plates IS 2062 GRADE B WITH FULLY KILLED AND FREE FROM ANY INTERNAL DEFECTS of all thickness for, shell, & End Plates, and steel plates for fabrication of wind girders, reinforcement pad plates for shell manholes, RF Pad for all nozzles shall be supplied by contractor at appropriate place at site. Segregation, stacking, handling and bringing the plates to site of work shall be contractor's responsibility.

While every effort has been made to list all the supply items, it shall be the sole responsibility of the Contractor to review the list and seek clarifications, if any at the time of Unpriced Bid itself. Steel plates for Fabrication and all the other items shall be supplied by the Contractor only. No claims/ disputes by the Bidder/ Contractor shall be entertained by Owner at a later date.

Contractor shall independently verify the above design and confirm his verification of adequacy of the steel plates.

3.3 Centrifugal Pump

- The scope of supply includes for **20 M³/Hr Pump refer attached data sheet:**
 - i. Electric Motor Driven Pumps with effective sealing system.
 - ii. Flameproof Electric Motors as the prime mover having class F insulation.
 - iii. Flexible Coupling System between prime movers (electric motors) and driven (centrifugal Pumps).

3.4 Piping

3.4.1 List of materials to be supplied by contractor

Unless otherwise specified in above categories the scope of work includes following items but not limited to them. It is contractor's responsibility to execute the job in all respect as per the detailed piping drawings supplied progressively and to the satisfaction of engineer-in-charge and prices thereof shall be deemed to have included in above categories only.

- Electric Power & water for construction and other activities shall be arranged by contractor.
- Supply of all equipments, tools & tackles, various types of Welding electrodes, filler wires, flux, etc., consumables, all types of industrial gases such as Oxygen, Acetylene, inert gases with purity 99.999 PPM and Potable water less than 100 ppm for CS piping testing.
- All type of fittings like flanges, tee, reducer, elbow, stub end, nipple, half coupling, weldolet, nipple, reducing coupling, any special fittings etc. as per Piping specification and MTO (Material take off) List.
- All types of Gaskets for the flange joints.

- Supply and Fixing of Pipe Supports, Bolts, U-Bolts, studs, nuts, washers, Clips, clamps, foundation bolts, shoes, guides, stops / anchors, cradle, hangers, supporting fixture, brackets, cantilever, structural tee post, fixing, load setting of spring supports etc. and any other components to complete the piping and supporting work in all respects
- Supply and fitting of Shims, wedges and packing plates (wherever required)
- Supply of all materials such as metallic blinds, temporary gaskets etc. and arrangements required for the pressure testing and flushing and pipelines. No blinds shall have thickness less than 10 mm.
- Supply of all materials and arrangements required for all types of tests such as radiography. DP test etc.
- Supply and application of all sealing and protective materials required for protecting equipments supplied by owner.
- Supply and erection of earthing lugs for pipes and equipments.
- Supply of all other materials, consumables, testing appliances tools and tackles etc. required for carrying out the work in all respect.
- Supply and application of primer, paint, coating & wrapping for site fabricated equipments, pipes, fitting & piping items, etc.
- Package Items: If any
- Items other than those mentioned above and which may be required during execution of work will be provided by contractor.

3.4.1.1 Non material requirement

- Documents as specified in commercial terms and conditions.
- Inspection and test reports.
- Submission of 6 sets of following drawings with site changes duly marked on hard prints supplied by owner for the preparation of As-built drawing.
 - P & I diagrams
 - Equipment layouts
 - Piping layout
 - Piping fabrication Isometric drawings As built drgs etc.
- All the design documents apart from owner and / or all drawings prepared by contractor shall be provided in 8 sets, Submission of 04 Nos. quality dossier with DVD 04 Nos. as well.

3.4.2 Deviations

In case any item of work is not covered by drawings, specifications, standards and codes referred to above or where a deviations from provision of such drawings, specifications standards and codes, is deemed advantageous or essential then the matter shall be brought to the notice of Engineer in Charge and the work shall be carried out only after obtaining written approval from client in each or any case.

3.5 Electrical

3.5.1 Contractor's scope of supply

As stated in the bill of material and the schedule of rates.

All material has to be procured through approved vendor list and category A type vendor only.

3.5.1.1 Set of documents / information to be provided by Contractor

I. Information to be provided along with the Contract

Documentation: 5 sets of following as built drawings and document in hard copy bounding folder of standard size and 2 sets in soft form on CD to be submitted:

- Electrical diagram
- Mechanical drawings
- GA drawings
- Layout of all equipment/ earth pits
- Single starter control panel with LCS
- Relay settings data
- Operation and maintenance manual of all equipment
- Spare part list
- Inspector approval copy Equipment test report Safety precautions

II. Documents to be submitted immediately after the date of award of contract

On placement of order the successful SELLER shall submit following drawing for approval:

- SLD & Control Scheme with GA of Starter & Local control panel
- GA drawing
- Cable tray/ bus duct layout
- Earthing drawing
- Earth pit layout with earth strip connections

Upon approval of BUYER necessary approval shall be taken by the successful SELLER from concerned electrical authorities before taking up actual work at site.

3.6 Instrumentation

3.6.1 Documentation schedule

- “Contractor” shall strictly adhere to the documentation schedule and submit required numbers of data sheets, catalogues, and softcopies.
- “Contractor” shall submit 2 copies of the following along with the offer.
- Technical data and specification / Catalogues or leaflet information.
- List of deviations to specification.
- “Contractor” shall submit 1 copy of price list of spare parts required for commissioning and also 2 years trouble free operation along with price bid.
- “Contractor” shall furnish 5 copies each of the following data/documents within 2 weeks after placement of order for “Owner representative” review / approval.
- Drawing showing overall drilling and mounting dimensions.

“Contractor” shall submit 6 copies and 1 softcopy of all the following documents in a folder to “Owner representative”.

- Calibration certificates including functional test.
- Material certificates of compliance.
- Installation, operation and maintenance manuals.
- Priced list of tools and devices for maintenance.

4 General Civil Technical Specification

4.1 Earth Work and Backfilling

4.1.1 Scope

This section of the specification covers the technical requirements for excavation and filling & around structures, buildings, pipes, foundations, trenches, pits, drains, channels, cable ducts, underground facilities & similar works. It also covers filling areas and plinths with selected materials, conveyance and disposal of surplus spoils and/or stacking them properly as directed by the Engineer-in-charge.

The contractor shall be fully responsible for proper setting out works, profiling in excavation, stacking, etc. taking adequate safety measures etc. The Contractor shall carry out all works meant within the intent of this specification even if not explicitly mentioned herein. All works shall be executed to the satisfaction of the Engineer-in-charge.

Existing trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, drains, sewers or other surface or subsurface systems/ drainage facilities within or adjacent to the works being carried out which are not to be disturbed, shall be protected from damage by the Contractor. The Contractor shall provide and install suitable safeguards approved by the Engineer-in-charge for this purpose.

During excavation, the Contractor shall take all necessary precautions against soil erosion, water & environmental pollution, and where required undertake additional works to achieve this objective. Before start of operations, the Contractor shall submit to the Engineer-in-charge for approval, his work plan and the procedure he intends to follow for disposal of waste materials etc. and the schedule for carrying out temporary and permanent control works. However, the approval of the Engineer-in-charge to such plans and procedures shall not absolve the Contractor of his responsibility for safe and sound work.

4.1.2 General

The Contractor shall make his own surveying arrangements for locating the coordinates and positions of all work and establishing the reduced levels (RL's) at these locations based on two reference grid lines and one bench mark which will be furnished by the Owner. The Contractor has to provide at site all the required survey instruments, along with qualified surveyors, to the satisfaction of the Engineer-in-charge so that the work can be carried out accurately and according to the specification and drawings.

The Contractor shall furnish all skilled and unskilled labour, plant, tools, tackle, equipment, men and materials required for complete execution of the work in accordance with the drawings and as described herein and/or as directed by the Engineer-in-charge .

The Contractor shall control the grade in the vicinity of all excavations so that the surface of the ground will be properly sloped or dyked to prevent surface water from running into the excavated areas during construction.

All materials obtained from excavation shall remain the Owner's property. All salvaged materials of archaeological importance or of value (in the opinion of the Engineer-in-charge) shall be segregated from

the other materials and both stacked separately and in a regular manner at location indicated by the Engineer-in-charge.

Excavation shall include removal of trees including roots & organic remains, vegetation, grass, bushes, shrubs, plants, poles, fences etc. that are in the area to be excavated as well as beyond the excavation line so as to ensure safety of the excavated side slopes and of men and equipment operating in the area. Before start of excavation work, joint measurements of ground level shall be taken after clearing all grass, vegetation etc.

Excavation shall include the removal of all materials required to execute the work properly and shall be made with sufficient clearance as decided by the Engineer-in-charge to permit the placing and setting of forms, inspection and completion of all works to the satisfaction of the Engineer-in-charge for which the excavation was done.

Classification of Earth Work: The earth work shall be classified under the following main categories.

- a) All types of soils, murrum, boulders.
- b) Soft rock.
- c) Hard rock.

Ordinary soils: This includes earth, murrum, top deposits of agricultural soil, reclaimed soil, clay, sand or any combination thereof and soft and hard murrum, shingle etc., which is loose enough to be removed with spades shovel and pick axes. Boulders not more than 0.03 cum. in volume found during the course of excavation shall also fall under this classification.

Soft Rock: This shall include all materials which are rock or hard conglomerate, all decomposed weathered rock, highly fissured rock, old masonry, boulders bigger than 0.03 cum in volume but not bigger than 0.5 cum and other varieties of soft rock which can be removed only with pick axes, crow bars, wedges and hammers with some difficulty. The mere fact that the contractor resorts to blasting and / or wedging and chiselling for reasons of his own, shall not mean the rock is classifiable as hard rock.

Hard Rock: This includes all rock other than soft rock mentioned in para 2.07.02 viz.

Soft rock, occurring in masses, boulders having approximate volume more than 0.5 cum plain or reinforced cement concrete, which can best be removed by blasting or chiselling and wedging where blasting cannot be permitted owing to any restriction at site.

4.1.3 Codes and Standards

All standards, specifications, acts and code of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of conflict between this specification and those (IS standards, codes etc.) referred to herein, the former shall prevail.

Some of the relevant Indian standards, Acts and Codes are referred to here below:

Table 4.1: I S code lists

| Code no | year | Title of codes |
|--------------------|------|--|
| IS: 383 | 1970 | Specification for coarse and fine aggregates from natural sources for concrete. |
| IS 2720 (Part- 2) | 1973 | Methods of test for soils-Determination of water content |
| IS 2720 (Part4-4) | 1985 | Methods of test for soils-Grain size analysis |
| IS 2720 (Part-5) | 1985 | Methods of test for soils-Determination of liquid limit & plastic limit |
| IS 2720 (Part-6) | 1972 | Methods of test for soils-Determination of shrinkage factors |
| IS 2720 (Part-7) | 1980 | Methods of test forsoils-Determination of water content-Dry density relation using light compaction |
| IS 2720 (Part-8) | 1983 | Methods of test for soils- Determination of water content-Dry density relation using heavy compaction |
| IS 2720 (Part-14) | 1983 | Methods of test forsoils-Determination of dry index(relative density) |
| IS 2720 (Part-21) | 1977 | Methods of test for soils-Determination of total soluble solids |
| IS 2720 (Part-23) | 1976 | Methods of test for soils-Determination of calcium carbonate |
| IS 2720 (Part-24) | 1976 | Methods of test for soils-Determination of cat ion exchange capacity |
| IS 2720 (Part-27) | 1977 | Methods of test for soils-Determination of total soluble sulphates |
| IS 2720 (Part-29) | 1975 | Methods of test for soils-Determination of dry density of soil in-place by core cutter method |
| IS: 3764 | 1992 | Safety code for excavation work |
| IS: 4081 | 1986 | Safety code for blasting and related drilling operations |
| IS: 4701 | 1982 | Code of practice for earth work on canals |
| IS: 9759 | 1981 | Guide lines of dewatering during construction |
| IS: 10379 | 1982 | Code of practice for field control of moisture and compaction of soils for embankment and sub grade Indian Explosives Act 1940 as updated. |

4.1.4 Excavation in Soil

Side and bottom of excavation shall be cut sharp and true to line and level. Undercutting shall not be permitted. When machines are used for excavation, the last 300 mm before reaching the required level shall be excavated manually or by such equipment that soil at the required final level will be left in its natural condition. Suitability of strata (at the bottom of excavations) for laying the foundation thereon shall be determined by the Engineer-in-charge.

Excavation for foundation shall be to the bottom of lean concrete and as shown on drawing or as directed by the Engineer-in-charge. The bottom of all excavations shall be trimmed to required levels and when excavation is carried below such levels by error, it shall be brought back to the specified level by filling with concrete of nominal mix 1:3:6 (cement: coarse sand: 40 mm down aggregates) as directed by the Engineer-in-charge.

The Contractor shall ascertain for himself the nature of materials to be excavated and the difficulties, if any, likely to be encountered in executing this work., sheeting, shoring, bracing, maintaining suitable slopes, draining etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer-in-charge.

All excavation for installation of underground facilities, such as pipe lines, sewer line, drain lines etc. shall be open cuts. For deep and huge excavations and in other excavations, if required by the Engineer-in-charge, the Contractor shall submit for Engineer-in-charge's approval an "Excavation Scheme" showing the methodology to be adopted for excavation in order to maintain the stability of side slopes, means for ensuring safety of existing facilities nearby, dewatering. However, the Contractor shall be fully responsible

for the scheme irrespective of any approvals granted. Benching shall be provided for deeper excavation wherever required.

When excavation requires bracing, sheeting or shoring etc. the Contractor shall submit drawings to the Engineer-in-charge, showing arrangements and details of proposed installation. The Contractor shall also furnish all supporting calculations as called for and shall not proceed until he has received written approval from the Engineer-in-charge. However, the responsibility for adequacy of such bracing, sheeting, shoring etc. will rest with the Contractor, irrespective of any approval of the Engineer-in-charge.

The Contractor shall have to constantly pump out any water collected in excavated pits and other areas due to rain water, springs etc. and maintain dry working conditions at all times until the excavation, placement of reinforcement, shuttering, concreting, backfilling is completed. The Contractor shall remove all slush/muck from the excavated areas to keep the work area dry. Sludge pumps, if required, shall be employed by the Contractor for this purpose.

The Contractor shall remove all materials arising from excavations from the vicinity of the work either for direct filling, stacking the subsequent filling or for ultimate disposal as directed by the Engineer-in-charge. In no case shall the excavated soil be stacked within a distance of 1.5 m from the edge of excavation or one third the depth of excavation whichever is more. Material to be used for filling shall be kept separately.

4.1.5 Excavation in Rock

4.1.5.1 General

All clauses from 6.1 to 6.4 shall be applicable to excavation in rock also. In case of any discrepancy between the above mentioned clause and those specified in this clause then this clause shall govern.

For the work of excavation in rock, Contractor shall engage specialised agency having experience of excavation in rock involving wedging and blasting. The agency shall be subject to approval of Engineer-in-charge and the Contractor shall furnish details of relevant experience in support while seeking approval for the agency.

In case of over breaks in rock excavation, the excavated level shall be brought to the level shown on drawings with plain cement concrete of nominal mix 1:3:6.

4.1.5.2 Excavation by Blasting

Blasting shall be resorted to only with the written permission of the Engineer-in charge. All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards etc. pertaining to the acquisition, transport, storage, handling and use of explosives etc. shall be strictly followed.

The contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per Explosives Act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive materials.

The Contractor may adopt any method of blasting as permitted according to explosives act/rule consistent with the safety and job requirements (after approval from the Engineer-in-charge) and so as not to injure men or damage materials/structures during blasting operations.

The magazine for the storage of explosives shall be built by the Contractor to the designs and specifications of the Explosives Department concerned and located at the approved site. No unauthorized person shall be admitted into the magazine which, when not in use, shall be kept securely locked. No matches or inflammable material shall be allowed in the magazine. The magazine shall have an effective lightning conductor and the following shall be hung in the lobby of the magazine.

- a) A copy of the relevant rules regarding safe storage, both in English and in the language(s) with which the workers concerned are familiar.
- b) A statement of up to date stock in the magazine.
- c) A certificate showing the last date of testing of the lightning conductor.
- d) A notice stating that smoking is strictly prohibited.

The Contractor shall also observe any specific instructions given by the Engineer-in charge. The Contractor shall be responsible and liable for damage to property and any accident which may occur to workmen or to the public or to materials on account of any operation connected with the storage, transportation, handling or use of explosives and the blasting operations. The Engineer-in-charge shall frequently check the Contractor's compliance with these precautions and the manner of storing and accounting of explosives. The Contractor shall provide necessary facilities for this.

All materials, tools and equipment used for blasting operations shall be of approved make and type. In special cases, the Engineer-in-charge may specify the type of explosives to be allowed. The fuse to be used in wet locations shall be sufficiently water resistant so as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and precisely known to permit evaluation of the distance to which the firer should move before explosion takes place. Detonators shall be capable of effective blasting of the explosives.

The blasting powder, explosives, detonators, fuses etc. shall be fresh and not damaged due to dampness or any other Cause. Explosives shall be kept dry and shall not be exposed to direct rays of the sun or be stored in the vicinity of fire, stoves, steam pipes, or heated metal etc. They shall be inspected before use and damaged articles shall be discharged totally and removed from site immediately.

4.1.5.3 Blasting Operations

The blasting operations shall remain in the charge of a responsible, competent, authorized and experienced supervisor (called Man-in-Charge) and workmen who are thoroughly acquainted with the details of handling explosives and blasting operation and with the rules governing such work.

All rules under the Explosives Act and other local rules in force shall be fully observed. All blasting works shall be done in accordance with the stipulations contained in IS: 4081. Blasting shall only be carried out at certain specified times preferably during the mid-day lunchtime or at the close of work as directed in writing by the Engineer-in-charge. The hours when blasting will be done, shall be made known to people in the vicinity. All the charges shall be prepared by the Man-in-Charge (as defined in 5.03.01) above) only. Proper precautions for safety of persons and property shall be taken.

Prior to blasting, red danger flags shall be displayed prominently around the area to be blasted and shall be kept in position until blasting work is completed. All people, except those who actually light the fuses, shall be prohibited from entering this area. The flags shall be planted 200 metres from the blasting site

and all persons including workmen shall be evacuated from the flagged area at least 10 minutes before firing. A warning whistle shall be sounded for this purpose.

Controlled Blasting shall be carried out within 200 metres of an existing structure unless otherwise permitted by the Engineer-in-charge in writing. Where (generally with in plant area) controlled blasting is to be carried out in the proximity of other structures, then sand bags and/or earth bags etc. shall be used on top of the blast holes to prevent the rock fragments from causing damage to adjacent structures and property. At all stages of blasting operations, precautions shall be taken to preserve the rock in the soundest possible condition below and beyond the lines specified for the excavation. The quantity and strength of explosives used shall be such that it will neither damage nor crack the rock outside the limits of excavation. Any method of blasting which leads to overshooting shall be discontinued.

No explosive shall be brought near the work in excess of the quantity required for a particular amount of firing to be done and surplus left after filling holes shall be removed to the magazine. A careful and day to day account of the explosives shall be maintained by the Contractor in an approved manner and in an identified register, which shall be open to inspection by the Engineer-in-charge at all time.

At a time not more than ten such charges shall be prepared and fired. The man-in Charge shall blow the whistle in a recognized manner for cautioning the people. The number of blasts to be fired and actual number of shots heard shall be compared and the person responsible shall satisfy himself by examination that all blasts have exploded before any person working in the area is permitted to re-approach the work site. Sufficient time shall be allowed to account for delayed blasts. The Man-in-Charge shall inspect all the charge. The withdrawal of the unexploded charge shall not be permitted under any circumstances. After tamping, the unexploded charge shall be flooded with water and the hole marked in a distinguishable manner. Another hole shall be jumped at a distance of 450 mm from the old hole and fired in the usual way. This process shall be continued till the original blast is exploded. The Man-in-Charge shall at once report to the Contractor's office and the Engineer-in-charge, all cases of misfire, the cause for the same and what steps were taken in connection therewith.

If misfire is found to be due to defective materials, the whole quantity in the box form which the defective materials was taken must be sent to the Authority directive by the Engineer-in-charge for inspection to ascertain whether any of the remaining materials in the box are also defective.

4.1.5.4 Chiselling / Wedging

Where blasting is prohibited for any reasons or it is not practicable in the opinion of the Engineer-in-charge, then the excavation shall be carried out by chiselling, wedging or any other approved method. The decision of the Engineer-in-charge in this regard shall be final binding on Contractor.

4.1.5.5 Line drilling and pre-shearing

The number, size and location of holes shall be carefully worked out by the Contractor and shall be subject to the approval of the Engineer-in-charge. Line drilled holes shall generally be 48 mm dia. and, if so directed, interior blasting holes shall also be made. The Contractor shall carry out test to determine the amount of explosives required to ensure an even break at the line drilled holes after the interior holes are blasted and irregularities in the vertical drilled line face shall be removed and trimmed by wedging, splitting, chiselling and barring.

4.1.6 Excavation below Ground Water Table

Wherever ground water table is met with during excavation, the Contractor shall immediately report this fact to the Engineer-in-charge who shall arrange to record the exact level of the water table before start of dewatering operation. The decision of the Engineer-in-charge regarding sub-soil water level shall be final and binding on the Contractor. Ground Water Table for the purpose of this clause shall be taken as the level of standing water observed during the process of excavation. Capillary action of water in the surrounding soil mass shall not be considered for the above purpose.

The Contractor shall dewater and maintain dry working conditions by maintaining the water table below the bottom of the excavation level by well-point dewatering or deep well dewatering or any other method approved by the Engineer-in-charge. He shall continue doing so till excavation, concreting, curing, and all other operation included in the scope of work, which require dry condition in the area are completed.

4.1.7 Lift

The Contractor is required to excavate up to any depth as shown on the drawings or as directed by the Engineer-in-charge. Lifting of excavated materials shall be done either by manual or mechanical or both means if called for by the Engineer-in-charge.

4.1.8 Carriage of Materials

The Engineer-in-charge shall indicate the disposal/ stacking areas for excavated materials. The carriage of excavated materials shall be done by the methods mentioned below:

- a) The excavated materials shall be carried beyond the initial lead of 50 m but up to 500 m by manual /animal labour or by mechanical means. If directed by the Engineer-in-charge this material shall be used directly for filling purposes.
- b) For leads exceeding 500 m the Contractor shall transport the excavated materials by mechanical means only and as directed by the Engineer-in-charge. The Contractor may be allowed to carry materials through Kuccha roads. Providing and maintaining of the Kuccha roads shall be the responsibility of the Contractor. The transported material shall be neatly stacked as directed by the Engineer-in-charge.

Some excavated materials required for filling purposes, may have to be carried up to a lead of 500 m and stacked as per instructions of the Engineer-in-charge. Excavated materials carried beyond 500 m shall normally be for disposal purpose only. Double handling of materials shall be avoided as far as possible. However, depending on site condition excavated materials carried beyond a lead of 500 m may also be required to be brought back for filling purpose.

4.1.9 Filling

4.1.9.1 Materials

- 1) Materials to be used for filling purpose shall be stone, sand or other inorganic materials and they shall be clean and free from shingle, salts, organic matter, large roots and excessive amount of sod, lumps, concrete or any other foreign substances which could harm or impair the strength of the substances in any manner. All clods shall be suitably broken to small pieces. When the materials are mostly rock boulders, these shall be broken into pieces not larger than 150 mm

size. Sand used for filling shall be clean, medium grained and free from impurities. Fines less than 75 microns shall not be more than 20%. In any case, the materials to be used for filling purposes shall have the prior written approval of the Engineer-in-charge.

- 2) If excavated materials are to be used for filling, then the Contractor shall select the materials from the stockpile, land and transport this material and execute the filling. This shall include excavation of earth, which may become hard due to lying in stockyard for a long period of time.
- 3) In case the materials have to be brought from pits/quarries, it shall be the Contractor's responsibility for identification of such quarry areas, obtaining approval from their use from concerned authorities, excavation/quarrying loading and carriage of such material, unloading and filling at specified locations. The Contractor shall pay any fees; royalties etc. that may have to be paid for utilization of borrow areas.

4.1.9.2 Filling Procedure

- 1) After completion of foundation, footings, walls and other construction below the elevation of the final grades, and prior to filling, all temporary shoring, timber etc. shall be sequentially removed and the excavation cleaned of all trash, debris, and perishable materials. Filling shall begin only with the written approval of the Engineer-in-charge. Also, areas identified for filling shall be cleared of all soft pockets, vegetation, bushes, slash etc. In case of plinth and similar filling the ground shall be dressed and consolidated by ramming and light rolling.
- 2) Fill materials shall not be dropped directly upon or against any structure or facility where there is danger of displacement or damage. Filling shall be started after the concrete/masonry has fully set and shall be carried out in such a manner so as not to cause any undue lateral thrust on any part of the structure.
- 3) All space between foundation (concrete or masonry) and the sides excavation shall be filled to the original surface after making allowance for settlement, Fill shall be placed in horizontal layers not exceeding 200 mm loose thickness. Each layer shall be watered and compacted with proper moisture content and with such equipment as may be required to obtain a compaction/density as specified. Trucks or heavy equipment for depositing or compacting fill shall not be used within 1.5 meters of building walls, piers for operation. The methods of compaction shall be subjected to approval of Engineer-in-charge under any circumstances.
- 4) Fill adjacent to pipes shall be free of stones, concrete etc. and shall be hand placed and compacted uniformly on both sides of the pipe and where practicable up to a minimum depth of 300 mm over the top of pipes. While tamping around the pipes, care should be taken to avoid unequal pressure.
- 5) Filling shall be accurately finished to line, slope, cross section and grade as shown on the drawings. Finished surface shall be free of irregularities and depressions and shall be within 20 mm of the specified level.
- 6) Where filling with stone from excavated materials is specified, it shall be from broken pieces of boulders. At first a 75 mm thick cushion of selected earth shall be laid over which the 200 mm thick graded stones shall be laid in loose layers of 200 mm then the interstices filled with properly graded fine materials consisting of selected earth brought from borrow areas. Each layer shall be watered and compared to the specified density before the next layer is laid. However, no cushion shall be required where filling is over non-rocky surface.
- 7) Where filling with 65 mm downgraded stone obtained from excavated, it shall be selected stone laid over and initial 50 mm thick cushion layer of selected earth and then stone laid in 200 mm loose thick layers, interstices filled with the specified density before the next layer is laid. However, no cushion shall, be required where filling is over non-rocky surface.

- 8) Where clean stone fill is specified, it shall consist of clean selected stone metal of 40-mm nominal size. It shall be laid in layers not exceeding 150 mm (loose) and lightly tamped before the next layer is laid. No compaction shall be required for this type stone filling.

4.1.9.3 Compaction

- 1) Where compaction to 95% Standard Proctor Density or more is called for, it shall be by mechanical means only. Where access is possible, compaction shall be by 12 tonne rollers smooth wheeled, sheep foot or wobbly wheeled as directed by the Engineer-in-charge. A smaller weight roller may be permitted by the Engineer-in-charge in special cases, but in any case not less than 10 passes of the roller will be accepted for each layer. Each layer shall be wetted or the material dried by aeration to moisture content of 3-5% above the Optimum Moisture Content to be determined by the Contractor. Each layer shall be watered, rammed and compacted to the density as specified Engineer-in-charge.
- 2) For compacting sand layer, water shall be sprayed over it to flood it and it shall be kept flooded for 24 hours to ensure maximum compaction. Vibro-compactors shall also be used if necessary to obtain the required degree of compaction. Any temporary works required to contain sand under flooded condition shall also be undertaken. The surface of the consolidated sand shall be dressed to required levels or slope.
- 3) After the compacted fill has reached the desired level, the surface shall be flooded with water for 24 hours, allowed to dry and then rammed and consolidated to avoid any settlement, at a later date. The compacted surface shall be properly shaped, trimmed and consolidated to an even gradient or level. All soft spots shall be excavated, filled and consolidated.
- 4) The degree of compaction of compacted fill in place will be subject to tests by the Engineer-in-charge as the work progresses, and the contractor shall provide the necessary facilities to make such tests. If any test indicates that the compaction achieved is less than the specified degree of compaction, the Engineer-in-charge may require fill placed subsequent to the last successful test to be removed and re-compacted by the Contractor. Compaction procedure shall be amended as necessary to obtain satisfactory results.
- 5) When semi-compacted fill is specified by the Engineer-in-charge the contractor shall fill up such areas with available earth from stock piles of borrow pits or directly from excavation without special compaction except that obtained by moving trucks etc.

4.1.10 Sampling, Testing and Quality Control

4.1.10.1 General

- 1) The contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and/or International Standards and shall conduct such tests as are called for by the Engineer-in-charge. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted Engineer-in-charge ringing practice to the directions of the Engineer-in-charge. Tests shall be done in the field and at a laboratory approved by the Engineer-in-charge and the Contractor shall submit to the Engineer-in-charge, the test results in triplicate within three days after completion of a test. The Engineer-in-charge may, at his discretion, waive some of the stipulations given below, for small and unimportant operations.
- 2) Work found unsuitable for acceptance shall be removed and replaced by the contractor.
- 3) The work shall be redone as per specification requirements and to the satisfaction of the Engineer-in-charge.
- 4) Only as a very special case aid that too in non-critical areas, the Engineer-in-charge may accept filling work which is marginally unacceptable as per the criteria laid down. For such accepted

work, payment shall be made at a reduced rate pro-rata to the compaction obtained against that stipulated.

4.1.10.2 Quality Assurance Program

The contractor shall submit and finalize a detailed field Quality Assurance Program within 30 days from the date of award of the Contract according to the requirements of the specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of format for record, Field Quality plan etc. On finalized field quality plan the Owner shall identify Customer hold points beyond which work shall not proceed without written approval from the Engineer-in-charge.

Frequency of sampling and testing including the methods for conducting the tests shall be as per IS codal provisions. The testing frequencies set forth are the desirable minimum and the Engineer-in-charge shall have the full authority to carry out or call for tests as frequently as he may deem necessary to satisfy himself that the materials and work comply with the appropriate specifications.

4.1.10.3 Acceptance Criteria

- 1) Following Acceptance Criteria shall be as under:
 - a. All individual samples collected and tested should pass without any deviation when only one set of sample is tested.
 - b. For re-test of any sample two additional samples shall be collected and tested and both should pass without any deviation.
 - c. Where a large number of samples are tested for a particular test, 9 samples out of every 10 consecutive samples tested shall meet the specification requirement.
 - d. Tolerance on finished levels for important filling areas at approved interval shall be + 20 mm. However, for an unimportant area, tolerance up to + 75 mm shall be acceptable at the discretion of the Engineer-in-charge. However, these tolerances shall be applicable for localized areas only.

4.2 Sand Filling

4.2.1 Scope

Supply and filling coarse sand for filling in plinth / foundation / trenches, including transportation, all government taxes, royalties, filling, compaction, testing etc.

4.2.2 Codes, Standard and Rules

IS 383 Specification for coarse and fine aggregates from natural sources for concrete.

IS 2386 (Part I to VIII): Methods of test for aggregates for concrete

4.2.3 Materials Specification

The sand shall be free from any organic and deleterious materials as detailed in IS. Sand Gradation in Zone III shall be used for filling.

Machine made sand will be acceptable, provided the constituent rock/gravel composition shall be sound, hard dense, non-organic un-coated and durable against weathering.

4.2.3.1 Screening and Washing

Sand shall be prepared for use for such screening or washing, or both, as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size fractions

4.2.3.2 Foreign Material Limitations

The percentages of deleterious substances in sand delivered to the mixer shall not exceed the following:

| Percentage allowable | Minimum | Maximum |
|--|---------|---------|
| Material finer than 75 micron IS sieve | 3.00 | 15.00 |
| Shale | 1.00 | - |
| Coal and lignite | 1.00 | 1.00 |
| Clay lumps | 1.00 | 1.00 |
| Total of all above substances including items (i) to (iv) for un crushed sand and items iii) and (iv) for crushed sand | 5.00 | 2.00 |

4.2.3.3 Gradation

Unless otherwise directed or approved, the grading of sand shall be within the limits indicated here under:

Table 4.2: Grading Table

| IS Sieve Designation | Percentage passing for | | | |
|----------------------|------------------------|-----------------|------------------|-----------------|
| | Grading Zone I | Grading Zone II | Grading Zone III | Grading Zone IV |
| 10 mm | 100 | 100 | 100 | 100 |
| 4.75 mm | 90-100 | 90-100 | 90-100 | 95-100 |
| 2.36 mm | 60-95 | 75-100 | 85-100 | 95-100 |
| 1.18 mm | 30-70 | 55-90 | 75-100 | 90-100 |
| 600 Microns | 15-34 | 35-59 | 60-79 | 80-100 |
| 300 Microns | 5-20 | 8-30 | 12-40 | 15-50 |
| 150 Microns | 0-10 | 0-10 | 0-10 | 0-15 |

4.2.3.4 Fineness Modules

The sand shall have fineness Modulus of not less than 2.0.

The sand to be used for filling shall be free from salts, organic or other foreign matter.

4.2.4 Construction Specification

The sand shall be filled in layers not exceeding 150mm, below footing, grade slab etc., wherever indicated shall adequately be watered and consolidated. When filling reaches finished level, the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.

The finished level of filling shall be kept to shape and gradient, intended to receive any floor finish.

In case of large heavy duty flooring, the consolidation may be done by power rollers, where so specified or as directed. The extent of consolidation required shall also be as specified or as directed.

4.2.5 Testing procedure

Compaction test shall be carried out as per above specification of filling work.

4.2.6 Method of Measurements

The quantity shall be measured for filling in plinth and below foundations as per IS 1200.

No deductions shall be made for shrinkage or voids. Only consolidated measurements shall be considered.

4.3 Rubble Soling

4.3.1 Materials

Rubble used for packing under floors, foundations etc. shall be hard, durable rock, free from veins, black trap, flaws and other defects. The size of the rubble shall be 150 mm - 200mm unless otherwise specified in the item description in the Schedule of Quantities and the quality shall be got approved by the Engineer.

4.3.2 Workmanship

Rubble shall be laid closely in position on the sub-grade. All interstices between the stones shall be wedged in with smaller stones of suitable size well driven to ensure tight packing and complete filling of interstices. Such filling shall be carried out simultaneously with the placing in position of rubble stone and shall not lag behind.

Small interstices shall be filled with Murrum, well watered and rammed.

4.3.3 Mode of Measurement

The unit of measurement shall be Sq.M. of the work done as per the drawings and/or as specified in the Schedule of Quantities

4.4 Plain and Reinforced Concrete & Allied Works

4.4.1 Scope

This specification covers the general requirements for concreting to be used on jobs using on-site production facilities including requirements in regard to handling, storage of ingredients, proportioning, batching, mixing and testing and quality assurance. This also covers the transportation of concrete from

the mixer to the place of final deposit and the placing consolidation, curing, protecting, repairing and finishing of concrete.

The work shall include providing of materials, all necessary plant and equipment, providing adequate supervision and technical personnel, skilled and unskilled labour, etc. as required to carry out the entire work as indicated on the drawings and/or described herein subsequently and/or as directed by the Engineer-in-charge.

The Contractor shall carry out all works meant within the intent of this specification even if not explicitly mentioned herein. All works shall be executed to the satisfaction of the Engineer-in-charge.

4.4.2 General

The Contractor shall make his own surveying arrangements for locating the coordinates and positions of all work and establishing the reduced levels (RLs) at these locations, based on two reference grid lines and one bench mark, which will be furnished by Owner. The Contractor has to provide at site, all the required survey instruments, along with qualified surveyors, to the satisfaction of the Engineer-in-charge so that the work can be carried out accurately and according to the specifications and drawings.

Any approval, instructions, permission, checking, review, etc. whatsoever by the Engineer-in-charge, shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, quality, workmanship, etc.

4.4.3 Codes and Standards

All work shall be carried out as per the stipulations contained in various sections of these specifications and the latest Indian Standards, Acts, Codes and best practices.

All applicable standards, specifications, etc. and codes of practice shall generally be the latest editions, including all applicable official amendments and revisions. A complete set of all these documents shall generally be available at site, with the Contractor.

In case of conflict between the stipulations contained in various sections of these specifications and stipulations of Indian Standards, Codes, etc. the requirements of stipulations contained in various sections of these specifications, shall prevail over that of Indian Standards, Codes, etc.

4.4.3.1 The following are the various relevant Indian Standards:

Table 4.3: Indian Standards

| Code No | Year | Title of Code |
|-------------------|------|--|
| IS: 73 | 1992 | Specification for paving bitumen |
| IS : 216 | 1961 | Specification for coal tar pitch |
| IS: 269 | 1989 | Specification for 33 grade Ordinary Portland cement |
| IS: 280 | 1978 | Specification for mild steel wire for general Consulting purposes |
| IS: 383 | 1970 | Specification for coarse and fine aggregates from natural sources for concrete |
| IS:432 (Parts I) | 1982 | Specification for mild steel medium tensile steel bars and hard drawn steel wire for concrete reinforcement – Mild steel & medium tensile bars |
| IS: 432(Parts II) | 1982 | Specification for mild steel medium tensile steel bars and hard drawn steel wire for concrete reinforcement - Hard drawn steel wire |

| Code No | Year | Title of Code |
|---------------------|------|--|
| IS: 455 | 1989 | Specification for Portland slag cement |
| IS: 456 | 2000 | Code of practice for plain and reinforced concrete |
| IS: 457 | 1957 | Code of practice for general construction of plain & reinforced concrete for dams & other massive structures |
| IS: 516 | 1959 | Method of test for strength of concrete |
| IS : 650 | 1991 | Specification for standard sand for testing of cement |
| IS: 702 | 1988 | Specification for industrial bitumen |
| IS : 737 | 1986 | Wrought aluminium and aluminium alloy plate for general Consulting purposes |
| IS: 800 | 1984 | Code of practice for general construction in steel |
| IS: 816 | 1969 | Code of practice for use of metal arc welding for general construction in mild steel |
| IS: 1161 | 1998 | Specification for steel tubes for structural purpose |
| IS: 1199 | 1959 | Methods of sampling and analysis of concrete |
| IS: 1200 (Part-II) | 1974 | Method of measurement of building and civil Consulting works - Concrete works |
| IS: 1200 (Part-V) | 1982 | Method of measurement of building and civil Consulting works - Form work |
| IS:1200(Part VIII) | 1993 | Method of measurement of building and civil Consulting works - Steel work & iron work |
| IS:1200(Part XVIII) | 1974 | Method of measurement of building and civil Consulting works - Demolition & dismantling |
| IS: 1322 | 1993 | Specification for bitumen felts for waterproofing and damp proofing |
| IS: 1363 (Part 1) | 2002 | Hexagon head bolts, screws and nuts of product grade 'C' – Hexagon head bolts (size range M 5 to M 64) |
| IS: 1363 (Part 2) | 2002 | Hexagon head bolts, screws and nuts of product grade 'C' – Hexagon head screws (size range M 5 to M 64) |
| IS: 1363 (Part 3) | 2002 | Hexagon head bolts, screws and nuts of product grade 'C' – Hexagon nuts (size range M5 to M 64) |
| IS: 1489 (Part-I) | 1991 | Specification for Portland-Pozzolona cement: Fly ash based |
| IS:1489 (Part-II) | 1991 | Specification for Portland Pozzolona Cement: Calcined clay based. |
| IS : 1566 | 1982 | Specification for Hard-drawn steel wire fabric for concrete reinforcement. |
| IS : 1609 | 1991 | Code of practice for laying damp proofing treatment using bitumen felts. |
| IS : 1786 | 1985 | Specification for high strength deformed steel bars and wires for concrete reinforcement. |
| IS : 1791 | 1985 | General requirements for batch type concrete mixer. |
| IS: 1834 | 1984 | Specification for hot applied sealing compound for joints in concrete |
| IS : 1838 (Part-I) | 1983 | Specification for preformed fillers for expansion joints in concrete pavements and structures (non extruding and resilient type).- Bitumen impregnated fibre |
| IS: 2016 | 1967 | Plain washers |
| IS: 2074 | 1992 | Specification for ready mix paint, air drying, red oxide zinc chrome |
| IS : 2386 (Part 1) | 1963 | Methods of test of aggregates for concrete – Particle size & shape |
| IS : 2386 (Part 2) | 1963 | Methods of test of aggregates for concrete – Estimation of deleterious material and organic impurities |
| IS : 2386 (Part 3) | 1963 | Methods of test of aggregates for concrete – Specific gravity, Density, voids, absorption and bulking |
| IS : 2386 (Part 4) | 1963 | Methods of test of aggregates for concrete – Mechanical properties |
| IS : 2386 (Part 5) | 1963 | Methods of test of aggregates for concrete – Soundness |
| IS : 2386 (Part 6) | 1963 | Methods of test of aggregates for concrete – Measuring mortar making properties of fine aggregates |
| IS : 2386 (Part 7) | 1963 | Methods of test of aggregates for concrete – Alkali aggregate reactivity |

| Code No | Year | Title of Code |
|---------------------|------|---|
| IS : 2386 (Part 8) | 1963 | Methods of test of aggregates for concrete – Petrographic examination |
| IS : 2438 | 1963 | Specification for roller pan mixer. |
| IS : 2502 | 1963 | Code of practice for bending and fixing of bars for concrete reinforcement. |
| IS : 2505 | 1992 | General requirements for concrete vibrators, immersion type. |
| IS : 2506 | 1985 | General requirements for concrete vibrators, screen board type. |
| IS : 2514 | 1963 | Specification for concrete vibrating table. |
| IS : 2571 | 1970 | Code of practice for laying in-situ cement-concrete flooring. |
| IS : 2645 | 2003 | Specification for Integral cement water proofing compounds for cement mortar and concrete |
| IS : 2722 | 1964 | Specification for portable swing weigh batchers for concrete. (single and double type) |
| IS : 2750 | 1964 | Specification for steel scaffoldings. |
| IS : 2751 | 1979 | Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction. |
| IS: 2812 | 1993 | Recommendation for manual tungsten inert gas arc welding of aluminium and aluminium alloys |
| IS : 3025 (Part 22) | 1986 | Methods of sampling and test (physical & chemical) for water & waste water - Acidity |
| IS : 3025 (Part 23) | 1986 | Methods of sampling and test (physical & chemical) for water & waste water - Alkalinity |
| IS : 3037 | 1986 | Specification for bitumen mastic for use in water proofing of roofs |
| IS : 3150 | 1982 | Specification for hexagonal wire netting for general purposes. |
| IS : 3370 (Part I) | 1965 | Code of practice for concrete structures for the storage of liquids – General requirements |
| IS : 3370 (Part II) | 1965 | Code of practice for concrete structures for the storage of liquids- Reinforced concrete structures |
| IS : 3384 | 1986 | Specification for bitumen primer for use in waterproofing & damp proofing. |
| IS : 3414 | 1968 | Code of practice for design and installation of joints in buildings. |
| IS : 3550 | 1965 | Methods of test for routine control for water used in Industry. |
| IS : 3558 | 1983 | Code of practice for use of immersion vibrators for consolidating concrete. |
| IS : 3696 (Part I) | 1987 | Safety code for scaffolds and ladders - Scaffolding |
| IS : 3696 (Part II) | 1991 | Safety code for scaffolds and ladders - Ladders |
| IS : 4014 (Part I) | | Code of practice for steel tubular scaffolding – Definition & materials |
| IS : 4014 (Part II) | | Code of practice for steel tubular scaffolding - Safety Regulation for scaffolding |
| IS : 4031 (Part 1) | 1996 | Methods for physical tests for hydraulic cement – Determination of finess by dry sieving |
| IS : 4031 (Part 2) | 1999 | Methods for physical tests for hydraulic cement – Determination of fineness by specific surface by Blaine air permeability method |
| IS : 4031 (Part 3) | 1988 | Methods for physical tests for hydraulic cement – Determination of soundness |
| IS : 4031 (Part 4) | 1988 | Methods for physical tests for hydraulic cement – Determination of consistency of standard cement paste |
| IS : 4031 (Part 5) | 1988 | Methods for physical tests for hydraulic cement – Determination of initial and final setting times |
| IS : 4031 (Part 6) | 1988 | Methods for physical tests for hydraulic cement – Determination of compressive strength of hydraulic cement (other than masonry cement) |
| IS : 4031 (Part 7) | 1988 | Methods for physical tests for hydraulic cement – Determination of compressive strength of masonry cement |
| IS : 4031 (Part 8) | 1988 | Methods for physical tests for hydraulic cement – Determination of transverse and compressive strength of plastic mortar using prism |
| IS : 4031 (Part 9) | 1988 | Methods for physical tests for hydraulic cement – Determination of heat of hydration |

| Code No | Year | Title of Code |
|----------------------|------|---|
| IS : 4031 (Part 10) | 1988 | Methods for physical tests for hydraulic cement – Determination of drying shrinkage |
| IS : 4031 (Part 11) | 1988 | Methods for physical tests for hydraulic cement – Determination of density |
| IS : 4031 (Part 12) | 1988 | Methods for physical tests for hydraulic cement – Determination of air content of hydraulic cement mortar |
| IS : 4031 (Part 13) | 1988 | Methods for physical tests for hydraulic cement – measurement of water retentivity of masonry cement |
| IS : 4031 (Part 14) | 1989 | Methods for physical tests for hydraulic cement – Determination of false set |
| IS : 4031 (Part 15) | 1991 | Methods for physical tests for hydraulic cement – Determination of fineness by wet sieving |
| IS : 4130 | 1991 | Safety Code for demolition of buildings. |
| IS : 4218 (Part 3) | 1999 | ISO general purpose metric screws threads – Basic dimensions |
| IS : 4326 | 1993 | Code of practice for earthquake resistant design and construction of buildings. |
| IS : 4461 | 1998 | Code of practice for joints in surface hydro-electric power stations. |
| IS : 4656 | 1968 | Specification for form vibrators for concrete. |
| IS : 4671 | 1984 | Expanded polystyrene for thermal insulation purposes |
| IS : 4925 | 1968 | Specification for batching and mixing plant. |
| IS : 4990 | 1993 | Specification for plywood for concrete shuttering work. |
| IS : 4995 (Part I) | 1974 | Criteria for design of reinforced concrete bins for the storage of granular and powdery materials – General requirement & assessment of bin loads |
| IS : 5256 | 1992 | Code or practice for sealing joints in concrete lining on canals. |
| IS : 5525 | 1969 | Recommendations for detailing of reinforcement in reinforced concrete work. |
| IS : 5624 | 1993 | Specification for foundation bolts. |
| IS : 5871 | 1987 | Specification for bitumen mastic for tanking and damp proofing |
| IS : 6461 (Part 1) | 1972 | Glossary of terms relating to cement concrete – Concrete aggregates |
| IS : 6461 (Part 2) | 1972 | Glossary of terms relating to cement concrete – Materials (other than cement and aggregates) |
| IS : 6461 (Part 3) | 1972 | Glossary of terms relating to cement concrete – Concrete reinforcement |
| IS : 6461 (Part 4) | 1972 | Glossary of terms relating to cement concrete – types of concrete |
| IS : 6461 (Part 5) | 1972 | Glossary of terms relating to cement concrete – Formwork for concrete |
| IS : 6461 (Part 6) | 1972 | Glossary of terms relating to cement concrete – Equipment, tools & plant |
| IS : 6461 (Part 7) | 1973 | Glossary of terms relating to cement concrete – Mixing, Laying, Compaction, Curing and other construction aspects |
| IS : 6461 (Part 8) | 1973 | Glossary of terms relating to cement concrete – Properties of concrete |
| IS : 6461 (Part 9) | 1973 | Glossary of terms relating to cement concrete – Structural aspects |
| IS : 6461 (Part 10) | 1973 | Glossary of terms relating to cement concrete – Tests & testing apparatus |
| IS : 6461 (Part 11) | 1973 | Glossary of terms relating to cement concrete – Prestressed concrete |
| IS : 6461 (Part 12) | 1973 | Glossary of terms relating to cement concrete - Miscellaneous |
| IS : 6494 | 1988 | Code of practice for water proofing of underground water reservoirs and swimming pools. |
| IS : 6509 | 1985 | Code of practice for installation of joints in concrete pavements. |
| IS : 7193 | 1994 | Specification for glass fiber base coal-tar pitch and bitumen felts. |
| IS : 7293 | 1974 | Safety code for working with construction machinery. |
| IS : 7634 (Part 3) | 2003 | Code of practice for Plastic pipe selection, handling, storage and installation for potable water supplies – Laying and jointing of PVC pipes |
| IS : 7861 (Parts I) | 1975 | Code of practice for extreme weather concreting –Recommended practice for hot weather concreting |
| IS : 7861 (Parts II) | 1981 | Code of practice for extreme weather concreting –Recommended practice for cold weather concreting |

| Code No | Year | Title of Code |
|------------|------|--|
| IS: 8042 | 1989 | Specification for White Portland cement |
| IS: 8043 | 1991 | Specification for hydrophobic Portland cement |
| IS: 8112 | 1989 | Specification for 43 Grade Ordinary Portland Cement |
| IS : 9103 | 1999 | Specification for concrete admixtures |
| IS : 9417 | 1989 | Recommendations for welding cold-worked steel bars for reinforced concrete construction. |
| IS : 9595 | 1996 | Recommendations for metal-arc welding of carbon and carbon manganese steels. |
| IS : 10262 | 1982 | Recommended guidelines for concrete mix design. |
| IS : 11384 | 1985 | Code of practice for composite construction in structural steel and concrete. |
| IS : 12118 | 1987 | Specification for two-part poly-sulphide based sealants– General requirements |
| IS : 12118 | 1987 | Specification for two-part poly-sulphide based sealants– Methods of test |
| IS : 12200 | 2001 | Code of practice for provision of water stops at transverse construction joints in masonry and concrete dams |
| IS : 12269 | 1987 | Specification for 53 Grade ordinary Portland cement. |
| IS: 12330 | 1988 | Sulphate resisting Portland Cement |
| IS : 12600 | 1989 | Specification for low heat Portland cement |
| SP : 23 | 1982 | Handbook of concrete mixes. |
| SP : 24 | 1983 | Explanatory Handbook on IS: 456 |
| SP : 34 | 1987 | Handbook on concrete reinforcement and detailing. |

4.4.3.2 General:

- 1) All the materials used in the manufacture of concrete shall be in accordance with the Technical Specification for Properties, Storage and Handling of Common Building Materials, which shall be deemed to form a part of this specification.
- 2) The Engineer-in-charge shall have the right to inspect the sources of materials, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment's and the quality control system. Such an inspection shall be arranged by the contractor and the Engineer-in-charge approval shall be obtained prior to starting the work.

4.4.4 Aggregates

- 1) Aggregate in general designates both fine and coarse inert materials used in the manufacture of concrete. Coarse Aggregate is fraction retained on 4.75 mm IS sieve. Fine Aggregate is fraction which passes through 4.75 mm IS sieve.
- 2) Aggregate shall consist of natural sand crushed stone and gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, strong, hard, durable against weathering, of limited porosity and free from deleterious materials that may cause corrosion to the reinforcement or may impair the strength and / or durability of concrete. Aggregates shall conform to I.S. 383
- 3) Properties: Aggregates with a specific gravity below 2.6 shall not be used without special permission of the Engineer-in-charge. Machine-made sand will be acceptable provided the constituent (rock/gravel) is sound, hard, dense and is acceptable to the Engineer-in-charge. Sand, natural gravel and crushed rock shall be prepared for use by such screening or washing, or both, as necessary to remove all objectionable foreign matter.
- 4) The coarse aggregate and fine aggregate shall be tested from time to time as required by the Engineer-in-charge to ascertain its suitability for use in construction and the charges for testing aggregate shall be borne by the contractor as specified herein after. Sampling of the aggregates

for mix design and determination of suitability shall be taken under the supervision of the Engineer-in-charge and delivered to the laboratory, well in advance of the schedule placing of concrete. Records of tests which have been made on proposed aggregates and on concrete made from this source of aggregates shall be furnished to the Engineer-in-charge in advance of the work for use, in determining suitability of the proposed aggregate.

- 5) The grading of aggregates shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the “mix design” and preliminary test on concrete specified herein-after.

Grading of Coarse Aggregate: Coarse aggregates shall be either in single or graded, in both the cases. The grading shall be within the following limits.

Table 4.4: Gradation of Sand

| IS Sieve Designation | Percentage passing for | | | | | | | | | | |
|----------------------|------------------------|--------|--------|--------|---------|--------|--------|--------|--------|---------|--|
| | 63 mm | 40 mm | 20 mm | 16 mm | 12.5 mm | 10 mm | 40 mm | 20 mm | 16 mm | 12.5 mm | |
| 75mm | 100 | - | - | - | - | - | - | - | - | - | |
| 63mm | 85-100 | 100 | - | - | - | - | 100 | - | - | - | |
| 37.5mm | 0-30 | 85-100 | 100 | - | - | - | 95-100 | 100 | - | - | |
| 19mm | 0-5 | 0-20 | 85-100 | 100 | - | - | 30-70 | 95-100 | 100 | 100 | |
| 16mm | - | - | - | 85-100 | 100 | - | - | - | 90-100 | - | |
| 11.2mm | - | - | - | - | 85-100 | 100 | - | - | - | 90-100 | |
| 9.5mm | - | 0-5 | 0-20 | 0-30 | 0-45 | 85-100 | 10-35 | 25-55 | 30-70 | 40-85 | |
| 4.75mm | - | 0-5 | 0-5 | 0-10 | 0-20 | 0-20 | 0-5 | 0-10 | 0-10 | 0-10 | |
| 2.36mm | - | - | - | - | 0-5 | 0-5 | - | - | - | - | |

Foreign Material Limitations: The percentages of deleterious substances in the coarse aggregate delivered to the mixer shall not exceed the following:

Table 4.5: Foreign Material limitation

| Substances | Percentage by weight of aggregates | |
|---|------------------------------------|---------|
| | Uncrushed | Crushed |
| Material finer than 75 micron IS Sieve. | 3.00 | 3.00 |
| Coal and lignite | 1.00 | 1.00 |
| Clay lumps | 1.00 | 1.00 |
| Soft fragments | 3.00 | -- |
| Total of all the above substances | 5.00 | 5.00 |

Grading of fine aggregate shall be within the limits indicated hereunder:

Table 4.6: Aggregate Gradation

| IS Sieve Designation | Percentage Passing for | | | |
|----------------------|------------------------|-----------------|------------------|-----------------|
| | Grading Zone-I | Grading Zone-II | Grading Zone-III | Grading Zone-IV |
| 10 mm | 100 | 100 | 100 | 100 |
| 4.75 mm | 90-100 | 90-100 | 90-100 | 95-100 |
| 2.36 mm | 60-95 | 75-100 | 85-100 | 95-100 |
| 1.18 mm | 30-70 | 55-90 | 75-100 | 90-100 |
| 600 micron | 15-34 | 35-59 | 60-79 | 80-100 |
| 300 micron | 5-20 | 8-30 | 8-30 | 20-65 |
| 150 micron | 0-10 | 0-10 | 0-10 | 0-15 |

Foreign Material Limitations: The percentages of deleterious substances in fine aggregate, delivered to the mixer shall not exceed the following:

Table 4.7: Foreign Material Limits

| Substances | Percent by weight | |
|--|-------------------|---------|
| | Uncrushed | Crushed |
| Material finer than 75 micro IS sieve | 3.00 | 15.00 |
| Shale | 1.00 | -- |
| Coal and lignite | 1.00 | 1.00 |
| Clay lumps | 1.00 | 1.00 |
| Total of all above substances including items (I) to (iv) for uncrushed sand and items (iii) and (iv) for crushed sand | 5.00 | 2.00 |

- 6) Fineness Modulus: The fine aggregate shall have a fineness modulus of not less than 2.2 or more than 3.2. The fineness modulus is determined by adding the cumulative percentages retained on the following I.S. sieve sizes (4.75 mm, 2.36 mm, 1.18 mm, 600 micron, 300 micron and 150 micron) and dividing the sum by 100.
- 7) Storage of aggregates: All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign materials and earth during storage and while heaping the materials shall be avoided. The aggregate must be of specified quality not only at the time of receiving at site but also at the time of loading into mixer. Racers shall be used for lifting the coarse aggregate from bins or stock piles. Coarse aggregate shall be piled in layers not exceeding 1.00 meters in height to prevent conning or segregation. Each layer shall cover the entire area of the stock pile before succeeding layers are started. Aggregates that have become segregated shall be rejected. Rejected material after re-mixing may be accepted, if subsequent tests demonstrate conformity with required gradation.

4.4.4.1 Cement

- 1) The cement generally used shall be the Ordinary Portland cement 43 / 53 grade. However, any special type of cement such as High strength cement or sulphate resisting cement may be used under specific circumstances.
- 2) Cement unless otherwise specified or called for by the Engineer-in-charge shall be measured in 50 kg bags. Use of bulk cement will be permitted only with the approval of the Engineer-in-charge. Changing of brands of type of cement within the same structure will not be permitted.

Joint account of cement consumed at site for every day for items of work carried shall be maintained by the Contractor for verification to ensure effective control on quality of work.

- 3) A certified report attesting to the conforming of the cement to IS: specifications by the cement manufacturer's chemist shall be furnished to the Engineer-in-charge, if demanded. Should at any time the Engineer-in-charge have reasons to consider that any cement is defective, then irrespective of its origin and / or manufacturers test certificate, such cement shall be tested immediately at a National Test Laboratory / Departmental Laboratory or such approved laboratory, and until the results of such tests are found satisfactory, it shall not be used in any work. Cement held in store for a period of ninety (90) days or longer shall be retested before use in work.
- 4) The contractor shall make his own arrangements for the storage of adequate quantity of cement. If supplies are arranged by the Department, cement will be issued in quantities to cover work requirements of one month or more, as deemed fit by the Engineer-in-charge and it will be the responsibility of the contractor to ensure adequate and proper storage, which will provide complete protection from dampness, contamination and minimize caking and false set. Cement bags shall be stored in a dry enclosed shed (storage under tarpaulins will not be permitted), well away from the outer walls and insulated from the floor to avoid contact with moisture from ground and so arranged as to provide ready access. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. The storage arrangements shall be such that there is no dead storage. No more than 12 bags shall be stacked in any tier. The storage arrangement shall be got approved by the Engineer-in-charge. Consignments in cement shall be stored as received and shall be consumed in the order of their delivery.

4.4.4.2 Reinforcement

- 1) Steel reinforcement bars for concrete shall be either cold twisted high yield strength deformed bars conforming to IS 1786 or TMT bars with strength requirements conforming to IS 1786 manufactured by SAIL, TATA or RINIL. The grade of steel shall be as shown in the drawings, or as mentioned in the schedule of items or as directed by Engineer-in-charge.
- 2) Storage: Steel reinforcement shall be stored in such a manner that they are not in direct contact with ground but stacked on top of an arrangement of timbers sleepers or the like. Bars of different classifications and sizes shall be stored separately. In cases of long storage or in coastal areas, reinforcement shall be stacked above ground level by at least 15 cm, and a coat of cement wash shall be given to prevent scaling and rusting at no extra cost to the owner. Fabricated reinforcement shall be carefully stored to prevent, distortion, corrosion and deteriorations.
- 3) Contractor shall submit the manufacturers test certificate for steel. Random tests on steel supplied by contractor may be performed if the Engineer-in-charge so desires as per relevant Indian Standards. All costs incidental to such tests shall be at contractor's expense. Steel not conforming to specifications shall be rejected.

4.4.4.3 Water

- 1) Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water is generally considered satisfactory for mixing concrete. The maximum permissible values of impurities shall be as given in clause no. 5.4 of IS: 456.
- 2) In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time tests specified in IS: 456.
- 3) Average 28 days compressive strength of at least three 150 mm concrete cubes prepared with water proposed to be used shall not be less than 90% of the average strength of three similar

concrete cubes -prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with IS: 456.

- 4) The initial setting time of a concrete test block made with the appropriate cement and the water proposed to be used shall not be less than 30 minutes and shall not differ by + 30 minutes from the initial setting time of control test block prepared with the same cement and distilled water. The test shall be carried out as per IS: 4031.
- 5) Where concrete, made from water, proposed to be used does not satisfy the above requirements and/or contains an excess of acid, alkali, sugar, salt or other deleterious, substances, then the Engineer-in-charge may refuse to permit its use. Sea water shall not be used for curing and mixing in concrete.
- 6) Testing of water shall be done at intervals indicated by Engineer-in-charge. The sample of water taken for testing shall be typical of the water proposed to be used for concreting, due account being paid to seasonal variation. The samples shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water. The following concentrations represent the maximum permissible values.
 - a. Limits of acidity: To neutralize 200 ml sample of water, using phenolphthalein as an indicator, it should not require more than 2 ml of 0.1 normal NaOH. The details of test shall be as given in IS: 3025 (Part 22).
 - b. Limits of alkalinity: To neutralize 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10ml of 0.1 normal HCL. The details of test shall be as given in IS: 3025 (Part 23).
 - c. Percentage of solids shall not exceed the following :

Table 4.8: Percentage of solids

| solids | % Percentage |
|---------------------------------|---|
| Organic | 0.02% (200 mg/litre) |
| Inorganic | 0.30% (3000 mg/litre) |
| Sulphates (as SO ₄) | 0.05% (500 mg/litre) |
| Alkali chlorides (as cl) | 0.20% (2000 mg/litre) for plain concrete work & 0.10% (1000 mg/litre) for reinforced concrete work |
| Suspended matter | 0.20% (2000 mg/litre) |

4.4.4.4 Admixtures

Admixtures in concrete for promoting workability, entraining air for similar purposes may be used only after the written permission from the Engineer-in-charge is obtained. These shall be free from injurious amount of chloride, etc. Addition of admixtures should not reduce the specified strength or durability of concrete and should not have detrimental effect on reinforcement. The admixtures shall conform to IS: 9103 and shall be of proven make and from a reputed manufacturer. Calcium chloride as accelerating admixture is not permitted to be used other than in mass concrete works. The Contractor shall produce latest test results carried out at approved Government Test Houses for the approval of the Engineer-in-charge, before use.

4.4.4.5 Embedded parts

- 1) Steel for light structural work and for preparation of inserts and embedment shall conform to IS: 2062.

- 2) Bolts to be embedded in concrete shall, unless otherwise detailed in drawings, conform to IS: 5624. Material for bolts, shall, unless otherwise mentioned in drawings or the schedule of items, be corrosive resistant/coated steel conforming to IS: 2062.
- 3) Nuts and locknuts shall conform to IS: 1363 (Part 1 to 3) for diameters 6 to 39 and IS 3138 for Hexagon Bolts and Nuts (M-42 to M-150)".
- 4) Plain washers shall conform to IS: 2016 and spring washers shall conform to IS: 3063.
- 5) Steel pipe sleeves shall conform to Medium class of IS: 1161.

4.4.4.6 Filling material

- 1) General: Filling material shall conform to what is shown in drawing, described in the Schedule of Items or otherwise directed by the Engineer-in-charge. Earth or sand for filling under floors shall correspond to those described elsewhere in these specifications.
- 2) Mastic Bitumen: Mastic Bitumen shall conform to IS: 3037 or IS: 5871 as appropriate.
- 3) Flexible Boards: Flexible boards for use in expansion joints shall correspond to the description given in drawing or the Schedule of Items or the instruction of Engineer-in-charge.

4.4.5 Grades of Concrete

- 1) Concrete shall be in grades as tabulated below:

Table 4.9: Grades of Concrete

| Grade Designation | Specified Characteristic compressive strength at 28 days (N/mm ²) |
|-------------------|---|
| M10 | 10 |
| M15 | 15 |
| M20 | 20 |
| M25 | 25 |
| M30 | 30 |
| M35 | 35 |
| M40 | 40 |

- 2) The characteristic strength is defined as the strength of material below which not more than 5% of the test results are expected to fall.
- 3) In the designation of a concrete mix, latter M refers to the mix and the number to the specified characteristic compressive strength of 15 cm cubes at 28 days.
- 4) Minimum grades of concrete to be followed shall be as per guidelines of Table 5 of IS: 456 unless otherwise mentioned in the drawings/ schedule of items. Concrete leaner than those given above may be used for lean concrete, mud mat, or for foundations of masonry walls.

4.4.5.1 Concrete mix proportioning

- 1) Concrete mix proportions shall be selected based on the requirements of workability, strength, and durability. The proportions of cement, aggregates and water shall be determined either by designing the mix or by adopting nominal mix. Design mix concrete is designated as M20, M25, etc. and Nominal mix Concrete is designated as 1:2:4, 1:3:6, 1:4:8 or 1:5:10. The proportions referred to is by weight (mass) and not by volume. Use of volumetric mix concrete shall not be permitted.
- 2) Workability of concrete

- a) Workability of fresh concrete is mainly governed by placing conditions and compaction. The degree of workability necessary to allow the concrete to be well compacted and to be worked into the corners of formwork and around the reinforcement shall be as stipulated under clause no. 7.0 of IS: 456.
- b) The workability of concrete shall be checked at frequent intervals. The workability of concrete measured in accordance with IS:1199 for every sample taken for testing shall be recorded with the corresponding cube test result.
- c) Notwithstanding the above, the slump to be maintained for work in progress shall be as per directions of the Engineer-in-charge.
- d) Engineer-in-charge may permit use of plasticizers for improving workability. Use of certain other admixtures such as water proofing compounds also have an effect on workability and shall be considered during mix design.

4.4.5.2 Durability of concrete:

- a) The durability of concrete is mainly governed by the permeability of concrete. Dense concrete is least permeable. In addition, cement content and water-cement ration and compaction of concrete play a major role in producing impermeable concrete.
- b) Durability requirements are decided depending on the exposure conditions as stipulated in clause 8.2 of IS 456 is to be taken into account while designing the mix. For given aggregates, the cement content should be sufficient to make sufficiently low water cement ratio and table 5 of IS: 456-2000 shall be taken as guideline for durability considerations.
- c) Stipulations of minimum cement content and limiting water cement ratio should be considered during design of mix.

4.4.5.3 Design Mix Concrete

- a) Design Mix Concrete shall be used for all reinforced concrete works. The mix proportions shall be as per mix design, designed for each grade of concrete, workability and durability requirements. The characteristic strength shall not be less than the appropriate values given in Table-2 of IS: 456:2000.
- b) In proportioning concrete, the quantity of both cement and aggregates shall be determined by mass. Water shall be either measured by volume in calibrated tanks or weighed. All measuring equipment at site shall be maintained in a clean and serviceable condition, and their accuracy shall be periodically checked.
- c) To keep the water-cement ratio to the designed value, allowance shall be made for the moisture contents in both fine and coarse aggregates and determination of the same in accordance with IS: 2386 Part (III) shall be made as frequently as directed by the Engineer-in-charge.
- d) With the permission of the Engineer-in-charge, for any of the above mentioned grades of concrete, if the water quantity has to be increased, proportionately cement quantity shall also be increased, to keep the ratio of water to Cement same as adopted in mix design for the corresponding grade of concrete. The extra cement required on account of this shall be at no extra cost to Owner.
- e) At the beginning of the project, if so desired by the contractor, he/they may be allowed by the Engineer-in-charge, till the designed mix is obtained, to carry out the reinforced concrete work in foundation and plinth as per equivalent nominal mix against the specified design mix concrete as per IS codes. However, all other specification for design mix shall govern for nominal mix also and nothing extra shall be paid for use of extra cement or else on this account whether the cement is supplied by the Owner or procured by the contractor.

4.4.5.4 Mix design: Mix design shall generally be done at any of the approved laboratory.

The following is the guideline to be followed:

- a) IS: 10262 shall be followed as general guidance for mix design. The minimum value of target strength of design mix of various grades of concrete shall be as per clause no. 9.2 of IS: 456. However, the Engineer-in-charge may allow change in target strength values based on adequate numbers of works test results.
- b) Minimum cement content from durability consideration for different exposures and sulphate attack shall be as given in Table-4 and 5 of IS: 456. In case higher value is obtained from strength consideration, same shall be provided.
- c) Preliminary tests/trial mix, as specified or as required by the Engineer-in-charge, shall be carried out sufficiently ahead of the actual commencement of the work with different grades of concrete made from representative samples of aggregates and cement expected to be used on the works. These tests are to be conducted to arrive at the grading of aggregates, water-cement ratio, workability and the quantity of cement required to give Preliminary (target) compressive strengths as specified in of IS 456.
- d) At least four trial mixes are to be made and minimum six test cubes taken for each trial mix noting the slump for each type of mix. The cubes shall then be properly cured and three cubes for each mix shall be tested in a laboratory (approved by the Engineer-in-charge) at 7 days and others at 28 days for obtaining the compressive strength. The test reports shall be submitted to the Engineer-in-charge. The design mix particulars shall indicate, with the help of graphs and curves etc. the extent of variation in the grading of aggregates which can be allowed. While designing mixes, over wet mixes shall be avoided. For the structures, where assessment of early strength is required the concrete cubes shall also be tested for early age strength at 1 day and 3 days for establishing the values.
- e) The Contractor shall submit the test reports of mix design to the Engineer-in-charge for his review, indicating design criteria, analysis and proportioning of materials, etc. On the basis of the above test reports, a mix proportion by mass and the water-cement ratio, shall be determined by the Contractor such that concrete prepared with this mix will yield the desired characteristic strength and shall have suitable workability. The mix design to be adopted on the works shall be subject to the approval of the Engineer-in-charge. The proportions, once decided for different grades of concrete, shall be adhered to, during all concreting operations as long as the quality of the materials does not change. If, however, at any time, the quality of materials being used has changed from those for Preliminary mix design, or there is a change either in the required strength of concrete, or water-cement ratio or workability, the Contractor shall have to make similar trial mixes and Preliminary tests to ascertain the revised mix proportions and water-cement ratio to be used for obtaining the desired strength and consistency.
- f) The entire cost of all the trial mixes including all the preparatory works for trial mixes, preparation of test cubes and their testing shall be borne by the Contractor.

4.4.5.5 Nominal mix Concrete

- a) Nominal mix concrete shall be used only for plain cement concrete works and where shown on drawings or specifically allowed by the Engineer-in-charge. Such concrete shall not require preparation of trial mixes and all such concrete shall be mixed in a mechanical mixer. Proportions for nominal mix concrete shall be according to Table-9 of IS: 456.
- b) The proportion of mix may be slightly adjusted within limits, keeping the total value of aggregates to a given quantity of cement constant to suit the sieve analysis of both the aggregates. Cement shall on no account be measured by volume, but it shall always be used

directly from the bags (i.e. 50 kg/bag). The proportion of cement, sand, aggregate and water for concrete of proportion 1:5:10, 1:4:8, 1:3:6 & 1:2:4 by volume shall generally consist of quantities as given below:

Table 4.10: Material quantities by volume

| Proportion of Ingredients | Quantity of materials used per bag of cement | | | | |
|---------------------------|--|-----------------------|------------------|-------------------------------------|----------|
| | Cement | Fine aggregate (sand) | Coarse aggregate | Total of fine and coarse aggregates | Water |
| 1:5:10 | 1 | 170 ltrs. | 340 Ltrs. | 800 kgs. | 60 ltrs. |
| 1:4:8 | 1 | 130 ltrs. | 272 ltrs. | 625 kgs. | 45 ltrs. |
| 1:3:6 | 1 | 102 ltrs. | 204 ltrs. | 480 kgs. | 34 ltrs. |
| 1:2:4 | 1 | 68 ltrs. | 136 ltrs. | 350 kgs. | 32 ltrs. |

- c) The quantity of water used shall be such as to produce concrete of consistency required by the particular class of work and shall be decided by the use of slump cone. Sufficient care should be taken to see that no excess quantity of water is used. The final proportion of the aggregate and quantity of water shall be decided by the Engineer-in-charge on the basis of test in each case. For each class of work shall in general be as follows:

Table 4.11: Max. Slump

| Type of concrete | Max slump (in mm) |
|---|-------------------|
| Mass concrete | 50 |
| Concrete below water proofing treatment | 50 |
| Coping | 25 |
| Floor paving | 50 |

- d) As a general guidance the Nominal mix concrete of mix proportion 1:5:10 shall approximately correspond to grade M5, 1:4:8 shall correspond to grade M7.5, 1:3:6 to grade M10 and 1:2:4 to grade M15 of IS: 456.
- e) If fine aggregates are moist, the amount of surface water shall be determined. Also an allowance shall be made for bulking in case of volume batching, in accordance with IS: 2386 (Part-III). Allowance shall also be made for surface water present in the aggregates, when computing the water requirement. In the absence of exact data the amount of surface water may be estimated as follows:

Table 4.12: Surface Water

| Aggregate | Approximate quantity of surface water | |
|------------------------------|---------------------------------------|--------|
| | Percentage by mass | l/ cum |
| Very wet sand | 7.5 | 120 |
| Moderately wet sand | 5.0 | 80 |
| Moist sand | 2.5 | 40 |
| Moist gravel or crushed rock | 1.25-2.5 | 20-40 |

- f) If nominal mix Concrete made in accordance with specified proportions does not yield the specified strength of the corresponding grade and fails to satisfy the requirements of “acceptance criteria for concrete” as specified in IS: 456, such concrete shall be treated in the following manner:
- i. In case the Engineer-in-charge is satisfied that lower strength of concrete is attributed to material and workmanship of the Engineer-in-charge, then such concrete shall be

replaced by concrete of specified strength. The Engineer-in-charge may, however, also accept such lower strength concrete but such lower strength concrete shall be classified as belonging to the appropriate lower grade proportion.

- ii. In case the Engineer-in-charge is satisfied that lower strength of concrete is not attributable to the Contractor, he may direct in writing to increase the cement content to obtain specified strength at no extra cost to Owner. The use of richer mix shall be continued until the Engineer-in-charge instructs otherwise.
- g) Nominal mix proportion shall not be classified as higher grade proportion either on the ground that the test strengths are higher than the minimum specified or in the case where the Engineer-in-charge directs use of additional cement over the quantity specified for the particular mix proportion to achieve the minimum specified strength.
- h) However, only in some exceptional cases including concreting in some isolated areas, the Engineer-in-charge may allow the quantity of aggregates to be determined by an equivalent volume basis after the relationship between weight and volume is well established by trials and the same shall be verified frequently.

4.4.6 Preparatory Works

4.4.6.1 Preparation of earth for foundation

- 1) Earth surface on which direct placement of concrete is to be placed shall be rammed and consolidated as directed by the Engineer-in-charge such that it does not crumble and get mixed with concrete during or after placement. If the foundation is quite wet, the same shall be kept dry and then sufficiently consolidated, if necessary, a thin top layer of the wet soil shall be removed and replaced by sand or other suitable materials as directed by the Engineer-in-charge without any extra cost to the Owner.
- 2) All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft, yielding soils shall be removed and replaced with suitable earth and well compacted as directed by the Engineer-in-charge. Where specified, lean concrete shall be provided in the earth stratum for receiving concrete. The surface of absorptive soil against which concrete is to be placed shall be moistened thoroughly so that no moisture will be drawn from the freshly placed concrete.
- 3) The earth surface over which concrete is to be placed direct, shall not be kept
- 4) abandoned at the specified level and concrete shall be placed immediately following the final preparation of the formation otherwise suitable measures shall be taken, as directed by the Engineer-in-charge without any extra cost to the Owner.
- 5) In case the drawings indicate hard core below the blinding concrete, the same shall be provided as per relevant specifications.

4.4.6.2 Preparation of rock strata for foundation

- 1) To provide tight bond with rock foundation concrete shall not be deposited on large sloping rock surface. Where required by Engineer-in-charge or as indicated on the plans, the rock shall be cut to form rough steps or benches to provide roughness or a more suitable bearing surface.
- 2) Rock stratum shall be prepared by picking, barring, wedging and similar methods which will leave the rock in an entirely sound and un shattered condition.
- 3) Shortly before concrete is placed, the rock surface shall be cleaned with high pressure water and air jet even though it may have been previously cleaned in that manner.

- 4) Prior to placing concrete, the rock surface shall be kept wet for a period of 2 to 4 hours unless otherwise directed by the Engineer-in-charge.
- 5) Before placing concrete on rock surfaces, all water shall be removed from depressions to permit through inspection and proper bonding of the concrete to the rock.

4.4.6.3 Preparation of concrete surfaces

- 1) Preparation of concrete surface upon which additional concrete is to be placed later, shall preferably be done by scarifying and cleaning while the concrete is between its initial and final set. This method shall be used wherever practicable and shall consist or cutting the surface with picks and stiff brooms and by use of an approved combination of air and water jet as directed by Engineer-in-charge. Great care shall be taken in performing this work to avoid removal of too much mortar and the weakening of the surface by loosening of aggregate. When it is not practicable to follow the above method, it will be necessary to employ air tools to remove laitance and roughen the surface.
- 2) The final resulting surface shall be a pitted surface, from which all dirt, unsound concrete, laitance and glazed mortar have been removed.

4.4.6.4 Preparation of construction joints

- 1) All such joints shall have continuous square bond grooves to produce a substantial and water-tight key. Where the placement of concrete has to be resumed on a surface which has hardened, it shall be roughened, cleaned by wire or bristle brushing, compressed air, water jet etc., and thoroughly wetted.
- 2) For vertical construction joint, neat cement slurry shall be applied on the surface immediate before the placement of concrete.
- 3) For horizontal joints, the surface shall be covered with a layer of freshly mixed mortar about 10 mm thick composed of cement and sand in the same proportion as the cement and sand in the concrete mix and applied immediately before placing of the concrete. On this surface (i.e. on the surface of joints) a layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against old work, particular attention being paid to corners and close spots. To ensure water tightness, care shall be taken to put concrete properly against the old surface.
- 4) In placing concrete against formed construction joints, the surfaces of the joints, where accessible, shall be coated thoroughly with the specified bed joint bonding mortar immediately before they are covered with concrete or by scrubbing with wire brooms, dipped into the fresh concrete. Where it is impracticable to apply such a mortar coating, special precautions shall be taken to ensure that the new concrete is brought into intimate contact with the surface of the joint by carefully puddling and spading with aid of vibrators and suitable tools.

4.4.6.5 Bonding mortar

- 1) After rock or concrete surfaces upon which new concrete is to be placed have been scarified, cleaned and wetted as specified herein. It shall receive a bonding treatment, immediately before placement of the concrete.
- 2) The bonding medium shall be a coat of cement sand mortar. The mortar shall have the same cement sand proportion as the concrete which shall be placed on it. The water cement ratio shall be determined by placing conditions and as approved by Engineer-in-charge.

- 3) Bonding mortar shall be placed in sufficient quantity to completely cover the surface about 10mm thick for rock surface and about 5mm thick for concrete surfaces. It shall be brushed or broomed over the surface and worked thoroughly into all cracks, crevices and depressions. Accumulations or puddles of mortar shall not be allowed to settle in depressions and shall be brushed out to a satisfactory degree as determined by Engineer-in-charge.
- 4) Mortar shall be placed at such a rate that it can be brushed over the surface just in advance of placement of concrete only as much area shall be covered with mortar as can be covered with concrete before initial set in the mortar takes place. The amount of mortar that will be permitted to be placed at any one time, or the area which is to cover, shall be in accordance with directions of Engineer-in-charge.
- 5) Staging shall be checked for its soundness as a whole and for adequacy of the joints and its foundations. Formwork joints shall be inspected for soundness of connections. All joints shall be either vertical or horizontal and shall be such as to avoid loss of liquid through the formwork.

4.4.7 Formwork and Staging

- 1) The Contractor shall supply, fabricate, erect and dismantle (after use) all staging that is required for all activities covered under the specifications. He shall prepare the scheme and submit along with the supporting calculations for approval of the Engineer-in-charge.
- 2) Prior to construction of form work for any item where soil will not act as bottom form, approval shall be obtained from Engineer-in-charge as to the suitability of the soil.

4.4.7.1 Materials

- 1) Formwork shall compose of steel, best quality wood or non-absorbent -type plywood. Timber shall be free from significant knots and shall be of medium grain as far as possible and hard woods shall be used as caps and wedges under or over posts. Timber shall be well seasoned, free from sap, shakes, worm holes, warps or other surface defects and shall have smooth finish.
- 2) Staging, unless specified otherwise, shall generally be of mild steel tubes, steel beams and channels etc. or strong sal ballies 150 mm in diameter or above. Bamboos, small diameter ballies etc., shall not be used unless approved by the Engineer-in-charge in specific cases.

4.4.7.2 Classification of formwork

- 1) Ordinary: This shall be used in places where ordinary surface finish is required and shall compose of steel and/or approved good quality seasoned wood. Plywood shuttering can also be used by the Contractor.
- 2) Plywood: This shall be used in exposed surfaces as shown on drawings or as directed by the Engineer-in-charge where a specially, good finish is required. Such surfaces shall be formed using approved brand of heavy quality water resistant plywood to produce a perfectly leveled, uniform and smooth surface. Reuse of such forms may be permitted only after inspection and approval by the Engineer-in-charge, for each such reuse.

4.4.7.3 Quality of formwork and staging

- 1) Formwork shall consist of all materials required for forming the boxing to pour concrete, including steel/wood/plywood forms, ties, anchors, hangers, inserts, etc. Formwork shall be so constructed that vertical and horizontal adjustments can be made as required. The design

- and Consulting of formwork including staging as well as its erection and dismantling shall be the responsibility of the Contractor.
- 2) The staging shall be true and rigid and thoroughly braced in both directions as well as cross braced, strutted and propped such that it will not deform unduly under weight of concrete and other loads due to men, equipment, etc. Vertical members or props should not be supported on an un-propped lower suspended floor or beam unless it is ensured by the Contractor that the lower floor or beam can safely carry the loads. No propping shall take place until the Engineer-in-charge's approval has been given to the Contractor's scheme submitted along with supporting calculations.
 - 3) The forms and staging shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as liquid as well as anticipated working loads. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration, without appreciable deflection, bulging, distortion or loosening of its components.
 - 4) The joints in the formwork shall be sufficiently tight to prevent any leakage of mortar. The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete, must be brought to the notice of the Engineer-in-charge immediately and rectified as directed by him.
 - 5) To achieve the desired rigidity, ample studs, braces, bolts, spacer blocks, wires, clamps, ties, straps, shores, etc. shall be used to hold the form in proper position without undue distortion. These shall be approved by the Engineer-in-charge but they must in no way impair the strength of concrete or leave stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. Bolts passing completely through liquid and or earth retaining walls/slabs, basement walls etc. for the purpose of securing and aligning the formwork, shall not be permitted.
 - 6) For exposed interior and exterior concrete surfaces of beams and columns, plywood: other approved forms thoroughly cleaned and tied together with approved corrosion resistant devices shall be used. Rigid care shall be exercised ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so.
 - 7) Beveled strips 25x25 mm shall be provided to form angles and in corners of columns and beam boxes for chamfering of corners if shown on drawings or directed by the Engineer-in-charge. Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places, where these are necessary and as may be directed by the Engineer-in-charge. The temporary openings shall be so formed that they can be conveniently closed rigidly when required and must not leave any mark on the concrete.
 - 8) If it is so desired by the Engineer-in-charge, the Contractor shall prepare, before commencement of the actual work, designs and drawings for formwork and staging and get them approved by the Engineer-in-charge. Formwork shall -be so designed and positioned that it can be removed without damage to concrete.
 - 9) The Contractor shall maintain necessary camber in centering for all floor slabs and beams in all spanning directions, so as to offset the deflection and assume correct shape. The camber shall have the crown of not less than 8 mm for every 5 meters span unless otherwise shown on the drawings. For cantilever, camber at free end shall be 1 in 100.
 - 10) The Contractor shall provide the shuttering for complete stretch of work up to expansion joints for the structures like shell, folded plate etc. and/or as directed by the Engineer-in-charge.

4.4.7.4 Cleaning and treatment of forms

- 1) All forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before these are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Wire brushes, brooms, compressed air jet and/or water jet etc. shall be kept handy for cleaning, if directed by the Engineer-in-charge.
- 2) Before formwork is placed in position, the form surfaces that will be in contact with concrete shall be treated with approved non-staining oil or composition which is insoluble in water and not injurious to concrete. Care shall be taken that the oil or composition does not come in contact with reinforcing steel or stain the concrete surfaces. Burnt oil shall not be allowed to be used specially where the concrete surface will require finishing and/or plaster.

4.4.7.5 Removal of forms

- 1) The Contractor shall begin the removal of formwork only after approval of the Engineer-in-charge. He shall place on record the dates on which the concrete is placed in different parts of the work and the dates of the removal of formwork there from. This record shall be checked and countersigned by the Engineer-in-charge. The Contractor shall be responsible for the safe removal of formwork but the Engineer-in-charge may delay the time of removal if he considers it necessary. Any work showing signs of damage through premature removal of formwork, shall be entirely removed and reconstructed by the Contractor at no extra Cost to Owner.
- 2) The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls may be removed first, leaving the beam bottoms and their supports in position. Re-propping of beams shall not be done except with the approval of the Engineer-in-charge. Formwork for columns and walls at each stage of concreting shall be erected only up to the particular lift of construction. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment of the formwork and to allow it to be removed gradually without jerking the concrete.
- 3) Forms of various types of structural components shall, under normal circumstances, not be removed before the minimum periods specified in Cl. 11.3 of IS: 456, which shall also be subject to the approval of the Engineer-in-charge. However, in any case formwork shall not be struck until the concrete has reached a strength, at least twice that of the stress to which the concrete may be subjected -to at the time of removal of forms. The removal of form work shall generally be as per the following guidelines:

Table 4.13: Removal form work

| Part of Structure | Earliest Concrete age at stripping | |
|---|--|------------------------------------|
| | Ordinary Portland cement concrete | Portland Pozzolona cement concrete |
| Walls, columns and vertical sides of beams | 16 to 24 hours or as directed by the Engineer-in-charge. | 3 days |
| Slabs (Props left under) | 3 days | 7 days |
| Beam soffits (Props left under) | 7 days | 10 days |
| Removal of props to slabs Spanning up to 4.5 m. | 7 days | 10 days |
| Spanning over 4.5 m. | 14 days | 14 days |
| Removal of props to beams and arches Spanning up to 6 m. | 14 days 21 days | 14 days 21 days |

| Part of Structure | Earliest Concrete age at stripping | |
|-----------------------|------------------------------------|------------------------------------|
| | Ordinary Portland cement concrete | Portland Pozzolona cement concrete |
| ii)Spanning over 6 m. | | |
| Cantilever slabs | 14 days | 14 days |

- 4) The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab, beam or arch as the case may be together with any live load likely to occur during curing or further construction.
- 5) Where the shape of the element is such that the formwork has reentrant angles, the formwork shall be removed as soon as possible after the concrete has set, to avoid shrinkage cracking occurring due to the restraint imposed.
- 6) Contractor shall record on the drawings or a special register, the date up in which the concrete is placed in each part of the work and the date on which the shuttering is removed there from.
- 7) In case of cantilever slabs, the removal of forms shall begin from the outer edge and proceed towards the support, where as in the case of slabs supported on two/four sides, the removal of forms shall begin from center to supports.
- 8) The formwork shall be so made as to produce a finished concrete, true to shape, lines, plumb and to dimensions as shown on the drawings. The Engineer-in-charge may call for finished work at any time to set standards of workmanship. Once approved, these will become the accepted Sample.
- 9) In case PPC/PSC is used instead of OPC, the removal of shuttering/ support shall be after 50% more time from that being applied for OPC, unless otherwise permitted by the Engineer-in-charge. For concrete temperature above 40°C, stripping time shall be increased.
- 10) In case of special structures, such as shells, folded plates, etc., the sequence of removal of forms shall be as per drawings or as directed by the Engineer-in-charge.

4.4.7.6 Re-use of forms

- 1) Before reuse, all forms shall be thoroughly scraped, cleaned, all nails and adhering substances removed, holes and leaks satisfactorily plugged, joints examined and where necessary repaired and inside surfaces treated as specified herein before. Formwork shall not be used/re-used, if declared unfit or unserviceable by the Engineer-in-charge.

4.4.7.7 Dimensional Tolerance for Formwork

- 1) Tolerances is a specified permissible variation from lines, grade or dimensions given in drawings. Unless otherwise specified, the following tolerances will be permitted.

Table 4.14: Dimensional Tolerance for Formwork

| Tolerances for R.C. Buildings | | |
|-------------------------------|---|---|
| 1 | Variation from the plumb | |
| | In the line and surfaces of columns, piers, walls and in buttresses | 5 mm per 2.5 m, but not more than 25 mm |
| | For exposed corner columns and other conspicuous lines | |
| | In any bay or 5 m. maximum | (+/-) 5 mm |
| | In 10 m. or more | (+/-) 8 mm. |

| Tolerances for R.C. Buildings | |
|-------------------------------|--|
| 2 | Variation from the level or from the grades indicated on the drawings In slab soffits, ceilings, beam soffits and in arrises. |
| | In 2.5 m (+/-) 5 mm. |
| | In any bay or 5 m. maximum (+/-) 8 mm |
| | In 10 m. or more (+/-)15mm |
| 3 | For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines |
| | In any bay or 5 m. maximum (+/-)15mm |
| | In 10 m. or more (+/-)10mm |
| 4 | Variation of the linear building lines from established position in plan and related position of columns, walls and partitions |
| | In any bay or 5 m. maximum (+/-) 10 mm |
| | In 10 m. or more (+/-) 20 mm. |
| 5 | Variations in the sizes and locations of sleeves, openings in walls and floors except in the case of and for anchor bolts (+/-) 5 mm |
| 6 | Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls (+)10mm / (-)5 mm |
| 7 | Footings |
| | variation in dimensions in plan (+) 50 mm / (-) 5 mm |
| | Misplacement of concentricity 2% of footing within the direction of misplacement but not more than 50 mm. |
| | Reduction in thickness (-) 5% of specified thicknesssubject to maximum of 50 mm. |
| 8 | Variation in steps |
| | In a flight of stairs |
| | Rise (+/-) 3.0 mm |
| | Tread (+/-) 5.0 mm |
| | In consecutive steps |
| | Rise (+/-) 1.5 mm |
| Treed (+/-) 3 mm | |

Table 4.15: Dimensional Tolerance for other concrete Structure

| Tolerance in other Concrete Structure | |
|---------------------------------------|---|
| All structures | |
| 1 | Variation of the constructed linear out line from established position in plan |
| | In 5 m (+/-) 10 mm. |
| | In 10 m. or more (+/-) 15 mm. |
| 2 | Variation of dimensions to individual structure features from established positions in plan |
| | In 20m. or more (+/-) 25 mm. |
| | In buried constructions (+/-) 150 mm |
| 3 | Variation from plumb, from specifies batter or from cured surfaces of all structures |
| | In 2.5 m (+/-) 10 mm. |
| | In 5.0 m (+/-) 15 mm. |
| | In 10.0 m. or more : (+/-) 25 mm |

| Tolerance in other Concrete Structure | | |
|---------------------------------------|---|-------------------------------|
| | In buried constructions | (+/-) Twice the above limits. |
| 4 | Variation from level or grade indicated on drawings in slabs, beams, soffits, horizontal grooves and visible arises | |
| | In 2.5 m | (+/-) 5 mm. |
| | In 7.5 m. or more | (+/-) 10 mm |
| | In buried constructions | (+/-) Twice the above limits |
| 5 | Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members | (+) 10mm./(-) 5 mm. |
| 6 | Variation in the thickness of slabs, walls, arch sections and similar members | (+) 10 mm./(-) 5 mm |

Table 4.16: Tolerance for Footings for columns, piers, walls, buttresses and similar members

| Footings for columns, piers, walls, buttresses and similar members | | |
|---|---------------------------------|--|
| 1 | Variation of dimensions in plan | (+) 50 mm./(-) 10 mm |
| 2 | Misplacement or eccentricity | 2% of footing within the direction of misplacement but not more than 50 mm |
| 3 | Reduction in thickness | 5% of specified thickness subject to a maximum of 50 mm. |
| In case of inclined surfaces, the deviation in the alignment of inclined surfaces, shall not exceed 3 mm with reference to the theoretical alignment, for a length of 1000 mm measured vertically, subject to a maximum of 10 mm. | | |

Source: [Insert source text here](#)

4.4.8 Reinforcement Placement

All reinforcement for concrete works shall be provided as per the drawings or as indicated in the schedule of items. The Contractor shall prepare and furnish to the Engineer-in-charge, bar bending schedules for all RCC works for his review and approval. No work shall commence without the approval of the bar bending schedules by the Engineer-in-charge in writing.

The contractor shall plan the procurement of steel well in advance and complete the surface treatment, if specified in a planned manner. In case of non-availability of certain diameters Engineer-in-charge may permit substitution of bars. However such substitutions shall be the last resort and shall not be a reason for delay. The Contractor shall modify the bar bending schedule, and specific approvals of Engineer-in-charge obtained.

All bars shall be thoroughly cleaned before being fabricated. Pitted and defective bars shall not be used. All steel for reinforcement shall be free from loose scales, rust coatings, oil, grease, paint or other harmful matters immediately before placing the concrete. To ensure this, reinforcements with rust coatings shall be cleaned thoroughly before bending/placement of the same.

4.4.8.1 Bending and placing

- 1) Bending shall be as under:
 - a) Reinforcing bars supplied bent or in coils, shall be straightened before these are cut to size. Straightening of bars shall be done in cold and without damaging the bars. This is to be considered as a part of reinforcement bending and fabrication work.

- b) Unless otherwise specified, reinforcing steel shall be bent in accordance with procedure specified in IS: 2502 and/or as approved by the Engineer-in-charge. Bends and shapes shall comply strictly with the dimensions shown on the approved bar bending schedules and they shall be rechecked by the Contractor before bending and he shall be entirely responsible for their correctness. Bars correctly bent, shall only be used. Unless specified otherwise or directed by the Engineer-in-charge, the detailing of reinforcement shall be in accordance with IS: 5525 and SP: 34.
 - c) Bending of longitudinal bars for laps shall be done with 1:6 slopes. The ends of column bars at the top of columns shall be bent horizontally at the just below the beam bars permitting full development length of beam bars. The beam column junction reinforcement shall be tied by U-stirrups to develop full moment connection with good confined concrete.
 - d) No reinforcement shall be bent when in position in the work without approval of the Engineer-in-charge, whether or not it is partially embedded in concrete. Where reinforcement bars are bent aside, at construction joints and afterwards bent back into their original positions, care shall be taken to ensure that, at no time, the radius of the bend is less than 4 times the bar diameters for plain mild steel or 6 times the bar diameters for deformed bars. Care shall also be taken while bending back bars, to ensure that the concrete around the bar is not damaged.
 - e) Welding of bars to obtain continuity shall not be allowed, particularly for cold twisted bars, unless specifically approved by the Engineer-in-charge. If welding is approved, the work shall be carried out as per IS: 2751 and IS: 9417, according to the best practice and as directed by the Engineer-in-charge.
- 2) Placing in Position shall be as under:
- a) Spacing of bars shall be as indicated in the drawings. Minimum distance between reinforcing bars shall be in accordance with clause 26.3.2 of IS: 456.
 - b) All reinforcement shall be accurately fixed and maintained in position as shown on the drawings by such approved means as steel chairs, and/or concrete spacer blocks as per IS: 2502. Bars intended to be in contact at crossing points, shall be securely bound together at all such points by two numbers annealed steel wire of 0.9 mm to 1.6 mm size conforming to IS: 280 in such a manner that they do not slip over each other at the time of fixing & concreting. The tying of bars shall be in crisscross manner of bars shall be maintained by provision of spacer bars. These shall be so spaced that the main bars do not sag perceptively between adjacent spacers. Bundled bars shall be provided wherever shown on the drawing to facilitate concreting. Location of laps and development lengths shall be as indicated on the drawings or as directed by Engineer-in-charge.
 - c) The placing of reinforcement shall be completed well in advance of concrete pouring. The reinforcement shall be checked by the Engineer-in-charge, for accuracy of placement and cleanliness. Necessary corrections, as directed by the Engineer-in-charge shall be carried out. Care shall be taken to ensure that projecting ends of ties and other embedded metal do not encroach into the concrete cover. Where concrete blocks are used for ensuring the cover and positioning of reinforcement, these shall be made of mortar 1:2 (1 cement: 2 sand) by volume and cured for at least seven days. The sizes and locations of the concrete blocks shall be approved by the Engineer-in-charge. The 28 days crushing strength of cover blocks shall be at least equal to the specified strength of concrete in which the blocks will be embedded.
 - d) Laps and anchorage length of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller diameter will guide the lap length. Laps shall be staggered as far as practicable and as directed by the Engineer-in-charge and not more than 50% of bars shall be lapped at a

particular section. Mechanical connections, for splicing reinforcement bars in congested locations may be used by the Contractor, only if approved by the Engineer-in-charge. Reinforcement bars shall not be lapped unless the length required exceeds the maximum available lengths of bars at site.

- e) Unless otherwise specified by the Engineer-in-charge, reinforcement shall be placed within the following tolerances:
- f) Binders shall tightly embrace the bars with which these are intended to be in contact and shall be securely held. The vertical distance between successive layers
Tolerance in spacing
For effective depth 200 mm or less + 10 mm
For effective depth more than 200 mm. + 15 mm

4.4.8.2 Cover to reinforcement

- 1) The correct cover shall be maintained by cement mortar briquettes or other approved means. Reinforcement for footings, grade beams and slabs on sub grade shall be supported on precast concrete blocks as approved by the Engineer-in-charge. The use of pebbles or stones shall not be permitted.
- 2) Unless shown otherwise on the drawings, minimum clear concrete cover for reinforcement (exclusive of plaster or other finishes) shall be as follows:
 - a) At each end of a reinforcing bar, not less than 25 mm, nor less than twice the bar diameter,
 - b) For a longitudinal reinforcing bar in a column, 40 mm or bar diameter whichever is more. 25 mm cover may be adopted for columns of minimum dimension 200 mm or under and with longitudinal reinforcement diameter not exceeding 12 mm.
 - c) For longitudinal reinforcing bars in a beam, not less than 25 mm or less than the bar diameter.
 - d) For reinforcement in slabs and walls; not exposed to weather or ground not less than 15 mm nor less than the bar diameter.
 - e) For bottom reinforcement in footings; 75 mm, if concrete is laid against the ground or 50 mm if laid on a layer of lean concrete.
 - f) For retaining walls, grade beams, top and sides of footings and similar surfaces exposed to weather or ground; 50 mm for bars larger than 16 mm and 40 mm for bars up to 16 mm.
 - g) For liquid retaining structures; 40 mm or diameter of main bar, whichever is larger.
 - h) For any other reinforcement not less than 15 mm, nor less than the diameter of such bar.
- 3) Special requirements in corrosive atmosphere: Unless special protective coatings are used, the following measures shall be adopted for structures exposed to severe conditions.
 - a) Increased cover thickness may be provided when surfaces of concrete members are exposed to the action of harmful chemicals, acid vapor, saline atmosphere, sulphur smoke, etc. such increase may be between 15 to 50 mm beyond the figures indicated above as may be specified by Engineer-in-charge.
 - b) For reinforced concrete members totally immersed in sea water, the cover shall be 40 mm. more than specified in 8.02.02
 - c) For reinforced concrete members, periodically immersed in sea water or subject to sea spray, the cover of concrete shall be 50 mm. more than that specified in 8.02.02.
 - d) For concrete of grade M 25 and above, the additional thickness of cover specified in (a), (b) and (c) above may be reduced to half. In all such cases the covers should not exceed 75 mm.
 - e) Protection to reinforcement in case of concrete exposed to harmful surroundings may also be given by providing a dense impermeable concrete with approved protective coating, as

specified on the drawings. In such case the extra cover, mentioned in (c) and (d) above, may be reduced by the Engineer-in-charge -, to those shown on the drawing.

- 4) Unless otherwise specified the tolerance for cover from the required nominal cover shall not deviate by (+) 10/ (-) 0 mm.
- 5) The bars shall be kept in correct position by the following methods:
 - a) In case of beam and slab construction precast cover blocks in cement mortar 1 : 2 (1 cement : 2 coarse sand) about 4 x 4 cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering so as to secure and maintain the requisite cover of concrete over reinforcement.
 - b) In case of cantilevered and doubly reinforced beams or slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs spacers or support bars of steel at 1.0 meter or at shorter spacing to avoid sagging.
 - c) In case of columns and walls the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them; or with block of cement mortar 1 : 2 (1 cement : 2 coarse sand) of required size suitably tied to the reinforcement to ensure that they are in correct position during concreting.
 - d) In case of other R.C.C. structure such as arches domes, shells, storage tanks etc. a combination of cover blocks, spacers and templates shall be used as directed by Engineer-in-charge.

4.4.8.3 Inspection & testing

- 1) Erected and secured reinforcement shall be inspected and approved by Engineer-in charge prior to placement of concrete.
- 2) Sample bent bars shall be checked to ensure that they conform to the bar bending schedules. Reinforcement in position shall be checked for proper positioning, and rigidity, cover, spacing of bars, placement of chairs and spacers. etc. Also it shall be checked that all bars at crossings are properly tied.
- 3) Each batch of reinforcement procured shall be accompanied with manufacturer's test certificate. In addition, Engineer-in-charge may direct the reinforcement to be tested independently. Reinforcement shall tested in reputed testing laboratory, approved by Engineer-in-charge. The frequency of testing shall be as stipulated by Engineer-in-charge. The cost of testing shall be borne by the contractor.

4.4.9 Embedded Parts

Embedded steel parts shall be supplied, fabricated and erected by the Contractor as indicated in drawings.

Embedded steel parts shall be supplied, fabricated and erected by the contractor and shall include items such as, but not limited to, foundation grillages, anchor bolts, pipe sleeves, equipment mounting plates, steel rolled sections with or without properly welded lugs, plate inserts, edge protection angles, as shown on the drawings, auxiliary framing for equipment supports, peg stay plugs for door and window frames, miscellaneous frames, etc. Cold worked deformed steel bars shall not be used for lugs.

4.4.9.1 Foundation bolt assembly

- 1) Foundation bolt assembly shall comprise of foundation bolts, stiffener plates, washers, nuts, lock nuts, pipe sleeves, etc. Contractor's scope shall include supply, fabrication, erection and installation in position as per drawings.

- 2) The fabrication and erection of bolt assemblies shall include threading, cutting, grinding, drilling, welding, etc. complete. The bolts shall have coarse pitch screw thread in the diameter range, 8 to 64 mm and 6 mm pitch screw for diameter greater than 64 mm, as per IS : 4218.
- 3) For fabrication of any particular size of bolt indicated on the drawing, the diameter of the threaded portion of the bolt shall be considered as the diameter of the bolt unless otherwise mentioned in the drawings.
- 4) Fabrication & erection shall be carried out as per IS: 800. Welding shall conform to IS: 816 and IS: 9595.
- 5) Every bolt shall be provided with a steel washer, under the nut. The washer shall be flat and minimum outside inscribed circle have a diameter 2.50 times that of the bolt and of suitable thickness. All nuts shall be of steel with well-formed hexagonal heads, unless specified otherwise, forged from solid metal and shall be dipped in hot boiled linseed oil as soon as these are made. The nuts shall fit well on the bolts.
- 6) During erection, the Contractor shall provide necessary template, temporary bracings, supports, etc. to ensure proper positioning of the assemblies and holding them firmly during concreting or until they are grouted and the grout has set. All materials shall be erected in plumb and in level (unless otherwise specified) and at true locations as shown on the drawings. Threads shall be protected by using PVC tape. All threads for bolts and inserts shall be greased at intervals and kept covered to prevent damage.

4.4.9.2 Embedded plates, pipes, etc.

- 1) The Contractor shall fabricate, transport to site and erect accurately in position all embedded steel parts either by welding, bolting or any other means as approved by the Engineer-in-charge. Exposed surfaces of embedded parts other than holding down bolts, unless otherwise stated, are to be painted with two coats of approved anticorrosive paint (as per IS: 2074) and/or bituminous paint as directed. The threads of holding down bolts shall be greased and protected with waterproof tape.
- 2) During erection, the Contractor shall provide necessary strong temporary bracings and supports to ensure proper installation of the embedded parts which shall be erected at the true location as shown on the drawings and these shall be in plumb and level (unless otherwise shown on drawings). The Contractor shall furnish the Engineer-in-charge with fabrication and assembly drawings prepared for embedded steel parts showing the erection procedure, for major items, wherever necessary.
- 3) Fabrication & erection shall be carried out as per IS: 800. Welding rods & site/field welding shall conform to IS: 816 and IS: 9595. IS: 7634 (part-III) shall be followed for PVC pipe works.
- 4) Exposed surfaces of embedded materials shall be painted with one coat of anticorrosive paint or bituminous paint, as desired, without any extra cost to the Owner. If welding is to be done subsequently on the exposed surfaces of the embedded parts, the painting for a length of 50 mm beyond each side of the weld line shall be cleaned off.

4.4.10 Mixing of Concrete

- 1) Concrete shall be mixed in a mechanical mixer conforming to IS: 1791. However, mixing shall preferably be done at a single central batching plant, conforming to IS: 4925, situated within the area allocated for the Contractor's particular use as directed by the Engineer-in-charge. The plant shall have a mechanically operated mixer of an approved size and type, capable of ensuring a uniform distribution of the materials throughout the mass and the mass is uniform in color and consistency.

- 2) Water shall not be added into the drum of the mixer, until all the cement and aggregates constituting the batch are already in the drum and dry mixed for at least one minute and are uniformly distributed. Water shall then be added and mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass but in no case shall mixing be done for less than one and half minutes and for at least 40 revolutions after all the water and materials are in the drum. When absorbent directed by the Engineer-in-charge. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.
- 3) The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used and it shall be immediately removed from site. Each time if the work stops for more than 30 minutes, the mixer shall be thoroughly cleaned and when the next mixing commences, the first batch shall have 10% additional cement.
- 4) All plain concrete should be preferably mixed in a drum type powder driven machine with a loading hopper which will permit the accurate measure of various ingredients. In exceptional circumstances and/or work in remote areas, hand mixing may be allowed by the Engineer-in-charge, subject to adding 10% extra cement at no extra cost to Owner. The mixing shall be carried out on watertight platform and mixing shall be continued till a uniform colour and consistency of the mix is achieved.

4.4.11 Batching of Concrete

- 1) Cement shall always be batched by weight. A separate weighing device shall be provided for weighing cement. Where the weight of cement is determined by accepting the weight per bag, number of bags shall be weighed separately to determine the average net weight of cement per bag and the same shall be checked regularly.
- 2) Aggregates shall always be batched by weight. In particular cases, or where weigh batching is not possible proportioning by volume batching may be allowed by the Engineer-in-charge, provided Contractor guarantees the uniformity of aggregates throughout the period of construction. For this purpose, the Contractor shall submit to the Engineer-in-charge sufficient data indicating the weight/volume relationship of aggregates for different types of concrete and after such approval, periodic checks on the weight/volume relationship of the aggregates shall be made by the Contractor to the satisfaction of the Engineer-in-charge.
- 3) Where the aggregates are moist and volume batching is adopted, allowance shall be made for bulking in accordance with IS 2386 (Part-III). Suitable adjustments shall be made for the variation in the weight of aggregates due to variation in their moisture contents.
- 4) Water may be measured either by weight or by volume. When measured by volume, it shall be by well calibrated conical shaped jar or vessel or from a calibrated tank fitted to the mixer. It is very important to maintain the water cement ratio constant at its correct value. For the correct determination of amount of water to be added in the concrete mix, to maintain the water cement ratio constant, the amount of moisture content in both coarse and fine aggregates shall be taken into consideration, be as frequently as possible. According to weather conditions the frequency for a given job to be determined by the Engineer-in-charge.
- 5) Any solid admixture, to be added, shall be measured by weight, but liquid or semi liquid admixture may be measured by weight or volume.

- 6) The accuracy of batching shall be within the following tolerance:

Table 4.17: Accuracy of batching

| Material | % by weight |
|-----------|----------------|
| Cement | 2% by weight |
| Aggregate | 5% by weight |
| Water | 0.5% by weight |

Ready mix concrete supplied by commercial ready mix concrete plants shall be used only with the approval of Engineer-in-charge. Unless otherwise mentioned in the items no extra will payable on this account.

4.4.12 Transportation of Concrete

Concrete shall be handled and conveyed as rapidly as practicable, from the place of mixing to the place of final laying, by approved means, before the initial setting of the cement starts. Concrete shall be conveyed in such a way that there is no segregation or loss of any of the ingredients and maintaining the required workability. If segregation does occur during transport, the concrete shall be remixed. During very hot or cold weather, if directed by the Engineer-in-charge, concrete shall be transported in deep containers which will reduce the rate of water loss by evaporation in hot weather and heat loss in cold weather, at no extra cost to Owner.

Conveying equipment for concrete shall be mortar tight, well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipment shall be kept free from set concrete. Chutes shall not be used for transport of concrete without the written permission of the Engineer-in-charge. The chute in case permitted to be used shall be of such size and design as to ensure practically continuous flow. Slope of the chute shall be so adjusted that the concrete flow without the use of an excessive quantity of water and without segregation of its ingredients. The delivery end of the chute shall be as close as possible to the point of deposit.

Concrete may be conveyed and placed by mechanically operated equipment e.g. pumps or pneumatic placers only with the written permission of the Engineer-in-charge, who shall also review the entire scheme for which comprehensive details shall be furnished by the Contractor.

All equipment used for mixing, transporting and placing of concrete shall be maintained in clean condition. All pans, buckets, hoppers, chutes, pipe lines and other equipment's shall be thoroughly cleaned after each period of placement.

4.4.13 Concrete Placing

4.4.13.1 Final inspection and approval prior to concrete placement:

- 1) Before the concrete is actually placed in position, the inside of the form work shall be inspected to see that they have been cleaned and oiled. Temporary openings shall be provided to facilitate inspection, especially at bottom of columns and wall forms, to permit removal of saw dust, wood shavings, binding wire, rubbish, dirt etc., Opening shall be placed or holes drilled so that these materials and water can be removed easily. Such openings / holes shall be later suitably plugged.

- 2) The various traders shall be permitted ample time to install drainage and plumbing lines, floor and trench drain, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embedment to be cast in the concrete as indicated on the drawing or as necessary for the proper execution of the work. All such embedment shall be correctly positioned and securely held in the forms to prevent displacement during depositing and vibrating of concrete.
- 3) Prior to concrete placement, all works shall be inspected and approved by Engineer-in charge, and if found unsatisfactory, concrete shall not be poured until all defects have been corrected at contractors cost. Approval by Engineer-in-charge of any and all materials and work as required herein shall not relieve contractor from his obligations to produce sound concrete in accordance with the drawings and specifications
- 4) Formwork and reinforcement shall be approved in writing by the Engineer-in-charge before concrete is placed. Concrete shall be placed only after all preparations for casting have been approved by the Engineer-in-charge and approval given to proceed with the casting in writing on pour card to be maintained by the Contractor for this purpose and to be submitted along with the Contractor's bills.

4.4.13.2 Placement

- 1) Concrete shall be placed and compacted in its final position before the cement reaches the initial set and normally concrete shall be compacted in its final position within 30 minutes of leaving the mixer.
- 2) Where direct placement is not possible, the Contractor shall provide suitable arrangements such as chutes, tremie, elephant trunks, etc. to confine the movement of concrete as directed by the Engineer-in-charge. Concrete shall not be dropped from a height or handled in a manner which may cause segregation.
- 3) If concrete is placed by pumping, the consistency shall be the minimum necessary for such conveyance of concrete. Before commencement of regular pumping, the pipeline shall be lubricated by cement mortar (1:2), and once pumping commences, stoppages shall be avoided.
- 4) The placing of concrete shall be a continuous operation with no interruption in excess of 30 minutes between the placing of continuous portions of concrete. Concrete shall be placed in continuous horizontal layers of 150 mm or higher thickness as directed by the Engineer-in-charge and thoroughly compacted before placing next layer. The thickness of each layer shall be such that it will be deposited before the previous layer has stiffened. When placing concrete through reinforcing steel, care shall be taken to prevent segregation of the coarse aggregates.
- 5) Slabs, beams and similar members shall normally be poured in one operation. In special circumstances, with the approval of the Engineer-in-charge, these can be poured in horizontal layers, but it must be ensured that the under layer is not already hardened. Bleeding of under layer, if any, shall be effectively removed. Moulding, throating, drip course, etc. shall be poured as shown on the drawings or as desired by the Engineer-in-charge.
- 6) Mass Concrete shall be poured in lifts not exceeding 1.0 m in height unless otherwise indicated on drawings or as directed by the Engineer-in-charge. Horizontal lift shall not be more than 150 cm in thickness, according to provision of IS: 457.
- 7) No concrete shall be placed in wet weather or on a water covered surface. Any concrete that has been washed by heavy rain shall be entirely removed, if there is any sign of cement and sand having been washed away from the concrete mixture. To guard against damage which may be caused by rain, the works shall be covered with tarpaulins immediately after the concrete has been placed and compacted before leaving the work unattended. Any water accumulating on the surface of the newly placed concrete shall be removed by approved means and no further

concrete shall be placed thereon until such water is removed. To avoid flow of water over / around freshly placed concrete, suitable drains and sumps shall be provided.

- 8) Concrete, when deposited, shall have a temperature of not less than 5 degrees Centigrade and not more than 40 degree Centigrade. When depositing concrete in very hot weather, precautions shall be taken so that the temperature of wet concrete does not exceed 40 degrees Centigrade while placing. This shall be achieved by stacking aggregates under the shade and keeping them moist, using cold water, reducing the time between mixing by sprinkling water, starting curing before concrete dries out, etc. However, before mixing/placing concrete, when the above temperature conditions vary on either side, approval of the Engineer-in-charge shall be obtained for the method of execution.
- 9) Concrete must be placed in its final position before it becomes too stiff to work. On no account water shall be added after the initial mixing. Concrete which has become stiff or has been contaminated with foreign materials and which has not been placed within half an hour of mixing water with cement shall be rejected.
- 10) For members involving vertical placing of concrete (e.g. Columns, walls, etc.), each lift shall be deposited in horizontal layer extending the full width between shuttering and of such depth that each layer can be easily and effectively vibrated and incorporated with the layer before by means of compaction.
- 11) Should any unforeseen occurrence results in a stoppage of concreting for one hour or such other time as might allow the concrete, already placed, to begin to set before the next batches can be placed, the Contractor shall make at his own cost, suitable tongue, and groove construction joint, as approved by the Engineer-in-charge. Any additional reinforcement required as directed by the Engineer-in-charge shall also be provided by the Contractor at his own cost. Before placement of new batches of concrete over that construction joint, the surface preparation according to this specification stipulated earlier, shall be done by the Contractor at his own cost.

4.4.13.3 Work in Extreme Weather Conditions:

- 1) During hot weather (atmospheric temperature above 40 degree centigrade) or cold weather (atmospheric temp at 5 degree centigrade and below) the concreting shall be done as per the procedures and precautions set out in IS: 7861 (Parts I and II)
- 2) All concrete work performed in hot weather shall be in accordance with IS: 456, except as herein modified. Admixtures may be used only when approved by Engineer-in-charge.
- 3) Adequate provision shall be made to lower concrete temperatures by cool ingredients, eliminating excessive mixing, preventing exposure of mixers and conveyers to direct sunlight and the use of reflective paint, on mixers etc.,
- 4) The temperature of the freshly placed concrete shall not be permitted to exceed 300 deg. C.
- 5) Aggregate shall be stock piled in shade and prevented from direct sun rays. Spraying stock piles with water, use of cold water available and burying, insulation, shading and / or painting white the pipe lines and water storage tanks and conveyances.
- 6) In order to reduce loss of mixing water, the aggregates, wooden forms, subgrade, adjacent concrete and other moisture absorbing surfaces, shall be well wetted prior to concreting placement and finishing shall be done as quickly as possible.
- 7) Extra precautions shall be taken for the protection and curing of concrete, Consideration shall be given to continuous water curing and protection against high temperatures and drying hot wind for a period of at least 7 days after concrete has set and after which normal curing procedures may be resumed.

4.4.13.4 Placing concrete under water:

- 1) Under all ordinary conditions all foundations shall be completely de-watered and concrete placed on the dry surface. However, when concrete placement under water is necessary, all work shall be executed in accordance with clause 14.2 of IS: 456

4.4.14 Compaction

After the concrete has been placed, it shall be spaded and thoroughly compacted by approved mechanical vibrators to a maximum subsidence without segregation and thoroughly worked around reinforcement or other embedded fixtures into the correct form and shape. Hand tamping in some cases may be allowed subject to the approval of the Engineer-in-charge. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or disturbed during placing of concrete.

Vibrators shall penetrate both the layer poured and the under layer to ensure good bond and homogeneity and to prevent the formation of cold joints. Immersion vibrators shall not be allowed to come in contact with steel reinforcement after start of initial set. Also, they shall not be allowed to come in contact with forms or finished surfaces.

Immersion vibrators shall have a 'no load' frequency, amplitude and acceleration as per IS: 2505 depending upon the size of the vibrator. Immersion vibrators shall be operated by experienced men. These vibrators shall be immersed not more than 450 mm apart and withdrawn when air bubbles cease to come to the surface. Such vibrators shall in no case be used to push concrete inside the forms and vibrators shall be withdrawn slowly.

Whenever vibration has to be applied externally, the design of formwork and the disposition of vibrators shall receive special consideration to ensure efficient compaction and to avoid surface blemishes. Surface vibrators and form attached vibrator shall not be permitted under normal conditions. Their use shall require written approval of the Engineer-in-charge.

4.4.15 Protection and Curing of Concrete

4.4.15.1 Protection:

- 1) Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below ground level, shall be protected from falling earth, during and after placing. Concrete placed in ground containing any deleterious substances, shall be kept free from contact with such ground or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Engineer-in-charge.
- 2) The ground water around newly poured concrete shall be kept down to an approved level by pumping or other approved means of drainage. Adequate steps shall be taken to prevent floatation or flooding. Steps, as approved by the Engineer-in-charge, shall be taken to protect immature concrete from damage by debris, excessive loading, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

4.4.15.2 Curing:

- 1) As soon as the concrete has hardened sufficiently, it shall be kept in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, hessian or similar materials and kept continuously wet for at least seven days after final setting. This period may be extended, at the discretion of the Engineer-in-charge, up to fourteen days. Curing of horizontal surfaces exposed to drying winds shall begin immediately after the concrete has hardened. Concrete slabs and floors shall be cured for the periods mentioned above by flooding with water of minimum 25 mm depth.
- 2) Quantity of water applied shall be such as to prevent erosion of freshly placed concrete.
- 3) Approved curing compounds may be used in lieu of moist-curing with the permission of the Engineer-in-charge. However, such permission may be granted only in specific cases. Such compounds shall be applied to all exposed surfaces of the concrete, as soon as possible after the concrete has set. Curing compounds shall be liquid type while pigmented, conforming to U.S. Bureau of Reclamation Specification. No curing compound shall be used on surface where future blending with concrete, water or acid proof membrane or painting is specified.

4.4.16 Repairing and Finishing of Concrete Surfaces

4.4.16.1 Inspection and repair of concrete surfaces:

- 1) Immediately after the shuttering is removed, the surface of concrete shall be inspected very carefully for all defects. Engineer-in-charge who may permit patching of the defective areas or else reject the concrete unit either partially or entirely.
- 2) Holes left by form bolts etc., shall be filled up and made good with mortar composed of one part of cement to one and half parts of sand passing through 2.36 mm IS sieve after removing any loose stones adhering to the concrete. Mortar filling shall be struck off flush at the face of the concrete. Concrete surface shall be finished as described under the particular item of work
- 3) Superficial honey combed surfaces and rough patches shall be similarly made good immediately after removal of shuttering, in the presence of Engineer-in-charge and superficiant water and air holes shall be filled in. The mortar shall be well worked into the surface with wooden float. Excess water shall be avoided. Unless instructed otherwise by Engineer-in-charge, the surface of the exposed concrete placed against shuttering shall be rubbed down immediately on removal of shuttering to remove fine or other irregularities, care being taken to avoid damaging the surfaces. Surface irregularities shall be removed by grinding.
- 4) If reinforcement is exposes or the honey combing occurs at vulnerable position e.g. ends of beams or columns, it may be necessary to cut out the member completely or in part and reconstruct. The decision of Engineer-in-charge shall be final in this regard. Rejected concrete shall be removed and replaced by Contractor at no additional expense.
- 5) If only patching is necessary, the defective concrete shall be cut out till solid concrete is reached (or to a minimum depth of 25 mm), the edges being cut perpendicular to the affected surface or with a small undercut if possible, anchors, tees or dowels shall be provided in slots whenever necessary to attach the new concrete securely in place. An area extending several centimeters beyond the edges and the surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed. The area shall be repaired as follows:
 - (a) Small size holes having surface dimensions about equal to the depth of the hole, holes left after removal of form bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows:
 - (b) The hole to be patched shall be roughened and thoroughly soaked with clean water until absorption stops.

- (c) A 5 mm thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched followed immediately by the patching concrete which shall be well consolidated with a wooden float and left slightly proud of the surrounding surface. The concrete patch shall be built up in 10mm thick layers. After an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with hessian. Steel trowel shall not be used for this purpose. The mix for patching shall be of the same materials and in the same proportions as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessary and the mix shall be kept as dry as possible.
- (d) Mortar filling by air pressure (guniting) shall be used for repair of areas too large and / or too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and texture of the surrounding concrete. White cement shall be substituted for ordinary cement, if so directed by Engineer-in-charge, to match the shade of the patch with the original concrete.
- 6) Curing of Patched Work : The patched area shall be covered immediately with an approved non-staining water saturated material such as gunny bags, which shall be kept continuously wet and protected against sun and wind for a period of 24 hours. Thereafter, the patched area shall be kept wet continuously by a fine spray of sprinkling water for not less than 10 days.
- 7) Approval by Engineer-in-charge: All materials, procedures and operations used in the repair of concrete and also the finished repair work shall be subject to the approval of Engineer-in-charge. All fillings shall tightly bond to the concrete and shall be sound, free from shrinkage cracks after the fillings have been cured and dried.
- 8) Use of bonding agent: The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of Engineer-in-charge. Bonding agents shall be applied in strict accordance with the instruction of the manufacturer.

4.4.16.2 Finish for formed and un-formed surfaces

- 1) The type of finish for formed concrete surfaces shall be as follows, unless otherwise specified by the Engineer-in-charge.
 - (a) For surfaces against which backfill or concrete is to be placed, no treatment is required except repair of defective areas.
 - (b) For surfaces below grade, which will receive waterproofing treatment, the concrete shall be free of surface irregularities which would interfere with proper application of the water proofing materials which is specified for use.
- 2) The type of finish for un-formed concrete surfaces shall be as follows, unless otherwise specified by the Engineer-in-charge.
 - (a) Unless specified, surfaces which will be exposed when the structure is in service shall receive no special finish, except repair of damaged or defective concrete, removal of fins and abrupt irregularities, filling of holes left by form ties and rods and clean up of loose or adhering debris.
 - (b) Surfaces which will be exposed to the weather and which would normally be levelled, shall be sloped for drainage, Unless the drawing specify a horizontal surface or shows the slope required, the tops of narrow surfaces such as staircase treads, walls, curbs and parapets shall be stopped across the width approx. as 1 in 30. Broader surfaces such as walkways, roads, parking areas and platforms shall be sloped about 1 In 50. Surfaces that will be covered by backfill or concrete, sub floors to be covered with concrete topping, terrazzo or quarry tile and similar surfaces shall be smooth, screeded and levelled to produce even surfaces. Surface irregularities shall not exceed 6mm. Surfaces which will not be covered by backfill, concrete or tile topping such as outside decks, floors of galleries and sumps, parapets, gutters, sidewalks, floors and slabs shall be consolidated, screeded and floated.

- (c) Excess water and laitance shall be removed before final finishing. Floating may be done with hand or power tools and started as soon as the screeded surface has attained a stiffness to permit finishing operations and these shall be the minimum required to produce a surface uniform in texture and free from screed marks or other imperfections. Joints and edges shall be tooled as called for on the drawings or as directed by Engineer-in-charge.

4.4.16.3 Standard Finish for Exposed Concrete:

- 1) Exposed concrete shall mean any concrete other than floors or slabs exposed to view upon completion of the job. Unless otherwise specified on the drawings, the standard finish for exposed concrete shall be of smooth finish.
- 2) A smooth finish shall be obtained with the use of forms having smooth and even surfaces and edges. Panels and form linings shall be of uniform size and be as large as practicable and installed with closed joints. Upon removal of forms, the joint marks shall be smoothed off and all blemishes, projections etc. removed leaving the surfaces reasonably smooth and unmarred.

4.4.16.4 Integral Cement Concrete Finish:

- 1) When specified on the drawings, an integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded, as specified in the drawings and as per IS :2571. The surface shall be compacted and then floated with a wooden float or power floating machine. The surface shall be tested with a straight edge and any high and low spots eliminated. Floating or trowelling of the finish shall be permitted only after all surface water has evaporated. Dry cement or a mixture of dry cement and sand shall not be sprinkled directly on the surface of the cement finish to absorb moisture or to stiffen the mix.

4.4.16.5 Rubbed Finish:

- 1) A rubbed finish shall be provided only on exposed concrete surfaces as specified on the drawings. Upon removal of forms, all fins and other projections on the surfaces shall be carefully removed, off sets levelled and voids and / or damaged sections immediately saturated with water and repaired by filling with concrete or mortar of the same composition as was used in the surfaces. The surfaces shall then be thoroughly wetted and rubbed with carborundum or other abrasive. Cement mortar may be used in the rubbing, but the finished surfaces shall not be brush coated with either cement or grout after rubbing. The finished surfaces shall present a uniform and smooth appearance.

4.4.16.6 Joints in Concrete

Joints including joint filler materials, water bars, resilient pads type vibration damping material in and around the sides of concrete works, etc. shall be provided as shown in the drawings or as directed by the Engineer-in-charge. Where necessary or/and specified, joints shall be made water tight by use of water stops.

4.4.16.7 Classification of joints:

- 1) From the point of view of utility the joints as provided may be classified as below:
 - (a) Construction Joints: Construction joints are produced by placing fresh concrete against surface of hardened concrete. Construction joints are generally, but not necessarily, vertical or horizontal. Treatment of construction joints shall be as per clause 6.05.00.

- (b) Contraction Joints: These are provided to eliminate tensile stresses due to shrinkage and are commonly used where temperature variations are small and where there is no likelihood of expansion, such as spaces below water and earth levels & unexposed to atmosphere. At contraction joints, the reinforcement is discontinued and bond is not allowed to develop between the joint faces, thereby introducing a structural discontinuity. A contraction joint also serves as a construction joint so far as break in the pouring of concrete is concerned.
- (c) Expansion Joints: These are provided either to completely eliminate or to significantly reduce compressive stresses in concrete that would otherwise result from thermal expansion and might crush, buckle or crack, part of the structure. Expansion joints serve the purpose of contraction and also construction joints.
- (d) Control Joints: At places where cracking is inevitable, places of weakness are introduced by the provision of control joints so that the cracking takes place along these joints instead of allowing it to develop in a haphazard manner.
- (e) Separation Joints: The places where the expansion of the structure is not expected but they are required to be kept structurally separate so that stresses, vibrations, etc. are not transferred, a separation joint should be provided. Like expansion joint, a gap is provided in separation joint also, but this is not expected to be used up by the expansion of members. In case, no gap is required, the separation joint can be obtained by using an approved alkathene sheet stuck on the surface against which concrete shall be placed.
- (f) Settlement Joints: Structures, which are likely to settle with respect to the adjacent structures, shall be separated by a settlement joint so that the adverse effects of differential settlement are obviated. It is like an expansion joint but with a different sealing arrangement.

4.4.16.8 Joint Filler

- 1) Bitumen Board: The bitumen impregnated fiber board; a preformed material shall be used as joint filler which shall fill space between the concrete surfaces at the joints. The minimum thickness of board shall be 12mm and the material shall conform to IS: 1838.
- 2) Expanded Polystyrene: The expanded polystyrene slab shall be of fire retarding grade (type-2) conforming to IS: 4671. Density of material shall not be less than 25kg/Cu.M.
- 3) Installation: The bitumen impregnated fiber board may be secured to vertical concrete by nails in the first placed concrete. The joint filler shall be coated on both faces with coal-tar pitch conforming to IS: 216 or bitumen of suitable grade conforming to IS: 73 or IS: 702.

4.4.16.9 Water Stops/ Water bars

- 1) Water stops shall be provided at the joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure.
- 2) The Water stops shall be either metallic like Copper, or nonmetallic like P.V.C. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of Water Stops of similar make and shape for other jobs. Only PVC water stop shall be used, unless, otherwise, specifically approved by the Engineer-in-charge.

4.4.16.10 Non-metallic Water Stop

- 1) These will be normally in P.V.C. and can be of shape having any combination of the following features
 - i. Plain
 - ii. Central Bulb
 - iii. Dumb-bell or flattened ends

- iv. Ribbed and Corrugated Wings
 - v. V-shaped.
 - vi. Kicker type (Externally placed)
- 2) Water bars shall generally meet the stipulations of IS: 12200. The minimum thickness of P.V.C. Water Stops shall be 6 mm and the minimum width 225 mm unless otherwise specified. The actual size and shape will be as shown on drawings and/or as directed by the Engineer-in-charge. The material should be of good quality Polyvinyl Chloride, highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The performance requirements shall generally be as follows.

Table 4.18: Water Stop

| Particular | Limits |
|-------------------------------------|----------------------------|
| Sp. Gr. | 1.3 to 1.4 |
| Shore Hardness | 60A to 80A |
| Tensile Strength | 110 kgf/cm ² mm |
| Maximum safe continuous Temperature | 70°C |
| Ultimate Elongation | Not less than 300% |
| Tear Resistance | 45 kgf/cm ² mm |
| Stiffness in flexure | 25kgf/cm ² mm |
| Accelerated extraction | |
| Tensile strength | 110 kgf/cm ² |
| Ultimate elongation | 250% |
| Water absorption in 7 days | 5% (max) |
| Effect of Alkali (7 days) | |
| Weight increase | 0.25% max. |
| Weight decrease | 0.10% max |
| Hardness change | n 5 |
| Effect of Alkali (28 days) | |
| Weight increase | 0.40% max. |
| Weight decrease | 0.30% max |
| Dimension change | ± 1 % |

4.4.16.11 Installation

- a) Water stops shall not have any longitudinal joints and shall be procured and installed in largest practicable lengths having a minimum number of transverse joints. The jointing procedure shall be as per the manufacturer's recommendations and shall be reviewed and approved by the Engineer-in-charge. Suitable field splicing kit including heater shall be used for this purpose. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.
- b) As Non-metallic Water Stops can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer-in-charge. The method of forming these joints, laps, etc. shall be as specified by the Manufacturer and/ or approved by the Engineer-in-charge, taking particular care to match the center and the edges accurately.
- c) Particular care shall be taken for the correct positioning of the water stops to prevent any faulty installation which may result in joint leakage. Adequate provisions shall be made to support the water stops during progress of work and to ensure their proper embedment in the

concrete. The symmetrical halves of the water stops shall be equally divided between the concrete pours adjacent to the joints.

- d) Maximum density and imperviousness of the concrete shall be ensured by thoroughly working in the vicinity of joints. However, particular care should be exercised in use of vibrators in the proximity of joints to avoid dislodging of the water stops.
- e) Splices: Splices in the continuity of intersections of runs of water stops shall be jointed as per manufacturer's stipulations depending on the type of water stops used. In case of a cross section, overlapping must not be done but, instead factory made cross joint should be used. It is essential that the material is not damaged during the splicing operation and that the continuity of the entire water stops across the section be maintained.
- f) Inspection: All water stops installations shall be subject to inspection and approval by the Engineer-in-charge, before concreting operations, encasing water stops, are performed.

4.4.17 Sampling, Testing and Quality Assurance

4.4.17.1 General

- 1) Concrete cubes for works tests shall be cured under laboratory conditions, except when in the opinion of the Engineer-in-charge, extreme weather conditions prevail at which time, these may require curing under job conditions.
- 2) For the purposes of statistical analysis, any substandard cube result, which in the opinion of the Engineer-in-charge, is due to improper sampling, moulding or testing shall be discarded and a dummy result shall be substituted. The value of a dummy result shall be equivalent to the average value of the cubes from the same grade of concrete tested immediately before and after the discarded result. The number of such substandard cubes shall not exceed 5%.
- 3) If the 'strength' of the laboratory controlled cubes, for any portion of the concrete work, falls below the compressive strength specified, the Engineer-in-charge shall have the right to order a change in the proportions or the water content for the remaining portion of the structure.
- 4) If the 'strength' of the works cured test cubes falls below the specified strength, the Engineer-in-charge shall have the right to require provisions for temperature and moisture control during the period of curing as necessary to secure the required strength, and may require retests in accordance with the 'standard method of securing, preparing and testing specimens from hardened concrete for compressive and flexural strengths, or load tests to be made on the portion of the building so affected. All such tests shall be made at the Contractor's expense.
- 5) Unacceptable concrete work shall be dismantled by the Contractor and replaced by fresh work, meeting the specification requirements. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, by the Contractor, to the satisfaction of the Engineer-in-charge, at no extra cost.
- 6) Only as a very special case and that too in non-critical areas, the Engineer-in-charge may accept concrete work which is marginally unacceptable as per the criteria laid down in I S: 456. For such accepted work, payment shall be made at a reduced rate prorata to the concrete cube strength obtained, against that stipulated.
- 7) If directed by Engineer-in-charge, Ultrasonic tests on structures to ascertain the quality and grade of concreting shall be carried out. Contractor shall arrange for the specialized agency for conducting the test at his cost. The Contractor shall provide all the necessary facilities and arrangement for conducting the test at site in terms of access, scaffolding etc. In case of any defects, the Contractor shall rectify the same as directed by the Engineer-in-charge. Rebound hammer test shall be carried out for ascertaining the quality of concrete work, as directed by the Engineer-in-charge.

- 8) Test shall be conducted for the water tightness of the liquid retaining structures as per IS: 3370 and IS: 6494. The details and sequence of tests shall be as given hereunder:
 - a) All arrangements, including supply of water for testing purposes, shall be kept ready when the tank is nearing completion.
 - b) Water supply to the tank shall be in stages of 300 to 450 mm height in order to check the water tightness of the tank at full water level and location of leakage of various levels.
 - c) The permissible drop in level in 24 hours shall be 6 mm in case of covered reservoir/tank and 12 mm in the case of open reservoir-tank. If the structure does not satisfy the conditions of test and the daily drop in water level is decreasing the period of test may be extended for further seven days and if specified limit is then reached, the structure may be considered satisfactory.
 - d) The leakage points shall be marked and separately treated after dewatering
 - e) The underground structures /water retaining structures shall be retested for water tightness after rectification. For basement type structures like basin, neutralising pit, etc. the Contractor shall examine the water tightness against ingress of sub-soil water.
- 9) Optional Tests:
 - a) Engineer-in-charge , if he so desires, may order for tests to be carried out on cement, sand, coarse aggregate, water etc., in accordance with the relevant Indian Standards.
 - b) Tests on cement will be carried out by department and shall include (i) fineness test, (ii) test for normal consistency, (iii) test for setting time, (iv) test for soundness (v) test for compressive strength, (vi) test for heat of hydration (by experiment and by calculations) in accordance with IS :269.
 - c) Tests on sand shall include (i) sieve test, (ii) test for organic impurities, (iii) decantation test for determining clay and silt content, (iv) specific gravity test, (v) test for unit weight and bulkage factor, (vi) test for sieve analysis and fineness modulus.
 - d) Tests on coarse aggregate shall include (i) sieve analysis, (ii) specific gravity and unit weight of dry, loose and rodded aggregate, (iii) soundness and alkali aggregate reactivity, (iv) Petrographic examination, (v) deleterious materials and organic impurities, (vi) test for aggregate crushing value.

4.4.17.2 Sampling of Concrete

- 1) Samples from fresh concrete shall be taken according to IS: 1199 and tested as per IS: 516.
- 2) Normally only compressive test shall be performed but the Engineer-in-charge may require other tests to be performed in accordance with IS: 516.
- 3) Trial Mixes & mix design: At least four trial mixes shall be made with minimum 6 test cubes for each mix.
- 4) Works Tests:
 - a) The minimum. frequency of sampling of concrete of each grade shall be according to clause 15.2.2 of IS:456. However, after getting continuous satisfactory results and in the case of voluminous concrete works, the Engineer-in-charge, may at his discretion reduce the frequency of sampling as follows.
 - b) For each grade of concrete, and for each 8 hours (shift) of work or part thereof, at least one sample consisting of six specimens shall be taken from each 150 cum. of concrete or part thereof, 3 specimens shall be tested at 7 days and remaining 3 shall be tested at 28 days. However, in all cases, the 28 days compressive strength shall alone be the criterion for acceptance or rejection.
 - c) To control the consistency of concrete from every mixing, slump tests and compaction factor tests in accordance with IS: 1199 shall be carried out by the Contractor every two hours or as

directed by the Engineer-in-charge. Slumps corresponding to the test specimens shall be recorded for reference.

- d) The strength of sample shall be the average of the strength of three specimens. The individual variation should not be more than $\pm 15\%$ of the average.

4.4.17.3 Acceptance Criteria

- 1) The acceptance criteria of concrete shall be in accordance with clause no.16 of IS-456. However, in exceptional circumstances, the Engineer-in-charge may at his discretion, accept a concrete of lower strength than that specified at reduced rates.
- 2) In case of doubt regarding the grade of concrete used or results of cube strength are observed to be lower than the designed strength as per specifications at 28 days, compressive strength test of concrete based on core test, ultrasonic test and / or load test shall be carried out by the digital ultrasonic concrete tester by an approved agency as directed by the Engineer-in-charge all at the cost of the contractor
- 3) Core Test:
 - a) The points from which cores are to be taken and the number of cores required shall be at the discretion of the Engineer-in-charge and shall be representative of the whole of concrete concerned. In no case, however, shall fewer than three cores be tested. Cores shall be prepared and tested as described in IS: 516-1959.
 - b) Concrete in the member represented by a core test shall be considered acceptable if the average equivalent cube strength of the cores is equal to at least 85% of the cube strength of the grade of concrete specified for the corresponding age and no individual core has strength less than 75%.
 - c) In case the core test results do not satisfy the requirements as above or where such tests have not been done, load test may be resorted to.
- 4) Other non-destructive test such as ultrasonic sound methods may be adopted, in which case the acceptance criteria shall be agreed upon between the Engineer-in-charge and the contractor and the test shall be done under expert guidance.
- 5) Load Test: If in the opinion of the Engineer-in-charge, the safety of the structure, or any part of the structure is in doubt and the results of other tests are not encouraging, the Engineer-in-charge may direct load test to be conducted before ordering its removal and reconstruction, in accordance with the provision of clause no.17.60 of IS:456-2000.
- 6) Load Tests on Parts of Structure:
 - a) Load tests should be carried out as soon as possible after expiry of 28 days from the time of placing of concrete.
 - b) The structure should be subjected to a load equal to full dead load of the structure plus 1.25 times the imposed load for a period of 24 hours and then the imposed load shall be removed. Dead load includes weight of the structural members plus weight of finishes and walls of partitions, if any, as considered in the design.
 - c) The deflection due to imposed load only shall be recorded. If within 24 hours of removal of the imposed load, the structure does not recover at least 75% of the deflection under super imposed load, the test may be repeated after a lapse of 72 hours. If the recovery is less than 80% the structure shall be deemed to be unacceptable.
 - d) If the maximum deflection in mm shown during 24 hours under load is less than $40 L/D$, where L is the effective span in M and D the overall depth of the section in mm, it is not necessary for recovery to be measured and the recovery provision as above will not apply.
- 7) In case these tests do not satisfy the requirements, the Engineer-in-charge will be at liberty to reject the concrete, and the contractor, at his own cost, has to dismantle and redo the same or carry out such remedial measures as approved by the Engineer-in-charge.

4.4.17.4 Application of Live Load

The designated live load shall be allowed on any structure only after 28 days, after proper curing is carried out on the last concrete poured in structure.

4.5 Masonry Works

4.5.1 Scope

This specification recommends requirements regarding materials, workmanship, construction and mode of measurement of Brick work.

4.5.2 Applicable codes and specifications

The following codes, standards and specifications are made a part of this specification. All standards, tentative specifications, codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions.

| | |
|---------|---|
| IS:1077 | Common burnt clay building bricks |
| IS:3102 | Classification of burnt clay bricks |
| IS:2180 | Burnt clay building bricks, heavy duty. |
| IS:3495 | Method of sampling and testing clay building bricks |

4.5.3 Brick Masonry

4.5.3.1 Classification

The brick work shall be classified according to the class designation of bricks used. The thickness of joints shall not exceed 1cm for brick work with bricks of any class designation.

4.5.3.2 Soaking of bricks

Bricks required for brick work in cement mortar, shall be adequately soaked in stacks before use, by profusely spraying with clean water at regular intervals for a period of not less than six hours so as to keep them wet to the satisfaction of Engineer-in-Charge.

4.5.3.3 Laying

Brick work shall be laid in English Bond unless otherwise specified. Half or cut bricks shall not be used except where necessary to complete bond. Closers in such case, shall, be cut to the required size and used near the ends of walls.

A layer of mortar shall be spread for full width over a suitable length of the lower course. Each brick shall be properly bedded and set home (in position) by gently tapping with handle of trowels or wooden mallet. Its inside faces shall be battered with mortar before the next brick is laid and pressed against it. On completion of course, all vertical joints shall be fully filled from the top with mortar.

The walls shall be taken up truly in plumb and uniform in layers. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in alternate course shall come directly one over the other. Quoin, Jamb and other angles shall be properly plumbed as the work proceeds. Care shall be taken to keep the perpend properly aligned within following maximum permissible tolerances:

- a. Deviation from vertical within a story shall not exceed 6mm per 3M height.
- b. Deviation in verticality in total height of wall more than one story in height shall not exceed 12.5mm.
- c. Deviation from position shown on plan of any brick work shall not exceed 12.5mm.

No part of the wall during its construction shall rise more than one meter above the general construction level. Parts of wall left at different levels shall be raked back at an angle of 45 degrees or less with the horizontal. Tothing shall not be permitted as an alternative to raking back. For half brick partition to be keyed into main walls, indents shall be left in the main walls.

Both the faces of the walls of thickness more than one brick length shall be kept in proper plane. All connected brick work shall be carried up simultaneously and no portion of work shall be left more than one metre below the rest of work.

All non-fixtures, pipes, outlets of water, hold fasts which are required to be built into shall be embedded in mortar or concrete in their correct position. Spaces around metal door frames and other built in items shall be solidly filled with mortar.

Before new work is started, all loose mortar shall be removed and the exposed joints thoroughly cleaned before the laying of new work.

Joints : Brick shall be so laid that all joints are full of mortar. the thickness of joints shall not exceed 1.0 cm for brick work with bricks of any class designation. All face joints shall be raked to a minimum depth of 15mm by taking tool during the progress of work. When mortar is still green so as to provide proper key for the plaster or pointing to be done. Where plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying.

4.5.3.4 Brick Coping and Cut Corners

Top courses of all plinth, parapet, steps and loft wall below RCC shall be laid with brick on edge unless specified otherwise. The bricks forming the top courses and ends of walls shall be properly radiated and keyed into position.

4.5.3.5 Curing

Masonry work in cement mortar, shall be kept moist on all faces for a minimum period of seven days.

4.5.3.6 Scaffolding

Double scaffolding shall be provided for the construction of brick work. Piercing of wall for scaffolding supports shall not be permitted.

4.5.4 Measurement

Measurement of brick masonry shall be based on cum. of actual work done for brick work of one or more brick thickness. Deductions for opening etc. in brick wall shall be as per IS 1200.

The work shall be measured separately under the following categories.

- a) From foundation and up to plinth level.
- b) In super structure at all floors and at all levels.

4.6 Anchor Bolts

All materials used by the Contractor shall be of tested quality as per specifications below and test certifications of raw materials shall be provided by the Contractor.

- a) Bolts shall be turned from M.S conforming to IS 2062 and IS 432 Grade-I.
- b) Nuts shall be hexagonal type conforming to IS 1363-3138.
- c) Plain washers shall be of mild steel conforming to IS 2062.
- d) Sleeves shall be M.S. Tubes (Medium) conforming to IS 1239

4.6.1 Fabrication

Fabrication of anchor bolts shall be in compliance with the specifications. Complete anchor bolt assembly shall be as per drawings, and will include the cost of sleeve pipes, fine gussets, bottom plates, and other fixtures including all welding work if involved.

- a) Threads shall be of coarse type conforming to IS 1367 and IS 4218.
- b) Plain washers shall be of mild steel conforming to IS 2016.
- c) It shall conform to IS 1367.

The anchor bolt assembly to be anchored or embedded in concrete shall be placed and securely held in position strictly as per drawings before and during pouring of concrete, with necessary wooden or steel templates and other devices.

Tolerances allowed for anchor bolts positioning shall be:

- a) For sleeved bolts one tenth of bolt nominal diameter.
- b) For bolts without sleeves, one twentieth of the bolt nominal dia.

The surface not to be covered with concrete shall be greased and protected from damage by wrapping and tying jute cloth/polythene.

4.6.2 Payment

Payment for supply and fabrication of anchor bolts including sleeves and nuts shall be on weight basis of the finished product and shall include greasing etc. A sample bolt shall be got approved from Engineer-in-Charge

4.7 Painting of Civil Work

4.7.1 Scope

This specification covers painting, white washing, cement painting etc. of both interior and exterior surfaces of concrete, plaster, as shown on drawings, schedules or as directed by the Engineer.

The painting contractor shall inspect the work of other trades prior to the application of paint. If surface to be finished cannot be put in suitable condition for painting by customary preparatory methods, the painting Contractor shall notify the Engineer in writing or assume responsibility for and rectify unsatisfactory finishing that results.

Before commencing painting, the painting Contractor shall obtain the approval of the Engineer in writing regarding the scheduling of work to minimize damage, disfiguration or staining by other trades. He shall also undertake normal precautions to prevent damage, disfiguration or staining to work of other trades or other installations.

4.7.2 Applicable Codes and Specifications

The following codes, standards and specification are made a part of this specification. All standards, specifications, codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions. In case of discrepancy between this specification and those referred to herein, this specification shall govern.

Table 4.19: Codes and Specifications

| IS Code | Specification |
|---------|---|
| IS 1477 | Codes of Practice for painting of ferrous (I & II)metals in Buildings. |
| IS 2395 | Code of Practice for painting concrete, (I & II) masonry and plaster surface. |
| IS 2932 | Enamel, synthetic, exterior, type - I. |
| IS 5410 | Cement paint, colour as required. |

4.7.3 Installation

Materials

Materials shall be highest grade products of well-known approved manufacturer and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approval by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade be obtained from the same manufacturing batch. All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied. All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputed recognized manufacturers and shall be approved by the Engineer.

Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colors with accelerators, waterproofing agents and fungicides. The paint shall conform to IS 5410.

Storage

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement and stains. Paints shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

Preparation of Surface

Before starting the work the Contractor shall obtain the approval of the Engineer regarding the soundness and readiness of the surface to be painted on.

Masonry, Concrete and Plastered Surface

Surfaces shall be free from all oil, grease, efflorescence, mildew, loose paint or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from the original surfaces, the resurfaced area shall be treated with minimum one coat of cement primer which should be continued to the surrounding area for a distance of minimum 100 mm.

Application

General

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 m² as per instruction of the Engineer and obtain his approval prior to application of finishing paints.

Proper tools and implements shall be used. Scaffolding, if used, shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor holes.

Painting shall be done by skilled labours in a workman like manner. All materials shall be evenly applied, so as to be free of sags, runs, crawls or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoats for painting shall be applied by brush only, and rollers, spray equipment etc. shall not be used.

No work shall be done under conditions that are unsuitable for production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint which seals the surface to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before being rubbed with sand paper or before the succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered properly by applying the specified number of coats, further coats shall be applied by the contractor when so directed by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of moulding and ornaments shall be left clean and true to finish.

Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours), the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

4.7.4 Acceptance Criteria

- a) All painted surfaces shall be uniform and pleasing in appearance.
- b) The colour, texture etc. shall match exactly with those of approved samples.
- c) All stains, splashes and splatters of paint and varnishes shall be removed from surrounding surfaces.

4.7.5 Rates

Rates shall be fixed unit rates for complete item described in the Schedule of Items. No extra payment shall be made for preparation of surface before painting or for cleaning up after the work is complete.

4.7.6 Method of Measurement

Painting to concrete or masonry shall be measured and paid on the area painted. For measurements of openings whose jambs, sills, soffits etc. are to be painted the following procedure shall be followed:

- a) For openings up to 0.5 m² each, no deductions shall be made and no additions shall be made for jambs, sills, etc.
- b) For openings exceeding 0.5 m², but not exceeding 3.0 m² each, deductions shall be made for half the area of openings and no additions shall be made for jambs, sills, etc..
- c) For openings exceeding 3.0 m² each, deductions shall be made for the whole area and additions shall be made for the jambs, sills, soffits, reveals, etc.
- d) No extra shall be paid for painting, etc. done around openings, sleeves pipes ducts, inserts, etc.

5 General Mechanical and Piping Specifications and Requirements

5.1 Specification for Erection of equipment (As applicable)

5.1.1 General

Receiving and handling of all Equipments

All equipment received at site shall be checked by the Contractor for the equipment being intact, in the presence of Engineer-in-Charge and shall be unloaded and accepted by the Contractor for the storage and safe custody. The equipment shall be stored in the approved manner by Engineer-in-Charge and the Contractor shall be responsible for the storage and safety of the equipment.

Whenever the equipment is received in wooden crates the contractor shall carefully dismantle these crates and store all timber and packing materials properly.

It shall be the responsibility of the Contractor to study the requirements of installation and instructions for commissioning of the same, by employing skilled technicians experienced in the type of services required. The contractor shall be fully responsible for the safe custody of the equipment during the period from acceptance of the equipment to commissioning and handing over of the same to the Commission. Storage in Proper shed shall be in EPC contractor scope

Precautions to be taken by contractor

- The contractor shall take adequate care and precautions to prevent loss/damage of material and equipment.
- During the execution of the work the Contractor shall keep structures, materials and equipment adequately and safely braced by struts, guys, and any other approved means as required till installation work is satisfactorily completed. The Contractor shall design, provide and erect the struts, guys, shorting, bracing, planking support in such a way that they do not interfere with other work and shall not damage or cause distortion to other works executed by him.
- Openings for level gauges, thermo wells and other instruments shall be protected during and after erection.
- All accessories like pressure gauge, temperature indicators, safety valves, etc. shall be tagged and separately kept till erection.
- All flange connections and openings shall be kept blanked with wooden covers to prevent entry of foreign matter.

5.1.2 Erection of equipment

- The Contractor shall make careful checks of all the equipment received at site and ensure that protective greases and wrapping applied on the machined surfaces and other parts by the equipment supplier for protection during transportation and storage are intact. Any defects noticed shall be reported and corrective action shall be taken. Special care shall be taken by the Contractor for bearings, rotating parts etc., to prevent seizing. Generally, the packages shall not be opened until required for installation.
- Orientation of all the foundations, elevations, lengths, positions of anchor bolt and Dia. (diameter) of holes in base plates/supporting saddles of equipment, etc. shall be checked by the Contractor well in

advance. Minor rectification work like chipping of foundation shall be carried out by the Contractor in time.

- The Contractor shall also check the nozzle orientation on vessels and see their compliance with detailed drawings and specifications. Any discrepancy shall be brought to the notice of Engineer-in-Charge and start work only after his approval.
- Rigging procedures of all major lifts above 5 MT and at maximum crane capacity shall be submitted by Contractor for approval of the Engineer-in-Charge. However, such approvals shall not relieve the Contractor from the responsibility of safe rigging and lifting of the equipment, machinery, etc.
- Drilling and tapping of holes in base plates, fixing of couplings on shaft after enlarging the pilot bore to correct size with keyways etc. and doweling including provisions of dowel pins or similar arrangement for retaining the alignment shall be carried out by the Contractor with utmost care.
- All joints shall be assembled without undue stresses. Flanges must be parallel and correctly aligned.
- The Contractor shall execute the work with the help of relevant approved drawings, specifications and equipment supplier's special requirements as specified in his instructions manual. The Contractor shall prepare detailed procedures, outline sequence of operation, prepare time schedule for each operation and seek approval of Engineer-in-Charge, as mentioned in other clause of this tender.
- Wherever necessary the Contractor shall remove the anti-corrosive coating applied on the machine / equipment by the supplier, carefully and completely with light oil / Equivalent.
- After checking orientation and overall dimensions of the foundations, location and sizes of anchor bolts, shape of foundation shall be checked as per foundation drawing with reference to the equipment centre line.
- On the chipped and prepared foundation surface, the Contractor shall set up liners for installation and Centering of equipment. Liners shall be so arranged that the load of equipment is uniformly and exactly distributed to the foundation. Liners shall be placed as near as possible to both sides of anchor bolts. Where distance between anchor bolts is too long additional liner shall be set up in between. The height of each liner shall be measured on the basis of standard level bench mark. The liners shall be fixed with appropriate grouting material.
- The upper surface of the foundation shall be watered sufficiently, at least 24 hours prior to setting of liners, to ensure good adhesion of grouting material.
- The Contractor shall assemble, couple, fix, fit, install, level, align and grout the equipment / materials on foundations, structures, platforms, floors etc., as the case may be. He shall bolt, weld, cut, drill, rivet and brace all components and fix them rigidly with one another on the foundation supports, etc.
- All necessary shims scaffolding, temporary supports, staging, grouting cement, sand, etc., required for erection of the equipment shall be kept ready in advance.

5.1.3 Assembly, levelling and alignment

- Some of the equipment may be shipped by suppliers in knocked down condition. All drive motors, agitators etc. may be shipped separately. The contractor shall assemble all such parts and sub-assemblies as per the manufacturer's instructions/manuals, drawings etc.
- The Contractor shall assemble position and fix all internals of the equipment.
- Method of lifting and handling of equipment and its sub-assemblies shall be thoroughly discussed by the Contractor with the Engineer-in-Charge. The equipment wherever required shall be levelled for temporary setting using screw jacks at the lower parts of common bed.
- The Centring of alignment of the equipment is generally done in the factory. However, there are chances of this alignment getting disturbed during transportation of the equipment. The Contractor shall therefore, recheck the alignment and take remedial steps as per the instructions given in the installation manual of suppliers after discussing with Engineer-in-Charge, if any misalignment is observed. For motor driven equipment the driving and driven shafts shall be fully aligned, deflection and face deviation of the shafts shall individually be measured and it shall be confirmed that values

are within the tolerances. All readings of the inspection shall be properly recorded and submitted to Engineer-in-Charge.

- After completion of alignment, the equipment shall be assembled in accordance with approved procedure. After perfect alignment of driven shaft is achieved, these shall be coupled and base plates shall be cleared for grouting. Care shall be taken during grouting to see that the base plate level and alignment are not disturbed. Client instructions and equipment's manufacturer recommendation shall be strictly followed

5.1.4 Erection of rotary equipment (Pumps)

- All Rotary equipment may be erected as separate units of driver and driven parts. Before erection, Contractor shall inspect the foundation for dimensions, locating size and condition of anchor bolts. He shall properly carry out chipping, fixing, cleaning of foundation, place liners, place base plate on the liner and set anchor bolts, align provisionally base plates and fix anchor bolts by pouring mortar into anchor boxes. Assemble the complete unit and align for grouting. After grouting recheck the alignment of the unit and couple the shaft after connecting piping as per the detailed engineering drawings. The installation of base plate and the unit shall be carried out in such a manner that the requirement of tolerance on height, position, level as specified on the Manufacturer's drawings/instruction manual are fully met with.
- Levelling shall be carried out on four corners of the base plate ends for both directions of shaft and right angle to the shaft.
- The alignment of the unit shall be carried out on the basis of the finished surfaces which are as nearest as possible to the centre of the shaft with the help of dial gauge. Foundation jointly handed over (Civil and mechanical contractor along with client) with protocol sign shall be mandatory
- Where an adjustment between shaft and coupling is required for their fitting, the adjustments shall be carried out to the coupling and not to the shaft.
- The alignment of the unit shall be carried out until complete alignment of driving and driven shaft is obtained. While aligning, the deflection and face deviation of the driving and driven shaft shall individually be measured with the help of dial gauge and should conform to the allowable limits specified by manufacturer.
- After completion of alignment it shall be confirmed that the shaft can be rotated smoothly and freely by hand.
- After connection of piping, the alignment of the pump and other rotary equipment shall be rechecked. Any misalignment induced by the piping connections shall be corrected by adjusting piping.
- Running test of motor etc. shall be performed with no load and it shall be confirmed that vibrations, sound and temperature of motor are not abnormal.
- After running test of motor, the surface of motor and the driven unit shall be coupled with confirmation of rotating direction of unit and motor.
- Trial running of assembled unit shall be performed and it should be confirmed that vibration, sound and temperature readings are within the acceptable limits specified by the supplier.

5.1.5 Testing

- The contractor shall follow good engineering practice and / or the testing manuals supplied by the equipment manufacturer for the testing of equipment.
- All pumps shall be tested hydrostatically by running on water.
- No load running tests shall be carried out, where required.
- The mechanical testing of all equipment shall be carried out to the satisfaction of Engineer-in-Charge and their signature shall be obtained on the test certificates. Client engineer instruction shall be strictly followed

5.1.6 Miscellaneous steel

All bolts, anchor bolts, nuts, lock washers, supports and other miscellaneous items shall be supplied by the Contractor. Before installing the equipment, the Contractor shall verify location of bolts. M.S fasteners up to 8.8 grade shall be hot dip galvanized with coating 80-100 micron with painted after installation and torque tightening. Painting shall be as per client specification.

5.1.7 Grouting

Grouting of Anchor bolts, holes, pockets and under base plates or under all equipment have been broadly classified into two categories e.g. non-shrinking grout and ordinary grout. Non-shrinking grout shall consist of 1 part of ordinary Portland cement, 1 part of clean dry well grades sand and 1 part of Ferro-grout of similar additive (approved by the Engineer-in-Charge). Minimum amount of water shall be kept so that the mixture can be applied adequately. The grouting material shall solidly fill the spaces to be grouted and permanently retain its original volume so that the base plate will be held firmly in the set position. The amount of water used in mixing shall be kept to a minimum such that the grout shall have a consistency to stiff to flow. The top of foundation shall be clean and free of all laitance loose particles, oil, grease, etc. and shall be wetted thoroughly leaving no puddles prior to grouting. All trapped pockets in the steel structures shall be prepared using ordinary grout. Under no condition neat cement shall be used for grouting.

5.1.7.1 Non-shrinking grout shall be used for grouting purposes in:

- All vessels etc. having equipment height more than 6.0 meter from anchor base.
- All horizontal vessels having diameter 1000 mm and above.
- All compressor and engine foundations.

5.1.7.2 Ordinary grout shall be used for grouting purposes in:

- All vertical vessels etc. having height less than 6.0 m from anchor base.
- All horizontal vessels having diameter less than 1000 mm.
- All structural frames or platforms having height less than 6.0 m.
- All pumps, horizontal or vertical.
- All other miscellaneous foundations or piles or on paving.

5.1.7.3 Placement:

- All anchor bolts holes shall be completely filled with grout
- The finished surface shall be floated smooth and shall slope away from base plate approximately 1:25
- After the initial set is over, the grout shall be kept thoroughly wet for a minimum of 5 days
- Care is to be taken during grouting so that the base plate level and alignment is not disturbed.

Over and above the grouting clearance shown in foundation drawings, grouting of pockets made by base frame for machinery, equipment, steel structures etc. shall also be completely filled with grouting as per direction of Engineer-in-charge. DURING GROUTING THRED SHOULD BE COVERD PROPERLY BY USING CAP OR BY OTHER PROTECTION METHOD APPROVED BY CLIENT ENGINEER

5.2 Specification for Fabrication & Erection of piping

5.2.1 General

5.2.1.1 Basis of Work

The complete piping work shall be carried out in accordance with the following:

“Approved for construction” drawings and sketches issued by contractor to Owner / Consultant such as:

- Piping and Instrumentation diagrams
- Equipment layout drawings
- Foundation details of the equipment
- Piping layouts plans
- Piping material specifications
- Pipe support details
- Datasheets
- Orientations.
- Isometric drawings etc.

Table 5.1: Latest edition of following codes, standards and regulation shall be applicable

| Codes & standard | Description |
|-------------------|--|
| ANSI B 31.3 | Code for Chemical Plant Piping |
| ASME Sec IX | Code for welding procedure and welder qualification |
| ASEM Sec -V | Non Destructive Testing |
| IS : 823 | Code of procedure of Manual arc welding of mild steel |
| ASTM STD-F-441 | For dimensions, tolerances etc. for socket Schedule-80 |
| ASTM- F- 1970 | For Unions & Flanges |
| ASTM D 1598 /1599 | For failure test under constant pressure & short time rupture test |

Source: [Insert source text here](#)

5.2.2 Fabrication

5.2.2.1 Piping material

Pipe, pipe fittings, flanges, valves, gaskets, studs bolts, etc. used in a given piping system shall be strictly as per the 'Piping Material Specification' for the 'pipe class' specified for that system. To ensure the above requirements, all piping material supplied shall have proper identification marks as per relevant standards / certificates. Contractor shall provide identification marks on left over pipe length wherever marked up pipe length have been fabricated / erected.

5.2.2.2 Dimensional tolerances

Dimensional tolerances for piping fabrication should be as per the relevant piping code. The contractor is responsible for working to the dimensions shown on the drawings. However, the Contractor shall bear in mind that there may be variations in the location of equipment, inserts, etc. To take care of these variations, field welds shall be provided during piping fabrication. An extra pipe length of 100 mm over and above the dimensions indicate in the drawing may be left on the side of the pipe at each of the field welds. During erection, the pipe end with extra length of each field weld shall be cut to obtain the actual dimension occurring at site.. In any case, no extra claims will be entertained on this account. Wherever errors/omissions occur in drawings and Bills of Materials, it shall be the contractor's responsibility to notify the Engineer in charge prior to fabrication or erection.

5.2.2.3 Pipe joints

The piping class of each line specifies the type of pipe joints to be adopted. However, in piping 1.5" and below where socket welding/threaded joints are specified, but butt welds may be used with approval of Engineer in charge for pipe to pipe joining in long runs of piping. This is applicable for non-galvanized piping and piping without lining and Fit up by clamp.

5.2.2.4 Screwed piping

Galvanized piping shall have threads as per IS: 554 or ANSI B 2.1 NPT as required matching threads on fittings, etc. All other piping shall have tapered threads unless otherwise specified.

Threads shall be clean cut without any burn or stripping and shall have reamed ends. Threading of pipes shall be done preferably after bending, forging or heat treatment operations. If this is not possible, threads shall be gauge checked after welding heat treatment etc. During assembly of threaded joints, all threads of pipes and fittings shall be thoroughly cleaned of cuttings, dirt, oil or any other foreign matter. The male threads shall be coated with thread sealant or Teflon tape as directed by Engineer -in-charge, and the joint lightened sufficiently for the threads to seize and give a leak proof joint.

5.2.2.5 Flange connections

All flange facings shall be true and perpendicular to the axis of pipe to which they are attached. Flange bolt holes shall straddle the normal centre lines unless different orientation is shown in the drawing.

Wherever a spectacle blind is to be provided, drilling and tapping for the jack screws in the flange, shall be done before welding it to the pipe. Pipe should be 5 mm inside from flange for proper welding with flange from inside.

5.2.2.6 Branch connections

Branch connections should be as indicated in the piping material specifications, For end preparation, alignment, spacing, fit up and welding of branch connections (refer welding specifications) Templates shall be used wherever required to ensure accurate cutting and proper fit up.

For all branch connections accomplished by either pipe to pipe connections or by using forged tees, the rates quoted for piping shall be inclusive of this work.

Reinforcement pads shall be provided as indicated in drawing / specifications, In case if pipe to pipe joints Equal or non-Equal size "T" shall be used. No fabricated fittings shall be used.

5.2.2.7 Bending

Bending shall be as per ANSI B 31.3 except that corrugated or creased bends shall not be used.

Cold bends for lines 40mm and above, with a bend radius of 5 times the nominal diameter shall be used as required in place of elbows wherever allowed in accordance to piping specifications.

The completed bend shall have a smooth surface, free from cracks, buckles, wrinkles, bulges, flat spots and other serious defects. They shall be true to dimensions. The flattening of a bend, as measured by the difference between the maximum and minimum diameters at any cross sections, shall not exceed 8% and 3% of the nominal outside diameter, for internal and external pressures respectively.

5.2.2.8 Cutting and trimming of standard fittings

Fittings like elbows, couplings, half coupling etc. shall be cut trimmed wherever required to meet fabrication and erection requirements as per drawings or as instructed by Engineer in Charge.

5.2.2.9 Shop fabrication / pre- fabrication

The purpose of shop fabrication or pre fabrication is to minimise the work during erection to the extent possible. Piping spools, after fabrication, shall be stacked with proper identification marks, so as to

facilitate their withdrawal at any time during erection. During this period all flange faces (gaskets contact surfaces) and threads shall be adequately protected by coating with removable rust preventive. Care shall also be taken to avoid any physical damage to flange faces and threads.

Contractor shall fabricate miscellaneous elements like flash pots, seal pots, supporting elements including, and extension of spindles and inter locking arrangement of valves, operating platforms as required by Engineer in Charge to make the piping work to complete. In case of field joint edges shall be bevelled and covered by mask tape min 100 mm both sides to avoid paint. In yard or shop up to one coat of paint shall be applied.

5.2.3 Welding specifications

This specification shall be adapted to all welded pipe joints of stainless steel & carbon steel piping system under contractor's scope. The welded pipe joints are defined as under:

- All line joints of the longitudinal and circumferential butt welded and socket welded type.
- Attachments of castings, forgings, flanges and other supporting attachments pipes.
- Welded branch connections with or without reinforcing pads.
- Manufacture of welded / fabricated pipes & piping components.
- The attachments of smaller connections for vents, drains, drips and other instrument toppings.

5.2.3.1 Filler materials

- Filler materials, supplied by contractor shall be of the approved class and make.
- The electrodes supplied by contractor, for welding shall conform to the class specified in welding chart and as approved by Owner's/ Consultant's site engineers.
- The electrodes shall be suitable for the welding process recommended and base metal used. The physical properties of the weld produced shall not be lower than those of the base metal and shall correspond to the physical properties of the class of electrodes adopted. The choice of suitable electrodes shall be made after conducting tests on electrodes as per relevant standards and shall be the sole prerogative of the Engineer in Charge.
- The contractor shall submit batch test certificates from the Electrodes manufacturer giving details of physical and chemical tests carried out by them for each batch of electrodes supplied by the contractor.
- All electrodes shall be purchased in sealed containers and stored properly to prevent moisture absorption. The electrodes removed from containers shall be used in the job within 4 hours. If this is not practicable then they shall be charged in the storage ovens kept at temperature recommended by the electrodes manufacturer. The electrodes shall be handled with care to avoid damage to the flux coating.
- All low Hydrogen type electrodes shall be completely dry when used. These shall be pre-dried in suitable heaters at controlled temperature. Re drying temperature of low hydrogen electrodes shall be 340°C for 3 HRS OR AS PER MANUFACTURER RECOMMENDATIONS and subsequently held at 100°C unless otherwise specified by the electrode manufacturer.
- Electrodes wires and flux when used shall be free from rust, oil, grease, dust and other foreign matter which affect the quality of welding.
- For joints between carbon steel of different types or for heavy joints under restraint, low hydrogen electrodes shall be used. ARGON GAS PURITY 99.999 PPM , GAS FLOW FOR PURGING 18-20 LPM AND FOR SHIELDING 14-16 LPM.

5.2.3.2 Weather conditions

No welding shall be performed during rain or strong winds unless suitable protection is provided by the contractor for the parts to be welded and the welding personnel. Where this is not applicable, no welding shall be done during that time.

5.2.3.3 Welding process

Welding under this specification shall be done with the following processes subject to the approval of the Engineer in Charge and as per welding chart.

- Automatic or semi-automatic welding shall be done only with the specific approval of the Engineer in Charge. The procedure and materials applied for the same shall also meet the consent of the Engineer in Charge.
- Socket weld joints shall be done with low hydrogen type covered electrodes with manual shielded metal arc process.
- Downward technique is not allowed in welding pipes in horizontal position, unless permitted by the Engineer in Charge for particular cases not concerning process lines.
- Combination of welding processes or usage of electrodes of different classes or makes in a particular joint shall be done only after the welding procedure has been duly qualified and approved by the Engineer in Charge.
- GTAW process shall be used for piping.

5.2.3.4 End preparation

End preparation and welding fit up shall be as per standard / code. The contractor should prepare the joint in such a way to ensure full penetration.

Weld preparation shall be done as per client approved drg, detail joint configuration shall be mentioned in drgs

- Carbon steel
- Gas cutting, machining or grinding method shall be used. After gas cutting, machining / grinding shall be carried out on the cut surface to remove oxides.

Pug machine shall be used for edge preparation and profile shall be cut by profile machine

- Cleaning
- The ends to be welded shall be properly cleaned to remove paint, oil grease, rust oxides, sand, dust and other foreign matter with help of buffing machine and hand wire brushes. The ends shall be completely dry before commencing the welding.
- Alignment and spacing
- Pieces to be welded shall be aligned and spaced in a suitable manner, so as to hold the ends during welding at a distance to ensure full penetration. Root opening shall not be more than as specified. Internal misalignment shall not exceed 1.5 mm.
- For pipe with thickness 4mm or larger, the pieces to be butt welded shall be coupled by means of pipe couplers or by yokes or bridge "C" Clamps.
- Owner's inspector shall check and approve the joint fit up and alignment prior to the commencement of welding.

5.2.3.5 Welding techniques for root pass

- For Butt joints
 - The maximum electrodes size shall be For piping—root and other pass by 1.6/2.4 mm or as per WPS, tank and str size 2.6 mm. and the electrodes holder shall be connected, having due regard

for the polarity requirements of the electrodes approved for the use of pipe in horizontal position. Upward technique shall be used with the recommended values of current.

- The root pass of butt joints, regardless of the technique used, shall be such as to achieve full penetration. However, projection of weld metal into the pipe bore shall not exceed more than 3 mm. Inside reinforcement max 0.75 mm
- Root grooves and defective restart of the welding shall be carefully avoided.
- At each interruption of welding and on completion of each run, craters, weld irregularities and slag shall be removed by grinding or chiselling.
- After the welding is started and until the joint has been completed, displacements, shocks vibrations or stresses shall be avoided in order to prevent cracks or breaks in the weld.
- For root run of Alloy Steel piping or Carbon Steel of high pressure with 100% radiography shall be done through TIG welding method however no purging is required.
- For fillet welds
 - The max. Electrode size shall be 3mm max or (1/8") (10 SWG.)
 - On completion of the root pass, any visual defect or irregularities shall be ground off to avoid defects or irregularities in the next pass. Argon gas in SS purity 99.999 with 18-20 LPM flow, Shielding 14-16 LPM, Supplier certificate shall be submitted for review.
 - Welding to be carried out as per ASME B 31.3

5.2.3.6 Joint completion

Electrode size of more than 8 SWG (3 mm or 5/32") shall not be allowed for filling of the weld. Upward technique shall generally be used for pipe in horizontal and vertical position.

At each interruption of welding, and after each run of welding is completed, chipping and slag removal shall be done with rotary wire brush.

When the welding is complete, butt joints shall have a capping pass. It shall be slightly convex and fuse into the surface of the base metal in such a manner as to have a gradual notch free finish a good fusion at the joint edges. Welds shall have a regular appearance and shall be free from defects.

Welder number shall be stamped along each side of the weld, whenever required by the engineer in charge.

When welding is completed, the butt joints of piping regardless of welding methods used, shall have a weld reinforcement referred to the outside of the pipe, not more than 2mm, for pipes not thicker than 12 mm.

5.2.3.7 Welder's qualification

- Welder's specification shall be in accordance with the relevant code ASME Sec. IX latest edition. Owner's Inspector shall witness the test and certify the qualification of each welder. Only welders approved by the Owner's Inspector shall be employed. Contractor shall submit the welder's qualification report as per Appendix-B before the commencement of work. It shall be the responsibility of the contractor to carry out qualification tests of welders.
- The welders shall always have in their possession the identification card as per Appendix-D and shall produce it whenever demanded by Owner's Inspector. It shall be the responsibility of the Contractor to issue the identity cards only after it is certified by the Inspector.
- No welder shall be permitted to work without the possession of identity 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 such welding so performed shall be cut and redone at the expense of the Contractor. If qualified welder perform found not satisfactory then welder shall be disqualified.

- Inspection
 - Inspection of all welds shall be carried out as per API 1104 or ASME B 31.3 or equivalent latest edition. All finished welds shall be visually inspected for parallel and axial misalignment of the work, excessive reinforcement, for a concavity of welds, shrinkage cracks, inadequate penetration, unrepaired burn through under cuts, dimensions of the weld, surface and root porosity and other surface defects. LOP, LOF, CRACKES SHALL NOT BE ACCEPTED
- Radiographic examination
 - Radiographic requirements shall be as given below for process and utility systems with exception of steam piping falling under IBR where radiographic requirements of IBR should be compiled with.

Table 5.2: Radiographic examination

| No | Piping Material for | Extent of Radiographic Examination (%) |
|----|--------------------------------|--|
| 1 | Process lines in off-sites | As per specifications |
| 2 | Utility Pipeline | As per specifications |
| 3 | IBR Piping (if applicable) | As per specifications |
| 4 | Process Vapour (if applicable) | As per specifications |

Source: Insert source text here

- The radiographic procedure shall be approved by the Owner's Inspector, as per Appendix-E The procedure and quality of radiographic examination, limits of acceptability, require and removal of defects shall be checked as per API Code 1104, ASTM E 94, ASTM E 142 AND ASME B 31.3.
- The contractor shall be responsible for carrying out radiography, rectification of defects and re radiograph of welds repaired and rectified. He shall make necessary arrangements for providing all the equipment as well as radiographic film for the satisfactory and timely completion of the job.
- For welds between dissimilar materials, the radiographic examination shall be to the extent required for the material which calls for more stringent examination.
- Radiographic inspection of the welds shall be preferably made with X rays. Iridium isotope or any other X ray source may be used with the approval of the Engineer in Charge.
- The contractor shall fulfil all the statutory safety requirements for handling all the X ray and gamma ray equipment.
- The joints for radiography shall be selected by the Owner's Inspector and the radiography shall be performed in his presence. The contractor shall furnish all the radiographs to the Owner's Inspector immediately after processing them.
- The details of the radiography shall be duly entered and signed by him in a register and shall be submitted to the Owner's Inspector for approval.
- The contractor shall afford all the necessary facilities to the Inspector at site such as darkroom with controlled temperature, viewer, etc. for the examination of the radiographic film.
- Interpretation of radiographs shall be done as per acceptable standards.
- Magnetic particle or liquid penetration examination
 - The contractor shall arrange for all the equipment / materials required for carrying out dye Penetration / magnetic particle tests, as per the instruction of Engineer in charge.
- Proof test
 - Soundness of the welds shall be tested by means of hydrostatic and pneumatic tests as per part Appendix-F of this specification. The test shall be conducted only after fulfilling the requirements of visual inspection, radiography, etc. and when the entire work is certified by the Engineer in Charge for the performance of such tests.

1. PANELTY OF JOINTS AGAINST WELD DEFECTS- DOUBLE PANELTY WELDER , SPOOL, LINE WISE, APPROVED QAP SHALL BE REFERED. CS PIPING - 20% OF WELDING JOINTS

2. SS PIPING (if applicable) - 30% OF WELDING JOINTS, welding to be done FULL TIG, FILLER WIRE SS 316L.
3. The code of piping will be ANSI B 31.3, fluid category as per application. Normal, unless specified. In any case LF, LP and Crack are not permitted.

Note 1 - In case of defect in any joint, there will be penalty joints. The penalty joints will be 2 against 1 defective joint.

Note 2 - In case of both the piping the defects % has to be less than 2%.

Note 3 - SS piping (if applicable), the welding defects will be less than 2% (quality level). In case of defects % exceed 2%, the RT will be 50%. If defect % during the RT @ 50% is found more than 3% (quality level), RT will be 100%.

- Note 4 - The sampling will at random welder wise & size wise.
- Repairs of welds
 - Defects ascertained through the inspection methods which are not under permissible limits shall be removed from the joint completed by the process of chipping or grinding.
 - When the entire joint is unacceptable, the weld shall be cut completely and the pipe ends shall be restored for re-welding. After re-weld the joint shall be again checked.
 - No repair of welds shall be done without prior permission of the Engineer in Charge.
 - When random radiography is specified the first weld of each welder shall be completely radiograph except in pipe size 100 mm and below wherein the first two welds shall be taken for radiography.
 - For each weld found unacceptable due to welder's fault such as lack of fusion and penetration, two additional checks should be carried out on welds performed by the same welder whose weld joint was judged unacceptable originally, the operation is progressive and the procedure of radiography of two additional welds for each weld deemed unsatisfactory shall be followed till such time two consecutive satisfactory welds are obtained.
 - The contractor shall carry out these additional radiographs at his own expenses.
 - To avoid the possibility of too many defective welds by a single welder going undetected over a period of time, the contractor shall arrange for radiography promptly so that there is no backing in radiography.
 - Repairs and / or work of defective welds shall be done in time to avoid delays in the construction programme.
 - Repair procedure of weld should be carried out as per relevant pipe code and instruction of Engineer in charge.

Note: Welding of the pipe joints shall be done through welding generator or welding rectifiers only. MACHINE RANGE – 400 AMP.

5.2.4 Erection

5.2.4.1 Cleaning of piping before erection

Before erection all pre-fabricated spool pieces, pipes fittings etc. shall be cleaned from inside and outside by suitable means. The cleaning process shall include removal of all foreign matter such as scale, sand, weld spatter, cutting chips, etc. by wire brushes, cleaning tools etc. and blowing out with compressed air and/or flushing out with water. Special cleaning is required for Stainless steel (if applicable) prior to commissioning as specified in preceding chapter. Anticorrosive can be used with water after approval from client engineer

5.2.4.2 Piping routing

No deviations from the piping route, indicated on drawings shall be permitted without the consent of Engineer in Charge.

Pipe to pipe, pipe to structures, equipment distances/clearances as shown in the drawings shall be strictly followed as these clearances may be required for the free expansion of piping, operation & maintenance of equipment. No deviations from these clearances shall be permissible without the approval of Engineer in Charge.

In case of fouling of a line with other piping, structure, equipment etc. the matter shall be brought to the notice of Engineer in Charge and corrective action shall be taken as per his instructions.

5.2.4.3 Slopes

Slopes specified for various lines in the drawings, shall be maintained by the Contractor. Corrective actions shall be taken by the Contractor in consultation with Engineer in Charge wherever the Contractor is not able to maintain the specified slope.

5.2.4.4 Flange connections

While fitting up mating flanges, care shall be exercised to properly align the pipes and to check the flanges for trueness, so that faces of the flanges can be pulled together, without inducing any stresses in the pipes and the equipment nozzles. Extra care shall be taken for flange connections to pumps & all rotating equipment. The flange connections to these equipments shall be checked for misalignment, excessive gap etc. After the final alignment of the equipment is over, the joint shall be made up after obtaining approval of Engineer in Charge. Also axial & radial alignment shall be checked & corrected before the hook up.

Temporary protective covers shall be retained on all flange connections of pumps, and other similar equipments, until the piping is finally connected so as to avoid any foreign material from entering these equipments.

The assembly of a flange joint shall be done in such a way that the gasket between the flange faces is uniformly compressed. To achieve this, the bolts shall be tightened in a proper sequence. All bolts shall extend completely through their nuts but not more than 1/2".

Steel to C.I flange joints shall be made up with extreme care. Uniform tightening of the bolts shall be done only after accurately parallel and lateral alignment of flanges and its gaskets. IN CASE OF PIPE AND FLANGE JOINTS PIPE SHALL BE 5 MM DOWN FROM FLANGE END TO ACHIEVE WELD REINFORCEMENT.

5.2.4.5 Vents and drains

High point vents and low point drains shall be provided as per the instructions of Engineer in Charge, even if these are not shown in the drawings. The details of vents and drains shall be as per the piping material specifications/job standards.

5.2.4.6 Valves

Valves shall be installed with spindle/actuators orientation/position as shown in the layout drawings. In case of any difficulty in doing this or if the spindle orientation/position is not shown in the drawings, the Engineer in Charge shall be consulted and work done as per his instructions. Care shall be exercised to ensure that globe valves, check valves and other uni-directional valves are installed with the 'flow direction arrow' on the valve body pointing on the right direction. If the directional arrow is not marked on

such valves, this shall be done in the presence of Engineer in Charge before installation. Orientation of valve spindle shall be reconfirmed with the Engineer-in-Charge for the ease of operation & safety of operators. VALVES SHALL BE IN OPEN CONDITION DURING PNEUMATIC/HYDRO TEST

5.2.4.7 Pipe supports

- Pipe supports are designed and located to effectively sustain the weight and thermal effects of the piping system and to prevent its vibrations. Pipe on shoe / saddle (with suitable material frictional pad between supports and shoe) are provided to accommodate insulation, jacket, tracing, slope etc. supports Location and design of pipe supports will be shown in drawings. However, any extra supports, shoe, saddle etc. desired by Engineer in Charge shall also be installed at free of cost.
- Fabrication shall be done in accordance with IS 800 Section V AND ASME B 31.3
- All supports shall be strictly as per drawings/instructions of Engineer in Charge. Extra care shall be taken in the correct installation of supports of pumps, etc., according to the specific detailed drawings and supplier's erection instruction/drawings.
- No pipe shall be offset unless specifically shown in the drawings.
- Inspection of pipe supports shall be as per IS 800 , ASME B 31.3, NO PIPES SHALL BE DIRECTLY WELD WITH SHOE OR SUPPORT and other relevant codes.

5.2.5 Flushing

- POTABLE WATER FOR CS MAX 100 PPM CHLORIDE CONTENT flushing of all lines shall be done before pressure testing in the presence and as per the approval of the representatives of the owner/consultant - the Engineer in Charge.
- Flushing of pipelines shall be done by fresh potable water or by dry compressed air, wherever water flushing is not desirable, to clean the pipe of all dirt, debris or loose foreign materials. Required pressure for water flushing shall meet fire hydrant pressure or utility water pressure and for air flushing maximum pressure shall be 3.5 Kg/cm² OR AS PER CLIENT INSTRUCTION
- It will be contractor's responsibility to provide pumping equipment, compressors, water/air hoses with accessories, temporary carbon steel piping with valves, specials, fittings, etc. wherever required, instruments such as pressure gauges, safety valves etc. spool pieces, temporary gaskets, tools and tackles and all other arrangements, equipment, materials and consumable etc. required as aids for completing the flushing as per the directions of the Engineer in Charge.
- During flushing, care shall be taken for 'In line instruments'.
- The contractor shall carry out all the activities (with no extra cost to the owner) required before, during and after the flushing operation arising of the flushing requirements such as but not limited to the followings.
 - Dropping of valves, specials, distance pieces in line instruments and only piping part before flushing. The flanges to be blinded for this purpose should be envisaged by the contractor approved by the Engineer in Charge and should be provided with temporary gaskets at the time of initial erection.
 - After flushing is completed and approved, the valves, distance pieces, piping specials etc. shall be reinstalled by the contractor with permanent gaskets. However, flanges at equipment nozzles and other pieces where isolation is required during testing, only temporary gaskets will be provided.
 - From all permanent strainers the screens/ mesh shall be removed before flushing is done. During flushing temporary strainers shall be retained. After flushing temporary strainers shall be removed, cleaned and reinstalled before testing.
 - Full bore flushing shall be ensured and will be continued till the inside of the pipe is fully cleaned to the satisfaction of the Engineer in Charge.
 - For air flushing the line/system will be pressurized by compressed air at the required pressure which shall be 3.5 Kg/cm² (g) maximum. The pressure will be released by the opening of a valve already in line or installed temporarily for the purpose. This procedure will be repeated as many

times as required till inside of the pipe is fully cleaned. The arrangement for raising and releasing the air pressure will be made by the contractor as per the approval of the Engineer-in-charge.

- During flushing dirty water/air shall be discharged to the place directed by the Engineer in Charge. Care shall be taken during flushing, so as not to damage/spoil other agencies' `work'. As desired by the Engineer in Charge, proper temporary drainage for flushing water shall be provided by contractor. Precautions shall also be taken to prevent entry of water/foreign particles into equipment, electric meters, instruments, electrical installations etc. in the vicinity of lines being flushed.
- In case where fluid inlet into the pipeline through connected equipment such as vessels, etc. is unavoidable, this shall be done after having approval of Engineer in Charge.
- However, equipment thus included in the circuit for flushing shall be completely drained and dried with compressed air after flushing is completed.
- Records in triplicate shall be prepared and submitted by the contractor for each piping system (line wise), for the flushing done in the proforma in Appendix-F
- After water flushing is over, lines should be completely dried by dry compressed air.

5.2.6 Testing and inspection of piping

5.2.6.1 General requirements of testing

The intent of this specification is to provide a basis and guide for carrying out field testing of piping to assure leak tightness. This covers the general requirements for testing of piping after erection in accordance to the piping code ANSI B 31.6 Chapter VI. Clearance shall be taken before starting the tests from Engineer in Charge. TESTING HOLDING TIME 4 HRS.

Upon completion of installation, the piping system shall be inspected to ascertain that each of the following points has been adhered to:

- Proper use of materials
- Correct erection of line (in accordance with the approved drawings)
- Correct installation of guides and supports.
- Proper installation of (temporary) blind discs to be employed during testing.
- The correct application of pre-established pressure and temperature.
- Sectioning of the line in accordance with those materials and/or equipment which are not a part of the test.
- Radiography of weld joints as per specs.

With the exclusion of instrumentation, piping systems fabricated or assembled in the field shall be tested in the field, irrespective of whether or not they have been pressure tested prior to site welding or fabrication (Processing and utility piping system). Prior to testing all lines shall be flushed as per procedure mentioned. All tests shall be completed to the satisfaction of the Engineer in Charge.

On completion of test, the system shall be drained, dried with compressed air at the pressure decided by the Engineer in Charge and made ready for operation. WATER SHALL BE DRAINED IMMEDIATELY AND N₂ PURGING SHALL BE DONE WITH IN 8 HRS.

After completion of flushing and testing, draining and drying of lines, the permanent strainers screens shall be cleaned and reinstalled. After joints remaining untested during hydro testing shall be tested pneumatically after the hydro testing is over.

Pneumatic test pressure will be indicated by Engineer in Charge and contractor shall ensure that this test pressure is not exceeding any time during this test.

All tests shall be conducted as per the procedure outlined in this specification. Lines required by welding subsequent to the pressure test shall be retested after the repair at the same test pressure originally applied. However, Engineer in Charge may waive such retest in case of minor addition or alteration by taking same precautionary measures to assure sound construction.

Systems/lines may be tested in sections to facilitate completion of work in that area or areas however; such sections so tested shall be capped out, tagged suitably. Such weld joints untested may be exempted from hydraulic testing by the Engineer in Charge subject to radiographic approval of these joints.

Lines which are directly open to atmosphere such as vents, drains, safety valve discharges shall not be hydrostatically tested but all joints shall be visual inspected however, necessary as decided by continuous flow of fluid to eliminate the possibility of blockage.

Instrumentation pressure impulse piping shall start beyond first block valve located in the pressure line. During the pressure test this isolation valve must be kept closed to prevent dirt or any foreign matter entering into the instrument piping. Temperature impulse connections shall be closed off by a blind flange and for threaded joints plug to be provided by the contractor.

The Engineer in Charge shall be notified in advance by the contractor of the testing sequence/programme to enable him to be present for witnessing the test.

5.2.6.2 Test field

In general all pressure tests shall be hydrostatic using iron free water, which is clean and free of silt.

Air shall be used for testing only if water would cause corrosion of the system or overloading of supports etc. in special cases as directed by Company Site Representative.

Where air / water tests are undesirable, substitute fluids such as gas oil, kerosene, methanol etc. shall be used as the testing medium, with due consideration to the hazards involved. These test fluids shall be specified in the line list given to the contractor.

5.2.6.3 Test preparation

- - All equipment, materials consumable and services mentioned below but not limited to, required for carrying out pressure testing of piping shall be provided by the contractor at his own cost.
 - Pump sets for pressurization, air compressor etc.
 - Hoses for water, air or other test fluid with accessories and adapter flanges.
 - Supply, fabrication and erection of temporary carbon steel piping with valves, fittings, specials etc.
 - MIN TWO NOS CALIBRATED DIGITAL PRESSURE GAUGES WITH RANGE 1.5 TO 4 TIMES OF TESTING PRESSURE SHALL BE USED. Safety valves and all such instruments with necessary connections.
 - Temporary gaskets wherever required as per specification and instructions of the engineer in charge.
 - Soap, solution, grease, graphite, white lead, paint etc. all consumable materials.
 - Tools, tackles, pipe wrenches, spanners etc.
 - All aids are not specified here but only those required for carrying out pressure test of piping.
 - Before testing all piping shall be cleaned by fresh potable water or blown with compressed air where water flushing is not desirable to remove loose foreign matters. This should be completed wherever required prior to completion of final weld in order that visual inspection is possible. FOR C.S POTABLE WATER CHLORIDE CONTENT LESS THAN 100 PPM CHLORIDE CONTANT

- All safety valves and motor operated valves assemblies shall be installed only after flushing and testing is completed successfully.
- Wherever in the line any void exists, due to any reasons, for absence of control valves, safety valves check valves etc. It will be filled with temporary spools.
- All joints welded, screwed of, flanged shall be left exposed for the examination during the test. Before pressuring the lines each weld joint shall be cleaned by wire brush to free from rust and any other foreign matters.
- The test will be carried out with permanent gasket installed unless otherwise specified herein or instructed by the Engineer in Charge.
- In line instruments, other equipment and piping specialities shall be isolated during flushing and pressure testing by metallic blinds, blanks, caps or plugs.
- No pressure test shall be carried out against closed valves unless approved by the Engineer in Charge.
- Piping which is spring or counter weight supported shall be temporarily supported where the weight of the test fluid would overload the supports.
- Retaining pins or spring supports shall be removed only after testing is completed and test fluid fully drained. Gas lines when hydraulically tested, shall be provided with additional temporary supports during testing as directed by the Engineer in Charge by the contractor at his cost.
- Piping system subject to extended hydraulic test period shall be provided with protective device or relieve excess pressure due to thermal expansion for the test fluid.
- Test Pressure Gauges.
 - All gauges used for field testing should be of the bourdon type having a RANGE 1.5 TO 4 TIMES OF TESTING PRESSURE SHALL BE USED. and dial scale not less than 150mm diameter. Test pressure indication should fall in between 35% to 65% of gauge scale range. Gauges shall be of good quality in first class working condition.
 - Prior to the start of test and periodically during the field test programme all test gauges shall be calibrated using a standard Dead Weight Gauge tester or other suitable approved testing apparatus. Any gauge showing an un-corrective zero reading, or error of around $\pm 2\%$ of full scale range shall be discarded. The Engineer in Charge shall check the accuracy of master pressure gauge used for calibration.
 - The pressure gauge shall be installed as close as possible to the lowest point of piping system to be tested to avoid over stressing of any of the lower portion of the system. For longer lines and vertical lines two or more pressure gauges shall be installed at the locations decided by the Engineer in Charge.
- For lines containing check valves, any of the following alternatives will be adopted for pressure testing.
 - Wherever possible pressurize upstream of valve.
 - Replace the valve by a temporary spool and reinstall the valve after testing.
 - Provide blinds on the valve flanges and test the upstream and downstream of the line separately and remove the blind after testing.
- In all the above mentioned cases wherever valve flanges are required to make the break for testing, the contractor shall provide temporary gaskets at the time of initial installation of check valves. Final gaskets will be provided only after completion of testing.
- For lines below 2" i.e. welded check valves flapper or seat shall be removed (if pressurization of upstream of check valve is not possible) during testing. After completion of testing the flopper/seat will be refitted, the gasket in the inspection cover of check valve will be replaced by new one, if required by the engineer in Charge. The gasket for replacement will be supplied by the contractor. VALVES SHALL BE OPEN CONDITION, GASKETS SHALL BE REPLACED BEFORE BIX UP AND HANDING OVER.

5.2.6.4 Procedure for pressure testing

- Test pressure
 - The minimum hydraulic / pneumatic test pressure shall be as indicated in approved Line list or as per instruction of the Engineer in Charge.
 - The selections of the piping system for one individual test will be based on the followings
 - Test pressure required as per approved Line list / drawings.
 - Maximum allowable pressure for the material of construction of piping.

- Depending upon the above requirement and based on construction progress, maximum length of piping shall be included in each test.
- Pressuring, inspection and approval
 - All vents and other connections used as vent shall be left open while filling the lines with test fluid for complete removal of air. In all lines for pressurizing and depressurizing the system temporary isolating valves shall be provided if valve vents, drains do not exist in the system.
 - Pressure shall be applied only after the system/line is ready and approved by the Engineer in Charge.
 - Pressure shall be applied by means of a suitable test pump or other pressure source which shall be isolated from the system as soon as test pressure is reached and established in the system.
 - The test pressure shall be retained long enough to facilitate inspection of the complete system. Duration of the test in each case shall be fixed up by the Engineer in Charge but in no case it will be less than 4 hour. No leakage of any kind will be permissible. The glands of the valves in the system being tested shall be tightened by the contractors, so as to stop/minimize the leakage if any. In case leakage is not stopped after adequate tightening of gland, the hand wheel of such valves shall be painted red only on the rim to identify these valves for subsequent replacement of gland packing by the supplier. Valve gland tightening and hand wheel painting shall be the contractor's responsibility/scope.
 - Care shall be taken to avoid increase in pressure due to temperature variation during the test.
 - After completion of hydro test, the pressure shall be released. All the vents and drains shall be kept open till the lines are fully drained. After draining lines/systems shall be dried by air.
 - Pressure test shall be considered complete only after approved by the Engineer in Charge. Defects if any, noticed during testing shall be rectified immediately and re testing of the system lines shall be done by the contractor at his cost. Repairs if any shall be carried out after dewatering and completely drying the line by air.

5.2.6.5 Test records

Records in triplicate shall be prepared and submitted by the contractor for each piping system (line wise) for the pressure test done in the pro-forma as given in Appendix-G.

5.3 General specification for Painting

5.3.1 Scope of specification

This specification defines the requirements for surface preparation, selection and application of primer and finish paints for Piping & Steel structures, Equipment.

Not Withstanding whatsoever may or may not be indicated herein below, the contractor shall be bound to use the best available quality of materials, workmanship and methods of application, approved, and as per standard practice, it being understood that the specifications are largely indicative and not intended to be exhaustive.

5.3.2 Extent of work

The following surfaces and materials shall require painting.

- All structural steel work including steel supports, ladders, etc. as provided by the contractor.
- All above ground carbon steel piping and fittings (Including painting of identification marks).
- Coloured identification bands on all piping, as required.
- Storage tanks, & Equipment's & Chimneys, if applicable.

5.3.3 Codes and standards

Materials and workmanship for the work covered by this contract shall conform to the following codes and standards but not limited to:

1. IS : 5 Colour for ready mixed paints and materials
2. IS: 101 Methods of tests for ready mixed Paints and enamels.
3. IS: 2339 Aluminium paint for general purpose in dual containers.
4. IS: 2379 Colour code for identification of pipeline.
5. IS: 2932 Enamel, synthetic, exterior (a) undercoating (b) finishing.
6. Paint manufacturer's instruction & safety data sheet.
7. Technical data sheets for paints/touch – up paints system.

8. Surface preparation shall be carried out in accordance with project technical specification.

9. ISO 12944
10. ISO 8501
11. ASTM-D-3359
12. SSPC PA-2
13. ISO 8504
14. ISO 8502

The contractor shall arrange, at his own cost, to keep a set of the above standards at site.

5.3.4 General requirement

The paint manufacturer's instructions shall be followed as far as practicable at all times. Particular attention shall be paid to the following.

- Expiry date of paints/primers, wherever the same is indicated on the sealed containers and where not indicated, six months from the indicated date of manufacture to be considered.
- Proper storage to avoid exposure as well as extremes of temperature.
- Surface preparation prior to painting.
- Mixing and thinning.
- Application of primer paint and the recommended limit on time intervals between coats.
- Absence of inclement weather conditions while applying primer and paint.
- Lapse of minimum time interval between opening of sealed containers and their being fully used up.

Any painting work (including surface preparation) on piping shall be commenced only after the system tests have been completed and clearance for taking up painting work is given by the Engineer in Charge, who may, however, at his discretion authorize in writing, the taking up of surface preparation of painting work in any specific location, even prior to completion of system test.

5.3.5 Tools, tackles and Measuring Instruments

All tools, brushes, rollers, spray guns, blast materials, hand/power tools for cleaning and all equipment, scaffolding material, shot/sand blasting equipment, and air compressor etc. required to be used shall be suitable for the work and all in good order and shall be arranged by the contractor at site and in sufficient quantities.

All paints and primers shall be brought to the site in sealed containers which shall be opened in order of their manufacturing dates in the presence of the Engineer in Charge or his authorized representative. Time expired paints/primer shall not be used in the work.

5.3.6 Surface preparation

5.3.6.1 General

In order to achieve the maximum durability, one or more of the following methods of surface preparation shall be followed, depending on conditions of steel surface and as instructed by Engineer in Charge / Specification. Adhesion of the paint film to surface depends largely on the degree of cleanliness of the metal surface. Proper surface preparation contributes more to the success of the paint protective system.

- Manual or hand tools cleaning
- Mechanical or power tools cleaning.
- Solvent cleaning
- Sand blasting

Mill scale, rust, scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. Remove all other contaminants, oil, grease etc. by use of an aromatic solvent prior to surface cleaning.

Irrespective of the method of surface preparation the first coat of primer must be applied by brush on dry surface. This should be done immediately and in any case within 4 hours of cleaning of the surface. However, at times of unfavourable weather conditions, the Engineer in Charge shall have the liberty to control the time period, at his sole discretion and/or to insist on re-cleaning, as may be required before primer application of primer is taken up. In general, during unfavourable weather conditions, painting shall be avoided as far as practicable.

5.3.6.2 Procedure for surface preparation

CONTRACTOR SHALL SUBMIT DETAIL PAINTING PROCEDURE FOR CLIENT APPROVAL , PAINT MANUFACTURER SHALL CERTIFIED SURFACE PREPARATION PAINTING STAGES DURING WORKING BY INSPECTING FULL TIME AT WORKING AREA

- Manual or hand cleaning
 - Hand tool cleaning normally consists of the following.
 - Hand de-scaling and/or hammering
 - Hand scraping
 - Hand wire brushing.

Rust, mill scale spatters, old coatings and other foreign matter, shall be removed by hammering, scraping tools or emery paper cleaning, wire brushing or combination of the above methods. On completion of cleaning, loose material shall be removed from the surface by clean rags, and the surface shall be brushed, swept, de-dusted and blown off with compressed air to remove all loose matter.

- Mechanical or power tools cleaning
 - Power tools cleaning shall be done by mechanical striking tools chipping hammers, grinding wheels or rotating steel wire brushes. Excessive brushing of surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust, mill scale etc., shall be removed by clean rags and/or washed by air jet before application of the paint.
- Solvent cleaning
 - Solvent cleaning is a procedure for removing, detrimental foreign material like oils, grease, and other contaminants, which are soluble in solvents like white kerosene or mineral turpentine. Solvent cleaning is to be done, if warranted prior to surface preparation.
 - The following sequence of operations shall be followed for cleaning.
 - Soil, cement, spatter, drawing compounds, salts and other extraneous matter shall be removed by brushing with wire brushes, stiff fibre or by scraping. Fresh water cleaning may also be applied.
 - Oil, grease and other contaminants shall be wiped with rags or brushes dipped in solvent. The final wiping and scrubbing shall be done with clean rags and brushes to prevent spreading of loose oil, grease, etc. over the surface. After the cleaning it must be ensured that no residue is left on the surface.

Fire and explosion hazards are inherent in solvent cleaning operations. Recommended safety precautions of the solvent manufacturer shall be followed in the storage and handling of the solvent.

- Rub down and touch up of primer
 - The shop coated surface shall be rubbed down thoroughly with emery paper to remove all dust, rust and other foreign matters, washed with degreasing solvent (white spirit) to completely remove grease, etc. and then cleaned with warm fresh water or dry air. The portions wherefrom the shop coat has peeled off, shall be roughed up and allowed to dry before giving one coat of anti-corrosive primer. The compatibility between shop coat and primer should be ascertained from the paint manufacturer.
- Non compatible shop coat primer
 - The compatibility of the finishing coat with the earlier coat should be confirmed from the paint manufacturer. In the event of use of primer such as a Zinc rich epoxy, Inorganic Zinc Silicate, etc. as shop coat, the paint system shall depend on the condition of the shop coat. If the shop coat is in a satisfactory condition showing no major defects, the shop coat shall not be removed. The touch up primer and finishing coat (s) shall be identified for application by the Engineer in Charge.
- Sand blasting (To be considered only if carried out within controlled space and environment)
 - Blast cleaning is the ideal surface preparation method to achieve an ideal surface for painting. All the other forms of surface preparation have their limitations. In blast cleaning, an abrasive is directed at high velocity against the surface. The abrasives are generally chilled iron steel shots/grits or coarse sand. There are three recognized specifications for blast cleaning standards and all give three equivalent grades.

Table 5.3: Blasting Grade

| Blasting Grade Specification | | | |
|--|----------------------|-----------------------|----------------------|
| Steel structures painting council (USA) (SSPC Spec.) | White metal(SP-5-63) | Near white(Sp- 10-63) | Commercial(Sp- 6-63) |
| Swedish standard organization | Sa- 3 | Sa- 2 ½ | Sa- 2 |

Source: Insert source text here

Table 5.4: Blasting Grade Recommendation Guide

| Swedish standard | Corrosive environment | Application |
|------------------|-----------------------|--|
| Sa- 3 | Extremely aggressive | When long terms protection is desired because of difficult access to the surface |
| Sa- 2 ½ | Fairly Corrosive | When long term protection is desired, for chemically resistant systems such as polyurethane, epoxy and chlororubber resin paints |
| Sa- 2 | Mildly Corrosive | For steel to be painted with an ordinary synthetic conventional system |

Source: Insert source text here

The Swedish standard contains photographs of the various standards of three different degrees of blasted steel and is preferred for reference purpose by most individuals.

While the Swedish standard is pictorial, the other two are descriptive, attempting to define the areas of residual scale, etc. allowable for each grade. The Swedish standards, which are the most universally accepted, illustrate steel in four conditions before blasting has been carried out, as this will obviously affect the visual appearance of the surface after the required preparation. These are

- A completely mill scale covered un-corroded surface.
- A surface that has begun to rust with mill scales present.
- A surface that is fully corroded but not visibly pitted.
- A surface which is severely corroded with obvious pitting.

The grades of cleaning by blasting are pre-fixed by the reference Sa number. Thus Sa3 is steel blasted to white metal with all rust, mill scale etc., being removed fully. This is quite difficult to achieve practically and is normally only specified for certain speciality coatings. Sa 2.5 second quality or near white is the more usually accepted standard and would be considered as a suitable base to realise the full expected service of most coating systems.

Anything less than specified shall be a compromise.

Brush off or sweep blasting is frequently used as a more rapid and probably cheaper method of removing firmly adhering, fouling and broken coating systems.

Surface profile

Blast cleaning produces a roughened surface and the evenness of this profile is important. Most specifications call for peak to trough amplitudes of 100 microns maximum

Table 5.5: Surface profile

| Abrasive | Max. Abrasive particle Size (mesh) | Max. Height of Profile (mils) |
|-----------|------------------------------------|-------------------------------|
| Sand | | |
| Very fine | 80 | 1.5 |
| fine | 40 | 1.9 |
| medium | 18 | 2.5 |

| Abrasive | Max. Abrasive particle Size (mesh) | Max. Height of Profile (mils) |
|-------------------|------------------------------------|-------------------------------|
| coarse | 12 | 3.0 |
| Crushed Iron Grit | | |
| G-50 | 25 | 3.3 |
| G-40 | 18 | 3.6 |
| G-25 | 16 | 4.0 |
| G-16 | 12 | 8.0 |
| Iron Shots | | |
| S-230 | 18 | 3.0 |
| S-330 | 16 | 3.3 |
| S-390 | 14 | 3.6 |

Source: [Insert source text here](#)

5.3.7 Primer application

- After surface preparation, the primer should be worked into by brush application, also to cover the corners, sharp edges, etc. in the presence of an inspector nominated by the Engineer in Charge.
- The shades of successive coats should be slightly different in colour in order to ensure application of individual coats. The thickness of each coat and complete coverage should be checked as per provisions of this specification. This should be approved by Engineer in Charge before application of successive coats. AIR LESS SPRAY GUN METHOD SHALL BE USED FOR PAINTING

5.3.8 Type and application of paint

- Prepared surfaces shall not be left exposed to weather over-night and also to moist atmosphere before applying primer coat.
- Do not apply paint when the temperature falls below 10 degrees Centigrade.
- Do not apply paint when the relative humidity is above 90% or during fog, rain or mist.
- Primed surface should be over coated after the re-coat ability time specified in the datasheet given by concerned manufacturer.
- All the Primers and Finishes are supplied in brushing consistency. Thinner should be added only if viscosity increases during the application due to higher ambient temperature. Normally, addition of thinner is restricted up to 5-10% by volume in case of brush application. In case of spray application, only recommended thinner should be used to bring the paints to spraying consistency.
- Blast cleaned surfaces shall be coated with the primer within a maximum period of 3-4 hours. If relative humidity is over 75%, this period should be reduced to 1-2 hours, for better performance.
- All two pack primers and paints shall be used up within the pot life mentioned in the data sheets, given by the concerned manufacturer.
- Application of paints is recommended at ambient temperature. The substrata should also be at ambient temperature.
- Paint Material and Painting Systems shall be as per following table.

Table 5.6: Paint material and painting systems

| Sr. No | Description | Operating Temp o C | Activity | Specification of paint Material | No. Of Coats | Dry film Thickness Coat(IX) | Over coating Interval (Hours) | DFT Required (μ) | Total DFT Min(μ) |
|--------|-----------------------------------|--------------------|---------------------|---------------------------------|--------------|-----------------------------|-------------------------------|------------------|------------------|
| 1 | External Surface CS MOC Pipe with | 60 | Surface Preparation | Sa 2 ½ | - | - | - | - | 295 |

| Sr. No | Description | Operating Temp o C | Activity | Specification of paint Material | No. Of Coats | Dry film Thickness Coat(I)X | Over coating Interval (Hours) | DFT Required (μ) | Total DFT Min(μ) |
|--------|----------------------------|--------------------|--------------------|--|--------------|-----------------------------|-------------------------------|------------------|------------------|
| | fitting (Non Insulated) | | Prime coat | Inorganic base Ethyl Zinc silicate build (Min 60% Vol. solids) | 1 | 75 | 12 | 50 | |
| | | | Intermedi ate coat | Epoxy high build M10 Coating (Min 60% Vol. solids) | 1 | 150 | 24 | 150 | |
| | | | Final Coat | Aliphatic acrylic PU | 1 | 70 (35X2) | 12 | 50 | |

Source: Insert source text here

NOTE:

- All primers and finish coats shall be cold cured and air-dried unless otherwise specified.
- Technical data sheets for all paints shall be supplied at the time of submission of quotation.
- All paints shall be applied in accordance with manufacturer's instruction for surface preparation and application.
- The paints and primers, when supplied by the contractor, shall conform to the specifications given above and be of Approved Make.

5.3.9 Storage

All paints and painting material shall be stored only in rooms to be provided by the contractor and approved by the Engineer in Charge for the purpose. All necessary precautions shall be taken to prevent fire. The main storage building shall preferably be separate from the adjacent buildings. A sign-board bearing the words "PAINT STORAGE NO NAKED LIGHT HIGHLY INFLAMMABLE" shall be clearly displayed outside. Fire extinguishers shall be installed in the paint store.

5.3.10 Colour code

The scheme of identifying the materials contained in the equipments and carried in the pipeline shall generally follow the procedure mentioned in IS: 2379, colour code for the identification of pipelines.

The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour-coding consists of a ground colour and colour bands super imposed on it as per BIS standards.

Table 5.7: Color code for equipment

| Equipment | Colour |
|------------------------------|------------|
| Water meter | Light Blue |
| Tanks or Vessels | Dark grey |
| Pumps and Drives | Light grey |
| Compressors and Drives | Light grey |
| Generation Units | Dar grey |
| Instruments | Light grey |
| Electrical items cable trays | Dark grey |

| Equipment | Colour |
|--|---------------------------|
| Structural steel work and pipe supports | Dark grey |
| Overhead obstructions | Yellow with Black stripes |
| First aid Equipments | Signal green |
| Danger points on Electrical Installation | Orange |

Source: [Insert source text here](#)

Table 5.8: Color code for pipeline

| Table Heading Left | Column |
|---|-----------------------------|
| Portable water | Green |
| Fire water | Red |
| All drains | Dark grey + two black rings |
| Process fluids Acids | Yellow + one purple ring |
| Process fluids Alkali | Yellow + one violet ring |
| Process fluids Others | Dark Grey |
| Compressed air | Sky blue |
| Instrument air | Sky blue + one green ring |
| Width of colour band for one ring | 150 mm |
| For more than one ring width of each ring | 100 mm |
| Spacing between two rings | 100 mm |
| Spacing between two sets of rings | 1500 mm |

Source: [Insert source text here](#)

Colour bands to distinguish one fluid from another of the same group, shall be selected from tables of IS 2379. Ground colours as given in the scheme shall be applied throughout the entire length for un-insulated pipes. For insulated pipes colour coating of 2 m. length shall be applied over the aluminium sheeting at places requiring colour bands. Colour band (S) shall be applied at the following locations.

- At battery limit points
- At intersections in pipe racks
- At other points, such as midway of each piping rack, near valves, junction joints at service appliances, wells, etc.
- For long stretches/yard piping at 50m. Intervals.
- At start and at terminating point.

Lettering

The chemical, commercial or other commonly understood name of the flowing medium in the pipe or the contents in a tank or equipment shall be written on the ground color applied to the surface. The ground colour shall be applied in convenient lengths at selected places where personnel normally have to attend in the plant area.

Size of lettering

The following size of lettering shall be stencilled on the pipe or equipment such that the writing is clearly and easily visible from a maximum number of locations around the area.

Table 5.9: Size of lettering

| Dia of pipe, equipment | Size of lettering |
|---------------------------|-------------------|
| Upto 30 mm | 10 mm |
| Above 30 mm. upto 50 mm | 20 mm |
| Above 50 mm. upto 80 mm | 30 mm |
| Above 80 mm. upto 150 mm | 40 mm |
| Above 150 mm. upto 250 mm | 65 mm |
| Above 250 mm | 100 mm |

Source: Insert source text here

Direction of flow

Direction of flow shall be marked with arrows on pipe lines carrying fluids. The colour of the arrows shall be black or white and shall be in contrast to the ground colour on which it is painted

5.3.11 Inspection and testing

- All painting materials including primers and thinners brought to the site by the contractor for application shall be procured from reputed manufacturers as per specifications and shall be accompanied by manufacturer's test certificates. In case such certificates are not available, Engineer in Charge may direct the contractor to have the materials tested in accordance with relevant specifications at owner's/outside laboratories, accepted by the Engineer in Charge, and all costs thereof shall be borne by the Contractor.
- The Engineer in Charge, at his discretion may call for additional tests of materials accompanied by manufacturers test certificates. The Contractor shall arrange to have such tests performed, including batch wise test of wet paints for physical and chemical analysis. All costs thereof shall be borne by the Contractor.
- The painting work shall be subjected to inspection by the Engineer in Charge at all times. In particular, following stage inspection will be performed and contractor shall offer the work for inspection and approval at every stage before proceeding with the next stage. The record of inspection shall be maintained and FULL TIME INSPECTION BY PAINT MANUFACTURER.
- Stages of inspection are as follows :
- Surface preparation
- Primer application
- Each coat of paint.
- Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of the Engineer in Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period as defined in the General Conditions of Contract.
- RANDOM SALT CONTAMINATION SHALL BE CHECKED BEFORE APPLY OF PAINT TO ENSURE SALT DEPOSITION ON SURFACE, FREQUENCY SHALL BE DECIDED BY PAINT MANUFACTURER AND CLIENT ENGINEER. ADHESION TEST – XCUT AND DOLLY AS PER CLIENT INSTRUCTION
- Dry film thickness (DFT) and Wet Film Thickness (WFT) shall be checked and recorded after application of each coat.
- The contractor shall provide thickness-measuring instrument (ELKOMETER) with appropriate range(s) for measuring dry film thickness of each coat.
- At the discretion of the Engineer in Charge, the contractor shall ask the paint manufacturer to provide expert technical service at site as and when required. This service should be free of cost and without

any obligation to the owner, as it would be in the interest of the manufacturers to ensure that both surface preparation and application are carried out to their recommendations.

- Final inspection shall include measurement of dry film thickness, check of finish and workmanship. The thickness should be measured at as many points/ locations as decided by Engineer in Charge and shall be within + 10% of the dry film thickness.

5.3.12 Guarantee

The contractor shall guarantee that the chemical and physical properties of materials used are in accordance with the specifications.

The contractor shall produce test reports from the manufacturer regarding the quality of the particular batch of paint supplied. The Engineer in Charge shall have the right to test for quality, the wet samples of the paint at random. Batch test reports of the manufacturers for each batch of paint supplied shall be made available by the contractor.

APPLIED PAINT MUST BE GUARENTTED FOR 10 YRS MAINTENANCE FREE

5.4 Measurement of work and Basis of payment

- Measurement of weights will be in metric tonnes corrected to the nearest kilogram.
- Linear measurements will be in meters corrected to the nearest centimetre.
- Payment against erection of all types of equipment shall be on number basis at the rates given separately in the schedule of rates. Any dismantling and re-erection of equipment required for the purpose of flushing, testing, calibration etc. shall be carried out by the contractor within the quoted rates
- Measurement of pipelines shall be based on the approved execution drawings. Pipelines shall be measured along the centre lines of pipes, curvilinear centre lines of bends and elbows; centre lines of flanges and all other fittings, such as tees, reducers etc., all in the line instruments, filters, sight glasses etc. All types of valves including control valves shall be excluded from this measurement. Branch connections shall be measured from the outer surface of the header.
- Erection of all types of valves such as gate/globe/ check/ball/control safety valves strainer etc. will be paid on number basis at the rates given separately in the schedule of rates. Any dismantling and erection of the valves required for the purpose of flushing, testing, calibration etc. will be carried out by the contractor within the quoted rates. For safety valves, measurement shall be on the basis of inlet pipe size.
- All hot/cold bends, tees, reducers etc. for sizes 4" and above shall be fabricated and erected as per requirements, if required, by the contractor at no additional cost and his rates for piping of sizes 4" and above shall be inclusive of this work.
- For fabrication and erection of reinforcement pads, the rate is inclusive in piping work.
- Vents and drains shall be measured from O.D. of pipe lines and shall be paid for at the corresponding unit rates for similar sizes of pipe. Other piping attachments such as couplings, earthing lugs etc. shall be provided by the contractor within his quoted rates for piping.
- Fabrication and Erection of all types of supports, if required, shall be carried out by the contractor as part of piping work and rates for the same shall be quoted separately per tonne.
- While fabricating the supporting elements, the contractor will ensure that the dimensions shown in the approved drawings match with site conditions. In case of deviation due to site requirement payment will be made as per the actual measurement
- Supply, fabrication of spool pieces for temporary use to aid contractor's work such as fabrication, erection, flushing and testing of piping shall be done by contractor as part of piping work and no separate payment shall be made for this.

- Radiography And Dye Penetrate Test
- Schedule of rates of piping work category should include charges for radiography and required DP test as per piping code/ specifications. Repeat radiography due to defective films or on repaired joints due to contractor's fault or for additional radiography necessitated due to poor performance of contractor's welder will be done at contractor's cost
- ALL MEASURING LATEST VERSION AND DEMANDED BY CLIENT ENGINEER SHALL BE IN SCOPE OF CONTRACTOR

6 General Electrical Specifications and Requirements

6.1 List of applicable IS regulation:

BIDDER are required to consult following IS Codes (latest revisions only) along with subsequent amendments, where per applicable, before submitting their bids.

Table 6.1: List of applicable IS regulation

| S/N | IS Code- Year | Description |
|-----|--------------------|--|
| 1 | 732 –1989 | Code of practice for electrical wiring installation |
| 4 | 3043-1987 | Code of practice for earthing |
| 6 | 5216-1982 | Recommendation on safety procedure and practices in electrical work (Part 1 & 2) |
| 7 | 10118-1982 | Code of practice for Selection, installation and maintenance of Switchgear. (Part 1 to 4) |
| 8 | 3034-1993 | Fire Safety of industrial building: Electrical generating & distribution stations. |
| 10 | 5572-2009 | Classification of hazardous area having flammable gases and vapour for electrical installation |
| 11 | 1554-1988 | PVC insulated (Heavy duty) electrical cables Part 1 for working voltage up to and including 1100 V |
| 12 | 5571-2009 | Guide for selection of electrical equipment of hazardous areas |
| 13 | IS/IEC-60079-2007 | Explosive Atmosphere Part 1 Equipment protection by flameproof enclosures 'd' |
| 14 | 13947-2004 | Low voltage Switchgear and control gear |
| 15 | 10810-1984 | Methods of test of cables |
| 16 | 4237-1982 | General arrangement for Switchgear and control gear for voltage not exceeding 1000V |
| 20 | 3231-1987 | Electrical Relays for power system protection |
| 21 | 5578-1984 | Guide for making insulated conductor. |
| 22 | 2189-2008 | Selection, installation and maintenance of automatic fire detection & Fire alarm system code of Practice |
| 23 | 1646-1997 | Code of practice for Fire Safety of buildings (General) |
| 26 | 7098 part 1 : 1988 | XLPE insulated PVC sheathed cable for working voltage up to & including 1100 V. |
| 28 | 3842-1967 | Application guide for electrical relays in AC Systems (Part 1 to 5) |

6.2 Standards

- a. The work shall be carried out in the best workmanlike manner in conformity with this specification, the relevant Specification/Codes of practice of the Indian Standards Institution, approved drawings and the instructions issued by the engineer-in-charge or his authorised representative, from time to time. Some of the relevant Indian standards are listed elsewhere in this tender document.
- b. In addition to the above, all works shall also conform to the requirement of the followings:
 - Indian Electricity Act and Rules framed there under.
 - Fire Insurance Regulations.
 - Regulations laid down by the Chief Electrical Inspector of the State/State Electricity Board/Union Territory.
 - Regulations laid down by the Factory Inspector of the State/Union Territory.

- Any other regulations laid down by the local authorities.
- Installation & operation manuals of original manufacturers of equipment.

6.3 Equipment and Accessories Specifications

6.3.1 Single Starter Panel

6.3.1.1 Erection

Single starter control panel with all the electrical components of adequate rating of MPCB/MCCB, contactor, motor protection relay, auxiliary contacts and terminal blocks. The contractor shall be responsible for final assembly and inter-connection of bus bars/wiring. Switchgear shall be aligned and levelled on their base channels and bolted or tack welded to them as per the instructions of the Engineer-in-Charge. The earth bus shall be made continuous throughout the length. Relays and instruments shall be mounted and connected on the switchgear.

If the instrument transformers are supplied separately they shall be erected as per the direction of the Engineer-in-Charge. The contractor shall fix the cable glands after drilling the bottom/top plates of all switch boards with suitable holes at no extra cost.

Range of overload relays/timers etc. shall be checked with requirement of motor to be connected at site.

6.3.1.2 Testing

- The following tests shall be performed on the feeder during erection.
- All adjustable direct acting trip devices shall be set using values given by the Engineer-in-Charge/Manufacturer.
- Before switchgear is energised the following tests shall be performed on each circuit breaker in its tests position.
 1. Close and trip the circuit breaker from its local control switch push button or operating handle. Switchgear control bus may be energised to permit test operation of circuit breaker with AC closing with prior permission of the Engineer-in-Charge.
 2. Test tripping of the electrically operated circuit breaker by operating mechanical trip device.
 3. Test proper operation of circuit breakers latch, check carriage limit switch if provided.
 4. Test proper operation of lock-out device in the closing circuit. Wherever provided by simulating conditions which would cause a lock-out to occur.
 5. Trip breaker either manually or by applying current or voltage to each of its associated protective relays.
- Before switchgear is energised, the tests covered above shall be repeated with breaker in its normal operating position.
- The contractor shall arrange testing and calibrations of relays. The testing equipment including primary and secondary injection sets (if required) etc. shall also have to be arranged by the Contractor. Payment for the above work shall be deemed to have been included in the erection of switch boards/control panels.

6.3.2 Installation of cable

Cable network shall include power & control cables which shall be laid in underground trenches, Hume pipes, open trenches, cable trays, GI pipes, or on building structure surfaces as per the Engineer-in-Charge's instructions. Supply and installation of cable trays, GI pipes/conduits, cable glands and sockets

of both ends, isolators, junction boxes, remote push button stations, etc. shall be under the scope of the contractor.

6.3.2.1 General requirements for handling of cables

1. Before laying cables, these shall be tested for physical damage, continuity, absence of cross phasing, insulation resistance to earth and between conductors. Insulation resistance tests shall be carried out with 500/1000 volt Megger.
2. The cable shall be supplied at site, wound on wooden drum as for as possible. For smaller length and sizes, cables in properly coiled form can be accepted. The cables shall be laid by mounting the drum of the cable on drum carriage. Where the carriage is not available, the drum shall be mounted on a properly supported axle, and the cable laid out from the top of the drum. In no case, the cable will be rolled on, as it produces kinks which may damage the conductor.
3. Sharp bending and kinking of cables shall be avoided. The bending radius for PVC insulated and sheath armoured cable shall not be less than 10 D where 'D' is overall diameter of the cable.
4. While drawing cables through GI pipes, conduits, RCC pipes, ensure that size of pipe is such that, after drawing cables, 40% area is free. After drawing cables, the end of pipe shall be sealed with cotton/bituminous compound.
5. Armoured cables shall never be concealed in walls/floors/roads without GI pipes, conduits or RCC pipes.
6. Joints in the cable throughout its length of laying shall be avoided as for as possible and if unavoidable, prior approval of site engineer shall be taken. If allowed, proper straight through epoxy resin type joint shall be made, without any additional cost.
7. A minimum loop of 3 M shall be provided on both ends of the cable, or after every 150 M or unjointed length of cable, and on both ends of straight through cable joint. This additional length shall be used for fresh termination in future. Cable for this loop shall be paid for supply and laying.
8. Cable shall be neatly arranged in the trenches/trays in such manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the Contractor.
9. All cable routes shall be carefully measured and cable cut to the required lengths and undue wastage of cables to be avoided. The routes indicated in the drawings are indicative only and the same may be rechecked with the Engineer-in-Charge before cutting of cables. While selecting cable routes, interference with structures, foundations, pipeline, future expansion of building, etc. should be avoid.
10. All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be taped with an approved PVC or rubber insulating tapes. Use of friction type or other fabric type tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.

11. Wherever cable rises from underground/concrete/masonry trenches to motors/switchgears/push buttons, these shall be taken in GI pipes of suitable size, for mechanical protection up to 300 mm distance of concerned cable gland or as instructed by the Engineer-in-Charge.
12. Where cables pass through foundation/walls of other underground structures, the necessary ducts or opening will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures the electrical contractor shall determine their location and obtain approval of the Engineer-in-Charge before cutting is done

6.3.2.2 Laying of cables (underground system)

1. Cables shall be so laid in ground that these will not interfere with other underground structures. All water pipes, sewage lines or other structures which become exposed by excavation shall be properly supported and protected from injury until the filling has been rammed solidly in places under the ground them. Any telephone or other cables coming in the way are to be properly shielded/diverted as directed by the Owner/Consultant.
2. Cables shall be laid at minimum depth of 750mm in case of LV and 1200 mm in case of MV, from ground level. Excavation will be generally in ordinary alluvial soil. The width of the trench shall be sufficient for laying of required number of cables.
3. Sand bedding 75 mm thick shall be made below and above the cables. A layer of bricks (full size) shall be laid on the edge, above sand bedding on the sides of cables and a flat brick to cover cable completely. More than one cable can be laid in the same trench by providing a brick on Edge between two cables. However, the relative location of cables in trench shall be maintained till termination. The surface of the ground after back filling the earth shall be made good so as to conform in all respects to the surrounded ground and to the entire satisfaction of the Engineer-in-Charge.
4. For all underground cables, route markers should be used.
5. Route markers should be grounded in ground with 1:2:4 cement concrete pedestal size 230x230x300 mm.
6. Cable markers should be installed at an interval not exceeding 50 M along the straight routes of cables at a distance of 0.5 M away from centre of cable with the arrow marked on the cable markers plate indicating the location of cable markers plate indicating the location of cable. Cable markers should also be used to identify change in direction of cable route and for location of every joint in underground cable.
7. RCC Hume pipe for crossing road in cable laying shall be provided by employer. No deduction shall be made for cable laying in Hume pipe for not providing bricks, sand and excavation. RCC Hume pipe

At the ends shall be sealed by bituminous compound after laying and testing for cable by electrical contractor without any extra charge.

6.3.2.3 Laying of cable under floors:

1. GI class a pipe shall be used for laying of outgoing cables from distribution boards to motors, isolators/ junction boxes of motors, starter of motors and push button stations. Preferably one

cable shall be drawn through one pipe. Size of pipe shall be such that after drawing of cable 40% area is free. If length of pipe is more than 30 M, free area may be increased to 50%.

2. Uses of elbows are not allowed at all and number of bends shall be kept minimum. Instead of using bends with sockets, pipe bending machine shall be used for making long smooth bends at site.
3. Ends of pipe shall be sealed temporarily while laying with cotton/jute/rubber stopper etc. to avoid entry of building material.
4. Exact location of equipment/motor/isolator/push buttons etc shall be ascertained prior to laying of pipe.

6.3.2.4 Lying of cable in masonry trenches:

- a) Masonry/concrete trenches for laying of cable shall be provided by employer. Cable shall be clamped to these supports with aluminium saddles/clamps and galvanised bolts. However, steel members such as angles/flats, etc. shall be provided and grouted by the Contractor to support the cables without any extra charge. Minimum size of angles shall be 50 x 50 x 6 mm and flats 50 x 6 mm.
- b) Entry of cables in trenches shall be sealed with bituminous MASTIC compound to stop entry of water in trenches.

6.3.2.5 Laying of cables in cable trays:

- a) The erection of cables trays shall include providing, cutting, welding, fixing, etc. of steel members such as MS angles/channels/flats, GI fasteners, etc.
- b) Cables shall be fixed in cable trays in single tier formation and cables shall be clamped with aluminium flat clamps and galvanised bolts/nuts.
- c) Earthing flat/wire can also be laid in cable tray along with cables.
- d) After laying of cables minimum 20% area shall be spare

6.3.2.6 Laying of cables on building surface/structure:

- a) Such type of cable laying shall be avoided as far as possible and will be allowed only for individual cables or small group of cables which run along structure.
- b) Cables shall be rigidly supported on structural steel/masonry using individual cast/malleable iron galvanised saddles and these supports shall be approximately 400 – 500 mm for cables up to 25 mm diameter and maximum 1000 mm for cables larger than 25 mm. Unsightly sagging of cables shall be prevented. Only aluminium/GI clamps with GI bolts/nuts shall be used.
- c) If drilling of steel structure must be resorted to, approval must be secured from the Engineer-in-Charge and steel must be drilled where the minimum weakening of the structure will result.

6.3.2.7 Termination and jointing of cables:

- a. For MV cables suitable size of heat shrink termination kit shall be used.
- b. Use of glands:
 - All PVC cables up to 1.1 kV grade, armoured or unarmoured shall be terminated at the equipment/junction box/isolators/push buttons/control accessories, etc. by means of suitable size compression type cable glands. Armour of cable shall be connected to earth point. The contractor shall drill holes for fixing glands wherever necessary. Wherever threaded cable gland is to be screwed into threaded opening of different size, suitable galvanised threaded reducing bushing shall be used of approved type.
 - In case of termination of cables at the bottom of the panel over a cable trench having no access from the bottom, close fit holes should be drilled in the bottom plate for all the cables in one line, and then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables with glands, it shall be sealed with cold sealing compound.
- c. Use of lugs/sockets
 - All cable leads shall be terminated at the equipment terminals, by means of crimped type solderless connectors unless the terminals at the equipment ends are suitable for direct jointing without lugs/sockets.
 - The following is the recommended procedure for crimped joints and the same shall be followed:
 - Strip off the insulation of the cable and with every precaution, not to sever or damage any strand. All insulations to be removed from the stripped portion of the conductor and ends of the insulation should be clean and square.
 - The cable should be kept clean as far as possible before assembling it with the terminal /socket. For preventing the ingress of moisture and possibility of re-oxidation after crimping of the aluminium conductors, the socket should be filled with corrosion inhibiting compound. This compound should also be applied over the stripped portion of the conductor and the palm surface of socket.
 - Correct size and type of socket/ferrule/lug should be selected depending on size of conductor, and type of connection to be made.
 - Make the crimped joint by suitable crimping tool.
 - If after crimping the conductor in socket/lug, some portion of the conductor remains without insulation the same should be covered sufficiently with PVC tape.
 - For MV cable the manufacturer's recommendation should be followed.

6.3.2.8 Dressing of cable inside the equipment:

After fixing of cable glands, the individual, cores of cable shall be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Cable shall be dressed in such a manner that small loop of each core is available inside the panel.

For motors of 20 HP and above, terminal box if found not suitable for proper dressing of aluminium cables, the erector shall modify the same without any additional cost.

Cables inside the equipment shall be measured and paid for.

6.3.2.9 Identification of Cables/Wires/Cores

Power cables shall be identified with red, yellow & blue PVC tapes. For trip circuits, identification, additional red ferrules shall be used only in the particular cores of control cable at the termination points in the switchgear/control panels and control switches.

In case of control cables all cores shall be identified at both ends by their wire numbers by means of PVC ferrules or self-sticking cable markers, wire numbers shall be as per schematic/connection drawing. For power circuit also, wire numbers shall be provided if required as per the drawings of switchgear manufacturer/supplied.

6.3.2.10 Testing of cables

- a. Before energising, the insulation resistance of every circuit shall be measured from phase to ground. This requires 3 measurements if one side is grounded and 6 measurements for 3 phase circuits.
- b. Where splicer’s or termination are required in circuits rated above 650 volts, measure insulation resistance of each length of cable before splicing and/or terminating. Repeat measurements after splices and/or terminations are complete.
- c. DC high voltage test shall be made after installation on the following:
 - All 1100 volts grade cables in which straight through joints have been made.
 - All cables above 1100 volts grade. For record purpose test data shall include the measured values of leakage current versus time.
 - The DC High Voltage test shall be performed as detailed below.
 - Cables shall be installed in final position with all the straight through joints complete. Terminations shall be kept unfinished so that motors, switchgear, transformer etc. are not subjected to test voltage.

The test voltage and duration shall be as per relevant codes and practices of Indian Standards Institution.

6.3.2.11 Performa for Testing Cables:

- a. Drum No. from which cable taken Date of Test
- b. Cable from to
- c. Length of run of this cable Mtrs
- d. Insulation resistance test
 - between core-1 to earth Mega ohm
 - between core-2 to earth Mega ohm
 - between core-3 to earth Mega ohm
 - between core-1 to core-2 Mega ohm
 - between core-2 to core-3 Mega ohm
 - between core-3 to core-1 Mega ohm
 - Test voltage applied : 1 kV
- e. High voltage test Voltage Duration
 - between cores and earth

- between individual cores

(This proforma shall be jointly signed by the Engineer-in-Charge and the Contractor).

6.3.3 Earthing Network

The entire earthing installation shall be done in accordance with the earthing drawings, specifications and instruction of the Engineer-in-Charge. The entire earthing system shall fully comply with the Indian Electricity Act and Rules framed there under. The contractor shall carry out any changes desired by the Electrical Inspector or the Owner/Consultant in order to make the installation conform to the Indian Electricity Rules, at no extra cost. The exact location of the earth pits, earth electrodes and conductor and earthing points of the equipment's shall be determined at site, in consultation with the Engineer-in-Charge. Any change in the methods, routing, size of conductor etc. shall be subject to approval of the Owner/Engineer-in-Charge before execution.

6.3.3.1 Earthing pit with electrode

- a. Plate or pipe type earth electrode with earth pit shall be provided for this work unless otherwise advised by the Engineer-in-Charge due to typical site conditions. Earthing electrode and pit shall be as per IS: 3043-1987 (code of practice for Earthing). For ready reference, sketches for pipes and plate type earth electrodes earthing pit have been enclosed herewith all earth electrodes shall preferably be driven to a sufficient depth to reach permanent moist soil.
- b. Earth pit centre shall be at a minimum distance of 2 m from nearest building, unless otherwise advised. The minimum 3 M distance shall be maintained between centres of 2 earth pits.
- c. Earth bus, earthing lead and earth wire/strip:
 - All electrical equipment is to be doubly earthed by connecting two earth strips and wire conductors from the frame of the equipment to the earthing pit/main earthing ring. The earthing ring will be connected via links to several earth electrodes. The cable armour will be earthed through the cable glands. Conductor size of connection to various equipment shall be specified in the drawing/as instructed by the Engineer-in-Charge. However, the length of the branch leads from equipment to earthing grid/ring shall not be more than 10 to 25 meters.
 - All hardware for earthing installation shall be hot dip galvanised. Spring washers shall be used for earthing connections of equipment having vibrations.
 - However, while deciding type & size of earth lead, the resistance between the earthing system and the general mass of the earth shall be as per IS code of practice. The earth loop impedance to any point in the electrical system shall not be in excess of 1.5 ohm in order to ensure satisfactory operation of protective devices.
 - GI wire/aluminium wire shall be connected to the equipment by providing crimping type socket/lug.
 - Wherever earthing strips is to be provided in cable trays, it shall be suitably clamped on cable tray and electrically bounded to the cable tray at regular interval.
 - Excavation and refilling of earth, necessary for laying underground earth bus loops shall be responsibility of the contractor.
 - Wherever earth leads/strips/wire are in cable trenches, these shall be firmly and suitably cleated to the walls/supporting steel structure on which cable is clamped.
 - The neutral of the transformer shall be connected to earth pit independently.

6.3.4 Cable Trays

These shall be channel type, fabricated from slotted MS sheets (14 gauge minimum), hot dip galvanised, complete with all accessories such as bends, tees and reducers. Only aluminium flat clamps with GI/Chrome plated bolts/nuts/screws to be used for clamping cables. Sizes of these trays shall be as specified in Bill of Quantities or approved by Engineer-in-Charge. Cable Tray shall be of adequate size for power and control cable laying wherever required.

6.3.5 Cable Glands

Cable glands shall be of heavy duty double compression type of brass, chrome plated. These shall have a screwed nipple with conduit electrical thread and check nut. These shall be suitable for armoured/unarmoured cables which are being used.

6.3.5.1 Cable Connectors

Cable connectors, lugs/sockets, shall be of copper/aluminium alloy, suitable tinned, solder-less, crimping type. These shall be suitable for the cable being connected and type of function (such as power, control or connection to instruments etc.)

6.3.5.2 Cable Route Markers

These shall be galvanised Cast Iron plate with marking (LV/MV) diameter 150 mm with 600 mm long 25 x 25 mm MS angle riveted/bolted with this plate.

6.3.5.3 Cable Indicators

These shall be self-sticking type of 2 mm thick lead strap for overall cable. PVC identification number, ferrules shall be used for each wire.

6.3.6 Push Button Stations

These shall be floor/wall mounted type as specified in Bill of Quantities. These shall be fabricated from 1.6 mm thick stainless steel sheets (SS-304). In case of floor mounted stations, these shall be supported on 51 mm "A" class MS pipe clad with SS pipe. Front cover shall be removable type with suitable, rubber gaskets to make them dust, vermin and moisture proof. All outer SS surfaces shall be polished to 150 grit finish. Each feeder shall be provided with "ON" (green) Push Button, "OFF" (red) Push Button, Name Plate (white Bakelite), indication lamp, etc. Green & Red Push Buttons shall have contact elements having 1NO+1NO. "OFF" push button shall be provided with lockable (key operated) arrangements to prevent accidental starting. No. of feeders shall be specified in Bill of Quantities. The indication lamp can be combined with "ON" push button.

6.3.7 Motors

6.3.7.1 Erection and Testing

Erection and coupling of motors with machine will be done under the mechanical erection. However, earthing, cable termination, testing and commissioning are covered under this section. Before starting the alignment and coupling of motors with machines the insulation resistance of the motor will be

measured and recorded by the contractor. The direction of the rotation of the motor shall also be checked before the driven equipment is finally coupled.

Motor bearings are to be checked and rectified including supply and changing of grease, checking of fans coupling with bodies, etc. The contractor shall take adequate precaution and care while executing the work. For all damages due to negligence etc., the contractor shall be responsible to replace/repair at his own cost.

Before connecting power cables to motors the insulation resistance of all motor windings shall be measured. Measurement shall be repeated after power cable terminations are completed and before first charging.

Motor shall be operationally tested together with the starting gear and auxiliary apparatus such as push button stations, contactor, level and pressure controls, signal and alarm apparatus, power and control circuits, etc.

Check the anti-condensation heater and its circuit (if installed).

Check the setting of the thermal overload protection/ single phase prevention/under voltage protection. Testing of these devices is to be done wherever required as per the instructions of the Engineer-in-Charges.

All motors shall run uncoupled for a maximum period of 4 hours before the driven equipment is placed in regular service.

6.3.7.2 Performa for Motor Testing:

- | | | | |
|----------------------------|---|---------|-------|
| Name plate details Voltage | : | HP | kW |
| Mounting | : | Current | RPM |
| Frame size | : | Make | S.No. |
| Others | | | |
- | | | | |
|--|---|-----------|--|
| Insulation test (before cable connections) | | | |
| 1) between phase and earth | : | Mega ohms | |
| 2) between each phase | : | Mega ohms | |
- | | | | |
|--|---|-----------|--|
| Insulation test (after cable connection) | | | |
| 3) between phase and earth | : | Mega ohms | |
| 4) between each phase | : | Mega ohms | |
- | | | | |
|---------------------|---|---------|------|
| No. of load current | : | R phase | Amps |
| | | Y phase | Amps |
| | | B phase | Amps |

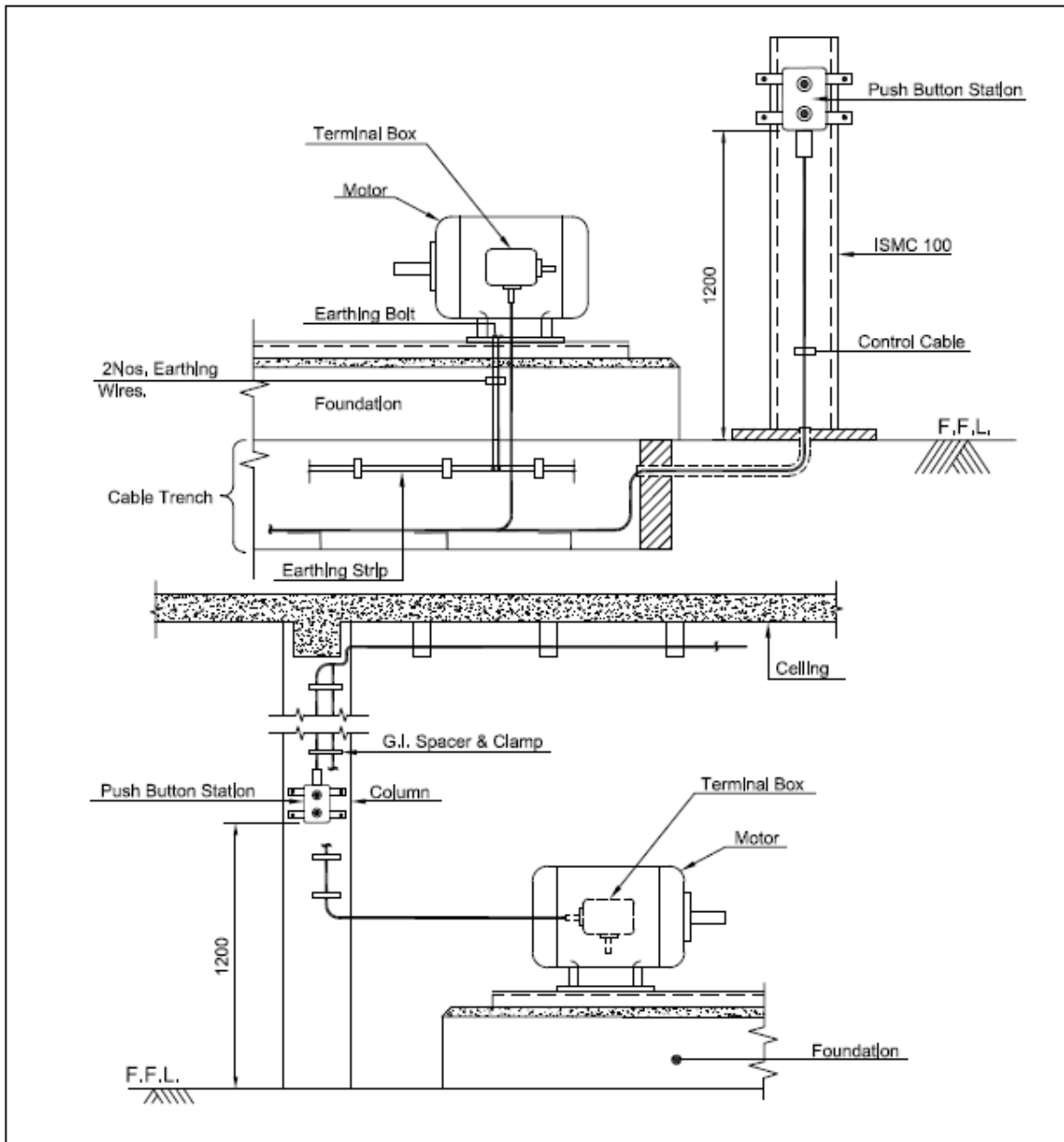
- Full load current : R phase Amps
- Y phase Amps
- B phase Amps
- Temperature rise after 4 hours running
 - On no load Deg. C
 - On full load Deg. C
- Ambient temperature during test Deg.C.
- Operation of overload relays
 1. At normal FL current of motor
 2. At twice FL current of motor

This Performa shall be jointly signed by the Engineer-in-Charge and the Contractor.

6.4 List of installation Standard drawing


Table 6.2: List of installation Standard drawing

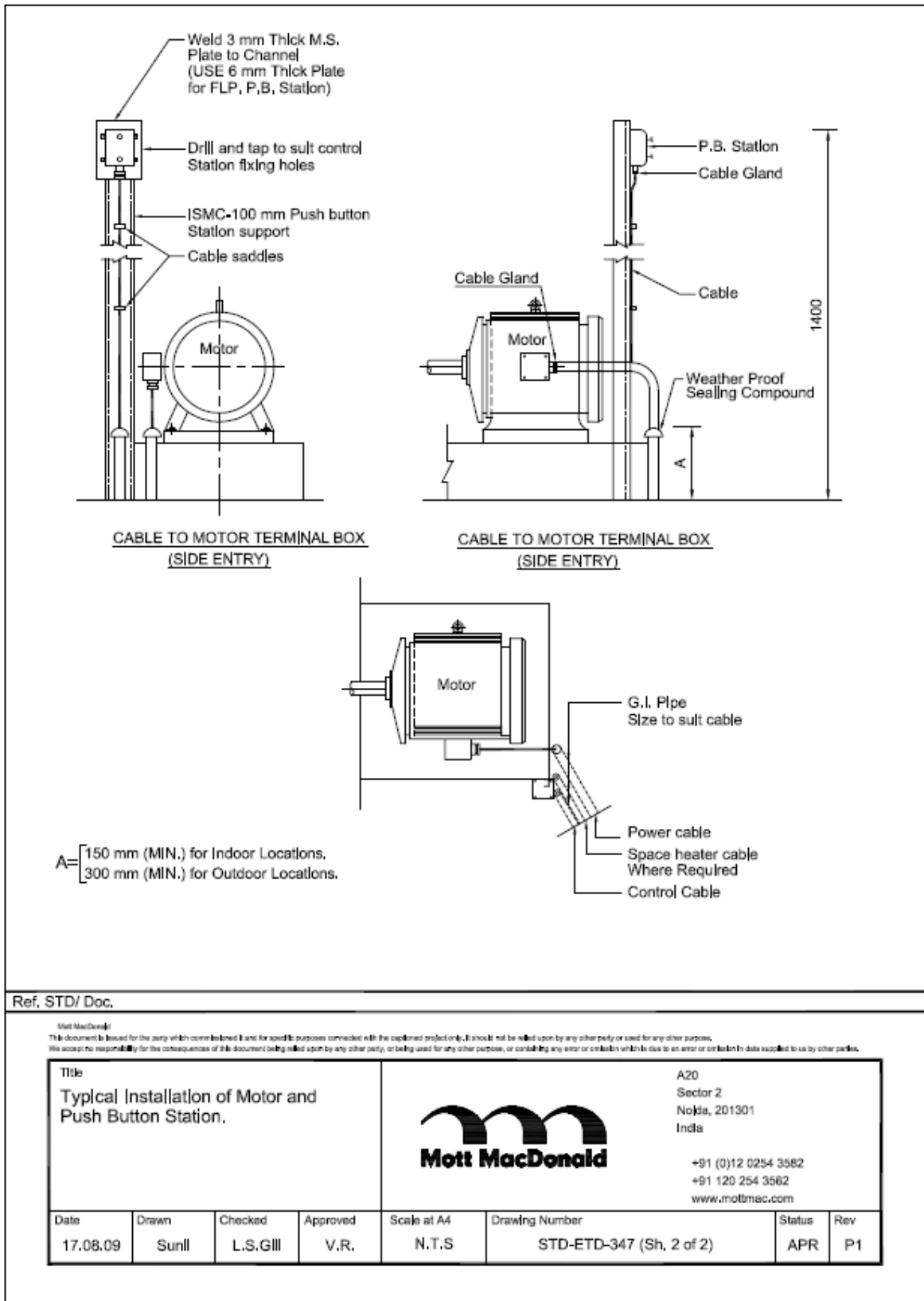
| Sr. No | Name of Standard | No. |
|--------|---|------------------------|
| 1 | Typical installation of motor and push button station | STD-ETD-347 (2 sheets) |
| 2 | Storage tank earthing connection | STD-ETD-308 |
| 3 | Earthing of Tank & Vessels | STD-ETD-309 |

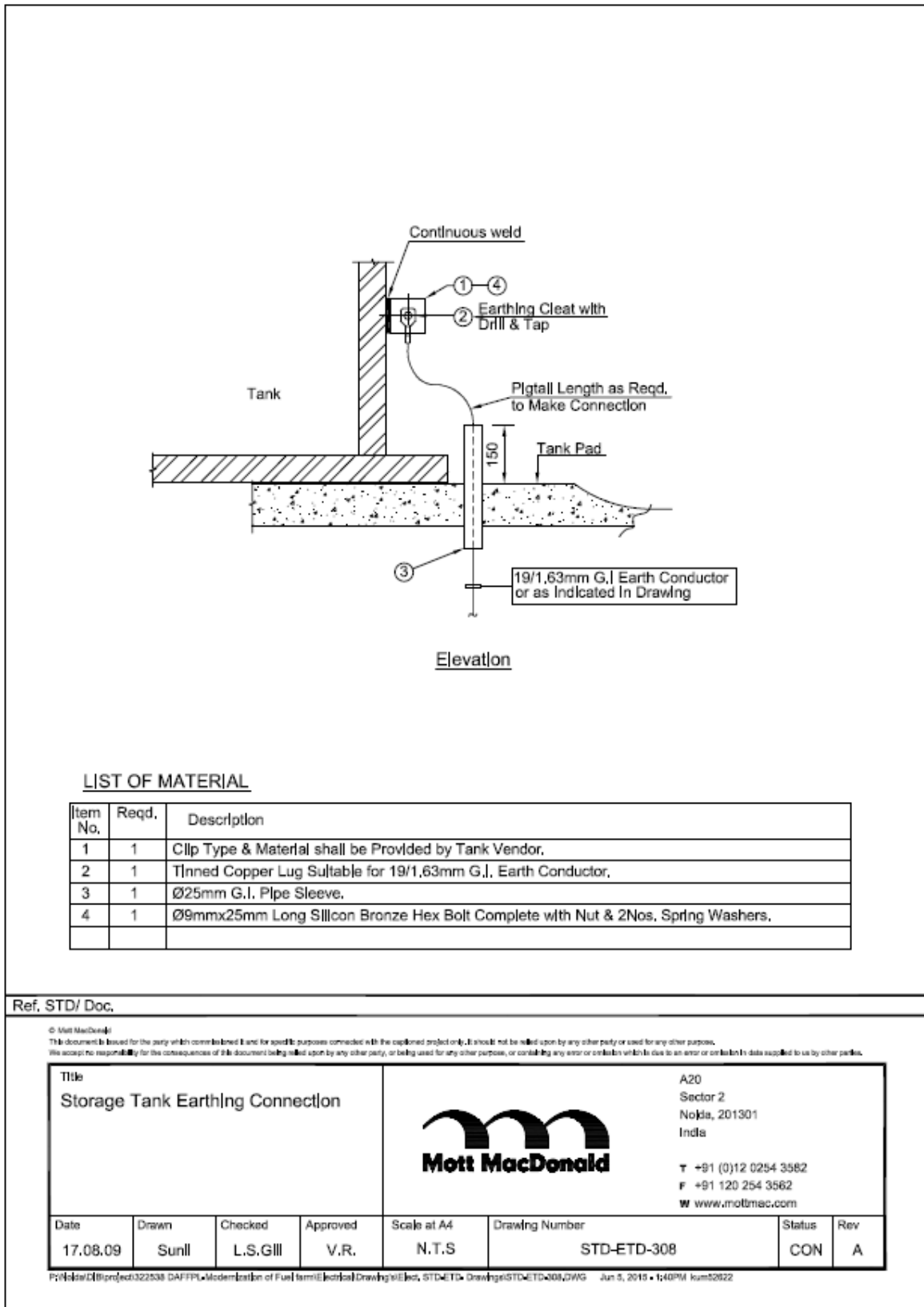


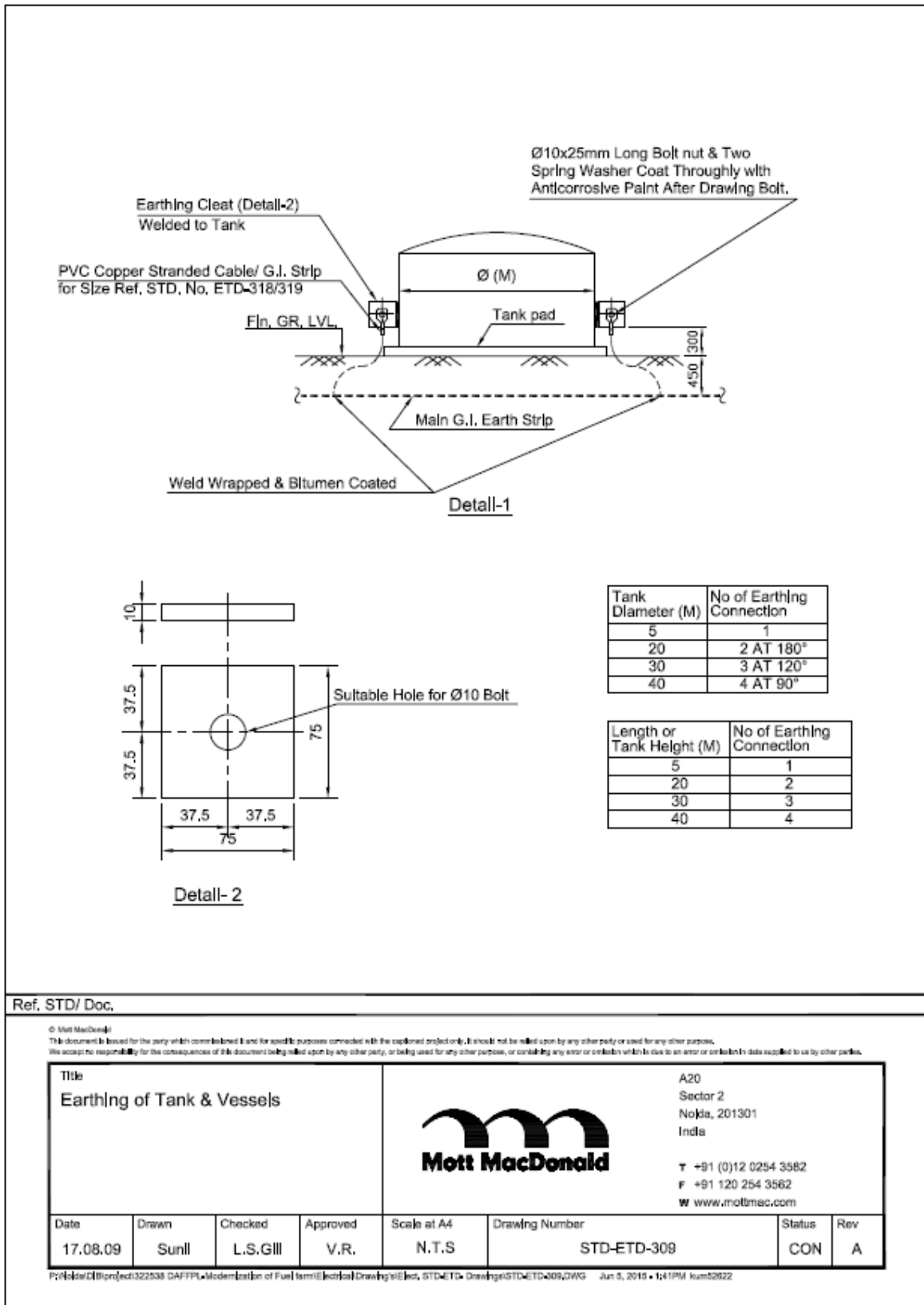
Ref. STD/ Doc.

Mott MacDonald
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| | | | | | | | |
|--|-------|----------|----------|--|--------------------------|--|-----|
| Title Typical Installation of Motor and Push Button Station. | | | |  Mott MacDonald | | A20 Sector 2 Noida, 201301 India | |
| | | | | | | +91 (0)12 0254 3582 +91 120 254 3562 www.mottmac.com | |
| Date | Drawn | Checked | Approved | Scale at A4 | Drawing Number | Status | Rev |
| 17.08.09 | Sunil | L.S.Gill | V.R. | N.T.S | STD-ETD-347 (Sh. 1 of 2) | APR | P1 |







7 General Instrumentation Specifications and Requirements

7.1 Pressure Gauge

7.1.1 Technical Requirements for Pressure Gauge

- The pressure element shall be an elastic element as specified in the data sheets.
- In the case of bourdon elements, they shall be directly connected to the socket, without any capillary in between.
- Pressure gauges shall have an accuracy of + 1% of FSD. These shall be weather-proof with dial size of 150mm and shall have features like screwed bezels, externally adjustable zero, over-range protection and blow-out discs.
- Where safety type cases are specified, they shall consist of a solid partition isolating the pressure element from the dial.
- Pressure gauge sensing element shall be minimum of AISI 316SS and movement of SS304 with 1/2" NPT (M) process connection.
- Primary elements shall withstand the specified overpressure for at least 30 minutes without having their elastic characteristics affected.
- The gauge movement shall be adjustable for calibration purpose and the use of 'S' link for calibration of span is not permitted.
- The design of the gauge shall be such that inspection and calibration can be carried out easily. The gauges having same or equivalent specifications shall give uniform performance from one to another and their component parts shall be interchangeable.
- Fluid (glycerine) filled gauges to dampen effect of shock and vibration to be used. All the gauges shall perform satisfactorily when subjected to violent pulsations and severe mechanical vibrations.
- Each Pressure sensing element shall be processed for over pressure and stress relieved, heat-treated to guaranteed calibration stability. Ranges shall be selected so that the normal operating pressure will read approximately 1/2 full scale to 2/3 full scale.
- Pointer shall be of Micro zero adjustment type made of aluminium anodized black enamelled. Window shall be of shatter proof toughened borosilicate (klinger / maxos / equivalent) glass with neoprene gasket
- Though the specification sheets indicate materials for various parts, it shall be the "Contractor's" responsibility to select and recommend the correct materials for these parts to ensure compatibility with the process conditions specified in data sheets.
- "Contractor" quote shall include a detailed specification sheet for each item furnishing as a minimum the details as meted out in this data sheets. The bid shall be duly, supported by product/technical catalogues, brochures etc.
- "Contractor" to ensure that all units referred to in his quote shall be to the same standards as those in this tender & data sheet.
- "Contractor" shall submit an item wise deviation list.
- "Contractor" shall quote for spares for initial one year trouble free operation.
- "Contractor" shall strictly adhere to the documentation schedule attached with this specification and submit required no. of data sheets. Catalogues, re-producible with prints

7.1.2 Codes Reference for pressure gauge

Unless otherwise mentioned, end connections shall be as detailed below:

- All threaded connections shall be to NPT as per ANSI B: 2.1.

- All flanged end connections shall be as per ANSI B: 16.5.
- Flange face finish shall be serrated concentric to paragraph 6.3.4.1, 6.3.4.2 and 6.3.4.3 of ANSI B: 46.1

7.1.3 Data Sheet for Pressure Gauge

Table 7.1: Data Sheet for Pressure Gauge

| General | |
|---------------------------|---|
| Type | Direct Reading |
| Mounting | Local |
| Enclosure | Weather proof to IP 65 as a minimum |
| Tag No. | Refer Follow Sheet |
| Range | Refer Follow Sheet |
| Gauge | |
| Dial | White with Black markings |
| Dial Size | 150 mm |
| Case and Bezel | Die cast Aluminium enamelled black with screwed type inter bezel |
| Case | Glycerine filled case |
| Pressure Element | Bourdon |
| Element Material | SS 316 |
| Socket Material | SS 316 |
| Movement Material | SS304 |
| Window Material | Shatter proof Borosilicate glass of Klinger / Maxos / equivalent make |
| Zero Adjustment | Internal micro adjustable pointer |
| Process Connection | 1/2 NPT M |
| Location | Bottom |
| Nominal Accuracy Required | ± 0.5% of FSR or Better |
| Resolution | 0.2 kg/cm ² |
| Blow out Protection | Disc (Material : Neoprene) |
| Over range Protection | 130% of Range |
| Options | |
| Snubber | Refer Follow Sheet |
| Snubber Material | SS316 |
| Connection | 1/2" NPT(F) X 1/2" NPT(M) |
| Others | |
| Manufacturer | * |
| Model No. | * |
| Notes: | |
| | 1) * "Contractor" to specify |
| | 2) Mounting details, Tests certificate, Operation and Maintenance manual to be provided. |
| | 3) Inspection will be done by the authorised "Owner / Owner Representative" |
| | 4) Spares required for commissioning & two years maintenance free operation to be submitted |

7.1.4 Follow sheet for Pressure Gauges

Table 7.2: sheet for Pressure Gauges

| Tag. No | Service NO. | Line No. | P&Id No. | Oper. Pr. Kg/Cm ² g | Design. Pr. Kg/Cm ² g | Oper. Temp. °C | Range Kg/Cm ² g | Remarks |
|---------|--|---------------------------|------------------------|--------------------------------------|---|-------------------|----------------------------------|---------|
| PG-214 | ATF transfer Pump PF-214 Discharge | DATF- 0304- A21A-3" | 322538-PIC- 0003-01 | 2.0 | 5 | Amb. | (0 to 6) | Snubber |

7.2 Thermal Safety Valve

7.2.1 Technical Requirements for Thermal Safety Valve

- In case, ASME section I valves are supplied, it shall have the certificate from ASME laboratories.
- Pressure relief valves shall be full nozzle full lift type except for thermal relief valves.
- Conventional valves shall be specified for constant back pressure while bellows seal type valves shall be specified for variable back pressure more than 10% of set pressure. Pilot-operated Thermal relief valves shall be used for special services and where set pressure is closer than 10% of the operating pressure, in general.
- Lifting lever shall be specified for steam and air service. Open bonnet shall be used for steam service.
- The percentage accumulation in case of thermal relief valves/safety valves shall be as follows:
 - Gas, Vapour or liquid except in (c) & (d) below - 10%
 - Liquid for thermal Relief - 25%
 - Fire exposure on unfired vessels - 21%
- 3/4" x 1" flanged nozzle type valves with typically 0.38 cm² orifice size shall be specified for thermal relief.
- The body material shall as a minimum, be as per piping Specifications. Nozzle and disc material shall be SS316 as a minimum with machined stainless steel guide and spindle. Whenever semi nozzle designs are unavoidable, body material shall be at least same as nozzle material.
- The spring material of Thermal relief valves shall be as follows unless otherwise necessary because of process conditions:
 - -29°C to 250°C : Stainless steel 316
 - Above 250°C : Tungsten alloy steel.
 - below -29°C : Stainless steel 316
- Flanged connection shall be for standard sizes 1" or larger. Minimum flange rating shall be 150 # ANSI.
- Where permissible, threaded connections shall be used on sizes 3/4" and below
- Pilot operated-Thermal relief valves shall have remote sensing facility for pilot valve. Internal sensing for pilot shall be avoided as far as possible.
- The Thermal relief valves shall be type tested for capacity with 5 % blow down as per ASME sec VIII UG-131 and the actual blow down of individual valves shall meet the process requirement. Contractor shall furnish the type test certificate for the same.
- Test gag shall be provided for all pressure relief valves.
- "Contractor" quote shall include a detailed specification sheet for each item furnishing as a minimum the details as meted out in "Owner representative "data sheets. The bid shall be duly supported by product/ technical catalogues, brochures etc.
- "Contractor "to ensure that all units referred to in his quote shall be to the same standards as those in "Owner representative "data sheet.

- “Contractor” shall submit an item wise deviation list. “Contractor” shall quote for spares for initial one year trouble-free operation.
- “Contractor” shall strictly adhere to the documentation schedule attached with this specification and submit required no. of data sheets. Catalogues, re-producible with prints. In the event of any conflict between specification, data sheets, standards and codes etc. “Contractor” shall refer to “Owner representative” for clarification and proceed only after obtaining the clarification.
- Size & rating of flange shall be punched on flange as per enclosed data sheet

7.2.1.1 Painting

All the items shall be suitable for use in humid and tropical land climate. These shall be furnished with all necessary weather and anti-corrosion protection to prevent damage from saline and corrosive process atmosphere.

All the items shall be fully de-rusted and then two coats of primer and two coats of baked epoxy paint shall be applied.

The painting shall be as per follows:

- Carbon Steel - Light Grey
- Alloy Steel - Canary Yellow
- Stainless Steel - Natural

7.2.2 Codes reference

The design, manufacturing and performance of the pressure safety valves shall confirm to the latest edition of the following standards and codes of practice.

- ASME - “Power Boiler code” & “Code for Unfired pressure Vessels”
- API - RP 520 ,526 & 527
- ANSI - B 2.1 & B 16.5

All safety valves shall be marked and certified in accordance with the ASME Boiler and pressure vessels code.

Unless otherwise mentioned, end connections shall be as detailed below:

- All threaded connections shall be to NPT as per ANSI B: 2.1.
- All flanged end connections shall be as per ANSI B: 16.5.
- Flange face finish shall be serrated concentric to paragraph 6.3.4.1, 6.3.4.2 and 6.3.4.3 of ANSI B:46.1

7.2.3 Data sheet for Thermal Safety Valve

Table 7.3: sheet for Thermal Safety Valve

| General | |
|------------------------------|-----------------------|
| Tag No. | Refer Follow Sheet |
| Equipment No. | Refer Follow Sheet |
| Process data | |
| Fluid | Aviation Turbine fuel |
| Required Capacity | Nominal LPM |
| Oper. Pressure Kg/Sq.cm | Refer Follow Sheet |
| Set Pressure | Refer Follow Sheet |
| % of Allowable over pressure | 0.1 |

| General | |
|-------------------------------------|---|
| Back Pressure Kg/Sq.cm | Discharge is connected to process line back pressure is assumed as 1 Kg/cm ² . (g) |
| Oper. Temp. in deg C | 45 |
| IBR Certificate in Form IIIC | Not Required |
| Calculated Area sq.cm | STS |
| Sel. Area sq. cm | 0.38cm ² |
| Orifice Designation | - |
| Reliving Capacity in kg/hr | * |
| Valve | |
| Type | Thermal Relief |
| Full Nozzle / Semi Nozzle | Semi Nozzle, Reduced Lift |
| Valve type/ Bonnet type | Conventional / Closed Bonnet |
| Inlet Connection : Size & Rating | 3/4" Flanged |
| Inlet Connection : Facing / Finish | 300#, RF, Serrated |
| Outlet Connection : Size & Rating | 1" Flanged |
| Outlet Connection : Facing / Finish | 150#, RF, Serrated |
| Cap over Adj. Bolt / Screwed | Cap over Adj. Bolt |
| Lever | Not Required |
| Test Gag | Required |
| Material | |
| Body | ASTM A216 Gr WCB |
| Seat | SS 316 |
| Guide | SS 316 |
| Spring | Zinc / Nickel plated Carbon Steel |
| Basis | |
| Code | API 520 |
| Others | |
| IBR Certificate in Form IIIC | NO |
| Manufacturer | * |
| Model No. | * |
| Hydro test Pressure | * |
| Notes | |
| 1) * Contractor" to specify | |

7.2.4 Follow sheet for thermal Safety Valves

Table 7.4: sheet for thermal Safety Valves

| Tag No. | Service Description | Line No./Eqpt. No. | P&ID No. | Fluid | Opera. Pressure Kg/Cm ² | Set Pressure Kg/Cm ² | Remark |
|----------|-------------------------------|--------------------|--------------------|-------|------------------------------------|---------------------------------|--------|
| TSV-2003 | Pump Suction Header (U/G Tank | DATF-0304-A21A-3" | 322538-PIC-0003-01 | ATF | 2.0 | 2.2 | |

7.3 Acceptance Criteria

The "Contractor" shall prepare a detailed shop "Quality Assurance Programme" to meet the requirement of this specification for "Owner representative" approval. This document shall also contain the formats for test reports and maintenance of test records and specifications of test equipment and simulation devices.

7.4 Tag Plate

Each Pressure gauge shall be provided with a Stainless Steel name plate permanently fastened to the back of the dial at a visible place. The name plate shall have following details:

- Manufacturer's name
- Tag number as per "Owner representative" data sheet
- Model no. and Serial No.
- Sensor material
- Process connections size
- Size & rating of flange shall be punched on flange.
- Year of Manufacture.

8 Specification of Underground Horizontal Storage Tank

8.1 Basis Scope

8.1.1 Compliance

- Compliance by the EPC Contractor with provisions in this specification shall not relieve him of his responsibilities to supply the tank conforming to the requirements and guide lines as specified in the mandatory codes and standards.
- In case, there is a conflict between the Owner supplied documents and the referenced / mandatory specifications, the more stringent one shall prevail.
- Should there be any deviation/ from this Specification or associated data sheets, the contractor shall notify the Purchaser in writing and obtain Owner's decision in writing in respect of such deviation/(s).

8.1.2 Quality Conformance

- The Contractor shall prove and satisfy the Owner that his obligations within the scope of this document are in accordance with the relevant section of BS EN ISO 9001. Prior to commencement of work, the Contractor shall submit a Quality Plan and procedural specifications for Owner's review and approval.
- The Quality Plan shall define scope of work of all the sub-Contractors associated with the work. This Specification shall only indicate a general requirement and shall not relieve the Contractor of his obligations to comply with the requirements of the Contract.

8.1.3 Safety

- All work shall be performed in accordance with the safety requirements listed in the contract documentation and any mandatory standards and legislation.
- Contractor shall have to take all Safety precautions for carrying out hot work in the premises on site after getting hot work permit from location in charge at his own cost as directed by the Engineer in Charge and Safety Supervisor. Necessary Safety Equipment such as Safety Belts, Heat resistance Eye Glasses, Safety Helmet, Safety Shoes and other necessary safety Instruments/Equipment's which are not mentioned but required to be positioned by the Contractor and same shall be followed by the work force as per work requirement. The Contractor has to enforce the same.
- Safety requirements shall be maintained strictly as per Owner/Representative's rules and regulations and International Safety norms. As a minimum the safety requirement spelt-out in the General Terms and Conditions shall be adhered to.
- The Contractor shall refer the separate document for "Health and Safety Plan" for resource and activity planning, satisfy the procedure etc.

8.1.4 Purchaser's Scope

- Open space at site for site storage and office as per availability of space at site.
- Raw water supply.
- Power

8.1.5 General purchase conditions

8.1.6 Qualification Criteria

8.1.7 The Contractor shall have the single point responsibility for the complete work.

- The Contractor shall be a regular manufacturer and supplier of the specified equipment/ package.
- Contractor in the last five years should have engineered, manufactured, tested, supplied and commissioned .The Contractor shall have full-fledged fabrication & testing set-up in India or have appropriate arrangements for the same with the established local reputed company.
- The offered equipment must meet performance requirement as stated in the specifications.
- The Contractor shall be required to submit the documentation and proof for above requirements and purchasers may at his discretion make additional checks for the same.

8.2 “Codes and Standards

8.2.1 Applicable industry standards

- The design and manufacture of storage tanks shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable Standards. In particular, the equipment shall conform to the latest editions of the following standards in absence of standards specified in the Data Sheet.

Table 8.1: List of codes and standards

| | API 650, 12th Edition, 01-Mar-2013 | Welded Steel Tanks for Oil Storage tank |
|----|---------------------------------------|--|
| 1 | IS 10987-1992 | Design, Fabrication & testing of Underground / Aboveground, Horizontal Cylindrical Steel Storage Tanks for Petroleum Products. |
| 2 | ASME Section IX, Edition 1 July, 2013 | Welding & Brazing Qualifications |
| 3 | ASME B16.5, Edition 2009 | Pipe Flanges and Flanged Fittings (NPS 1/2 through NPS 24 Metric / Inch Standard) |
| 4 | ASME B16.47, Edition 2011 | Large Diameter Steel Flanges (NPS 26 through NPS 60 Metric / Inch Standard) |
| 5 | ASME B16.20, Edition 2007 | Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound and, and Jacketed |
| 6 | ASME B16.9, Edition 2012 | Factory Made Wrought Butt welding Fittings |
| 7 | ASME B16.11, Edition 2011 | Forged Fittings, Socket-welding and Threaded |
| 8 | ASME B31.3, Latest Edition | Process Piping |
| 9 | NFPA 30 | Flammable And Combustible Liquid Code |
| 10 | API RP 1615 | Installation of Underground Petroleum Storage Tanks |
| 11 | ASTM A193 | Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service |
| 12 | ASTM A194 | Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure/Temperature Service, or both |
| 13 | ISO 9001 | Quality Management Systems |

- National laws and regulations together with local by-laws for the country or state wherever the tanks are to be erected must be complied with.

8.3 Modus Operandi for Execution

- Managing timely execution of all contract elements.
- Planning and reporting of time bound progress to Owner.
- Close co-ordination with Owner regarding any Techo-Commercial issue.
- Ensure HSE (Health, Safety & Environment) Systems at Contractor's factory.
- Strict control on QA/QC systems at the Contractor's factory.

8.4 Design Requirements

8.4.1 General

- All design calculations shall be carried out in corroded condition.
- The Contractor, within 10 days of award of contract, shall submit to the Owner the suggested solutions of any issue/(s) coming in way of completion of the design as required by this document.

8.4.2 Corrosion Protection

- Corrosion allowance, applicable to surfaces in contact with corrosive media, when required, will be specified on Purchaser's Data Sheets and/or drawings. Where no corrosion allowance is specified, none is required.
- Removable internal parts – bolted or clamped in-place shall have extra thickness equal to half of specified corrosion allowance over each exposed surface.

8.4.3 Minimum Thickness

- The thicknesses indicated in the Data Sheets and / or drawings for shell, side plates are the minimum acceptable thicknesses, even though the Code may permit a thickness less than that shown on Purchaser's Data Sheets and/or drawings. The minimum acceptable thickness includes specified corrosion allowance.

8.4.4 Supporting structures

- Supporting structures shall be designed to support the Tank
- Flat heads, side plates, etc. shall be adequately stiffened to support the loads as specified in the Data Sheet and/or drawings.

8.4.5 Connections and Appurtenances

- When connections and appurtenances are installed on tanks conforming to this specification, the use of designs as specified in the applicable codes is required, except that all alternate designs which provide equivalent strength, tightness and utility are permissible, if agreed to, by the Purchaser.
- Flange facings shall be in accordance with the details indicated in the Data Sheets.
- Manhole necks, nozzle necks, reinforcing plates and shell plate openings, shall have surfaces made uniform and smooth, with the corners rounded, except where such surfaces are fully covered by attachment welds.

8.4.6 Selection of Material

8.4.6.1 Material of Construction

- All materials shall be as per applicable codes/ Data sheet.
- Plate material conforming to IS2062 Gr. A/B.
- Manhole necks, may be fabricated from same plate material as used for shell.

- Nozzle necks / dip pie shall conform to SA 312 TP 316L.
- Heating coil pipes if applicable shall be of seamless quality, SA 312 TP 316L
- All clips and attachments shall be fabricated from MS plates of weldable quality.
- Gaskets for manholes and nozzles fitted with blind flanges shall conform to Gasket MOS as Non Bonded Non Asbestos Fibre , Ref. MDS Dwg. Thickness of gasket shall be 1.5mm for nozzle up to 450mm NB and 3.0mm for nozzles above 450mm NB.
- Bolts and nuts for all nozzles fitted with blind flanges shall conform to SA 193 Gr. B7 & SA 194 Gr. 2H

Bolts and nuts for all structurals shall conform to IS:1363.

- All materials shall be of well-trying and tested types from reputed manufacturers and shall be of adequate thermal rating and guaranteed tolerance.

8.4.6.2 Standardisation

- The Owner may indicate preferred suppliers for some items to the Contractor. This will be identified separately from this specification.

8.4.6.3 Testing Materials

- The Contractor shall supply all temporary materials required for strength and leak testing.

8.4.6.4 Tie in Materials

- The Owner shall supply all stud bolts, gaskets and ring joints for tie in of packages on site.

8.4.7 Data and document submission

8.4.7.1 Fabrication drawings

Contractor shall prepare all fabrication drawings based on the MDS issued on award of contract / purchase order and shall include the following:

- (a) General Arrangement drawing
- (b) All general information and special instructions provided in Data sheet.
- (c) Tolerances
- (d) Nozzle orientation.
- (e) Development and details of shell, roof and bottom.
- (f) Final plate cutting layout.
- (g) Complete bill of material indicating scope of supply by Owner / Contractor.
- (h) Weld seams, weld joints and weld sizes.
- (i) Reinforcements.
- (j) Fixtures for internals.
- (k) Non Destructive testing (NDT)
- (l) Inspection

In case the Contractor intends to make some modifications due to fabrication constraint, the same shall be submitted to the Purchaser / Consultant for prior approval with supplementary design calculations, before taking up fabrication. The approved modifications shall be incorporated in fabrication drawings and re-submitted for approval.

- Within 10 days of award of contract, the Contractor shall supply to the Owner, a schedule for the issue dates of all documents.

- The Contractor shall control its documents and drawings such that only the latest revision is available and a record of each document and drawing is made.
- The Contractor shall supply two copies of all documents and drawings to the Owner for review and submit them using a transmittal system
- Prior to submission to the Owner, the Contractor shall have reviewed sub-Contractor's documents/drawings. Within 12 working days from the date of submittal, the Owner shall provide comments after review of the documents and drawings. Contractor shall comply with Owner's comments for any changes without any additional cost.
- Contractor shall keep full fabrication records in order to have full information to accurately produce the As-Built documentation to hand over to Owner on completion of the works. No hand mark-ups or coloured markings are acceptable in the documents for hand over.

8.4.8 General Specification

- All dimensions are in mm unless otherwise specified.
- All flange bolt holes shall straddle with main tank centre line. For vertical tanks, all foundation bolt holes shall straddle with North South lines.
- Thicknesses specified on the data sheets are the minimum thicknesses and the same shall be achieved after forming / machining.
- Contractor shall provide suitable vent holes for SORF flanges pads (size 150 NB and above) and all pads. Vent holes shall be plugged with hard grease after testing. Vent holes shall be provided at the bottom most points.
- All internals shall be designed in such a way that they are able to pass through manholes.
- All internals (coils, dip pipes, demisters, sprayers, tube bundles, baffles, etc.) are to be suitably supported inside the tank.If Applicable
- All flat covers shall be suitably stiffened externally.
- Stiffening rings wherever included in Contractor's scope shall be staggered welded on the tank.
- All weld seams shall be located in such a way that they are clear of nozzles / pads / cleats / saddles / brackets, etc.
- No load /external force bearing parts shall be directly welded to the tank. The same shall be welded on to a suitable pad which in turn shall be welded to the tank. The thickness of pad shall be the same as the tank plate thickness onto which the pad is welded.
- All gasket contact faces of flanges shall have machined finish. The same shall also have serrations on raised faces as per ANSI B-16.5 unless otherwise specified.
- Longitudinal weld seams of adjacent shell sections shall be staggered 180 deg apart.
- Distance between two weld joint shall not be less than 300mm. Staggered vertical weld joints shall be more then 100mm apart.

8.4.9 Appurtenances

8.4.9.1 Nozzles & Accessories

- All appurtenances and accessories as shown in the Data sheets shall be supplied by the Contractor.
- Nozzle reinforcing plates shall be provided with threaded tell-tale hole for test purposes.
- Nozzle shall be welded to shell and roof with the same quality of electrodes as used for welding shell/roof plates.
- Manholes and nozzles with blind flanges shall be provided with gaskets and bolting.
- Nozzle and manholes may be shop assembled.
- Flange faces shall be varnished and protected by wooden discs using at least three bolts.
- All nozzles and accessories shall be prefabricated and attached to the shell plate. The prefabricated assembly shall be stress relieved prior to installation, wherever required as per code and applicable appendices.

8.4.9.2 Stairways/Ladder, Roof Access and Hand railing

Each tank shall be provided with stairway/ladder and roof access. Hand railing if not indicated otherwise on tank drawings shall be provided all around.

8.4.10 Fabrication

8.4.10.1 Plates

- Plate edges shall be preferably sheared or machine cut as per code. All machined parts shall be suitably protected before assembly.
- Gas cut plates shall be ground properly.
- All formed plates shall be match marked with paint on the concave side with numbers as shown on erection drawings.

8.4.10.2 Structure

- Structural steel fabrication shall be carried out to the required shapes for making the structure.
- All such fabrications shall be subjected to inspection by Owner/Representative/ 3rd party inspection agency as per stages defined in QAP.

8.4.10.3 Shell

- All vertical and horizontal shell joints shall be full penetration and full fusion welds as per approved drawings using any one of the edge preparations permitted by the Code. Single side butt welds are not permitted.
- The stiffening ring (wind girder), when necessary, shall be welded to the tank at the location shown in the respective tank drawings. These shall be of plate/section construction as shown in the drawings duly reinforced with gussets or struts welded to the shell. Welding shall be of same quality as used for shell.
- Drain holes of 20mm diameter suitably staggered shall be provided on the horizontal plates of the stiffening ring. Hand railing shall be provided when stiffening ring is used as walkway.
- Holes shall not be made in shell plates for erection purposes.
- Shell plate alignment shall be within the limits specified in code.
- Tank shall have outside finish as per applicable standards/specification.

8.4.10.4 Tank Earthing

- All tanks shall be fitted with earthing lugs. Required number is 3 for tanks up to 30m dia and 4 for greater diameter
- For earthing of the tanks earthing pits will be made adjacent to the tanks. The tank shall be connected to the earthing pit by 50 x 6 mm thick MS galvanised strip

8.4.10.5 Tagging of Tank

- The Contractor shall supply & tag the tank. The Contractor shall fix to each tank, a plate detailing the design, operating and test conditions.
- All tags, labels and signs shall be compatible with the environmental conditions.
- All tags shall be stainless steel engraved with black text in English.

8.4.11 Welding

- Welding or any related operations in connection with the above shall be done in strict accordance with the codes specified in Data Sheets and this specification.
- Pr Welding and weld repairs shall be performed in accordance with the procedures qualified to the requirements of relevant Section of ASME.

- The Contractor shall submit a detailed procedure for welding and weld repairs, for approval by the Owner before commencement of work. Pre-qualified procedures shall be permitted, subject to approval by the Owner.
- Welding and welds repairs shall be in accordance with a written procedure, duly approved by the Owner.

8.4.11.1 Procedure & Performance Qualifications

- Contractor shall be responsible for the quality of welding done by his organisation and shall conduct tests to determine,
 - The suitability of the process utilized for each class of work and
 - The ability of each individual welding operator / welder to make sound welds under standardised test conditions for each class of work on which he operates. Tests shall be conducted in accordance with ASME Sec IX (latest revisions). The tests shall also confirm to applicable local rules and regulations.
- The results and specimens from qualification tests of welding processes, welding operators and welders shall be made available to the Engineer / Inspector on request. All such qualification tests and specimen tests shall be conducted in the presence of the Purchaser's representative or the Inspector. The Inspector shall have the authority to reject unsatisfactory process or operators or the workmanship. The decision of the Inspector in this case will be final and abiding. In case of doubt a retest may be allowed at the discretion of the Purchaser's representative / Inspector.
- A certificate of qualification of procedure, welding operator and welder shall be kept on file by the Contractor and shall be made available to the Purchaser's / Inspector at any time upon request. The certificate for procedure shall designate welding process, material specification, pipe dia, and wall thickness, the thickness range, qualified no. of passes, the position of welding and the welding parameters. The Certificate of Performance shall designate the material specification, thickness range qualified position qualified, etc.

8.4.11.2 Preparation of Weld Joint

- The edges of surfaces of the parts to be joined by welding shall be machined or thermal cut and shall be cleaned of oil, scale or rust. When thermal cutting is used all slag, scale or serrations shall be removed by grinding or any other approved means to have a smooth surface for welding.
- The weld joint configuration will be as shown in the approved fabrication drawings. Any change in the joint configuration must be done in consultation with and the prior approval of the Engineer / Inspector.
- Reinforcing pads around manhole and nozzle openings shall not come or lap over the tank welded seams.
- Shells / side plate joints shall be double welded joints unless otherwise specified.
- When shell / side plates of unequal thickness are welded, the inner surface of the shells shall be coincided with each other.
- All the seam joints shall be butt joints. All the longitudinal and circumferential butt joints shall have complete penetration and fusion through the full thickness of the parent plate.

8.4.11.3 Welding Process

- The welding processes that are used in the welding of the joints are restricted to shielded metal arc welding, shielded gun metallic arc welding and shielded gas tungsten arc welding only.
- No production welding shall be undertaken until the welding procedures which are to be used have been qualified.
- The surfaces for welding shall be cleaned of paint, oil rust, scale or other objectionable material which may be detrimental to welding.

- The specification of electrodes, voltage, welding speed, the current and the polarity should be as specified in the approved welding procedure or as otherwise agreed in writing. Any deviation from the approved procedure will be treated as objectionable and may disqualify the procedure and the welder or the welding operator.
- The welding procedure shall be such as to assure substantially full root penetration and thorough fusion in the lands of the root and in the entire weld preparation.
- Each layer of weld metal in a multilayer welding shall be cleaned of slag and other deposits by suitable means before applying the next layer.
- Tack welds should be made by a qualified welder and as per welding procedure and shall be ground or removed completely when the purpose is served. They should not form a part of the final weld. The reverse side of double welded but joints specified to have complete penetration and fusion shall be thoroughly removed to sound metal prior to welding on second side. This can be done by chipping, grinding or melting out the metal by any approved method and DP Test to be carried out. Welding shall not be carried out when the surface of the parts to be welded are wet during any cause or rainy season. Welding shall not be done if surface temperature is below 10^oC.
- The welding sequence for tack welding and final welding of the bottom shell roof plates shall be such as to minimise the distortion due to welding.
- All butt joints shall be provided with a uniform and smooth reinforcement (the thickness of which shall not exceed 3 mm) so that the finished face area of fusion extends above the surface of the adjoining plates without a sharp angle. The Inspector / Purchaser's representative have the authority to reject any unsatisfactory process of operation or workmanship at any stage of fabrication.
- Welding Electrodes: Electrodes shall be in accordance with the codes mentioned in this specification and the welding Specification chart..
- Approved Makes of Electrodes : Advani- Oerlikon, Philips, D & H
- Notes:

Contractor shall indicate the make of welding consumables in his offer. All welding consumables shall be as per AWS & approved by Owner. Manufacturer test certificates shall be provided for all consumables
Welding Procedure Specification (WPS) & Procedure Qualification Records (PQR) shall be established and approved before carrying out welding

8.4.12 Testing and Inspection

- The Contractor shall prepare a detailed inspection plan (quality assurance plan) as per applicable codes and specifications and shall get the same reviewed by the owner / consultant, before commencing the work.

8.4.12.1 Inspection

- All tanks shall be offered for inspection at all stages, as desired by Engineer-in-Charge.
- Inspector or Owner's representatives shall have free access to all the Contractor's shops as well as to worksite.
- The Contractor shall provide all facilities, such as access ladder lighting, tools and tackles, instruments, etc. and personnel to inspectors, for proper execution of their inspection.
- All the inspection shall be carried out in accordance with the relevant codes and requirements of drawings and specifications.
- Approval of the Inspector shall in no way relieve the Contractor of his responsibilities for proper execution of work.

8.4.12.2 Off Site Inspection

Following shall be made available to the Purchaser:

- Mill Test Data shall be forwarded no later than the time of shipment of the plates to the field.

- All Chemical and Physical reports shall indicate the specification to which the steel plates were manufactured.
- All plates and data report shall be readily identifiable with matching Heat Numbers.

8.4.12.3 Welding

- Welding procedure qualification shall be carried out as per ASME Boiler and Pressure Vessel Code Sections IX.
- No welding shall be undertaken without approval of the welding procedure and welder qualification test by the Engineer-in-Charge. The Contractor shall make arrangements of such test at his own cost in the presence of Engineer-in-Charge.

8.4.12.4 Radiography and Inspection of Welds (Non-Destructive Testing- NDT)

- All welds shall be inspected and tested as per the code and the specification.
- The Contractor shall be responsible for taking the radiographs by his own equipment at his cost for the entire job.
- Weld areas to be radiographed shall be designated by the Engineer-in-Charge.
- Radiographs shall be taken as soon as welding of the Joint is completed. If repairs are required, these shall be carried out before starting other welds. New Radiographic examination of such repairs shall also be carried out by the Contractor at his own cost. Radiographic film shall be of approved quality
- For heating coils, number of joints to be radiographed shall be 25% and the interpretation of the radiography shall be as per ASME B31.3.
- Radiographic film shall be of approved quality.

8.4.12.5 Liquid penetrant / Magnetic particle examination

- Liquid penetrant / Magnetic particle examination / ultrasonic examination shall be carried out as per code, duly witnessed by Engineer in Charge and acceptance criteria shall be as per code. The rate quoted by the Contractor shall be inclusive of the same.

8.4.12.6 Testing

- All equipment required for testing shall be supplied by the Contractor.
- Openings other than those used for hydrostatic test or any other test shall be closed by plugs and blind flanges supplied by the Contractor.

8.4.12.7 Shell test

- Contractor shall perform the hydrostatic test in the presence of Engineer-in-charge.
- Clean fresh water shall be the primary hydrostatic test medium unless use of a different medium is approved by the purchaser.
- After hydro testing, water shall be drained and the tanks shall be dried thoroughly using hot air, immediately after draining to prevent the possibility of evaporation and concentration of chlorides.

8.4.12.8 Nozzle reinforcing plates

Nozzle reinforcing plates shall be pneumatically tested at 1.05kg/cm² g with soap solution. This test shall be carried out before filling the tank for hydrostatic testing.

8.4.12.9 Factory Acceptance Test (FAT)

- Upon satisfaction of the Contractor that the storage tank is meeting the requirements, the Contractor shall inform the Owner with 10 days advance notice for Factory Acceptance Test, which shall be undertaken in the presence of the Owner.

8.4.12.10 Post Test Inspection

- Owner shall undertake visual inspection of the storage tank after completion of the FAT and produce a list of his observations, which shall be corrected by the Contractor prior to commencing any activity for transportation of the tanks.

8.4.13 Painting

- Doping of External Surface of Tank as per Code

8.4.14 Calibration

- The Contractor shall arrange tank calibration in accordance with requirements specified in the Petroleum Measurement Manual published by the Energy Institute and any particular requirement of the Owner. The Contractor shall submit details of the intended calibration contractor to the Owner at least one month in advance.
- Calibration Data shall be provided in electronic format as well as printed copies, plastic sealed & encapsulated.
- The certified reference dip for the tank shall be indelibly marked on the Dip Hatch.

8.4.15 Preparation for Service

- After FAT, cleaning and drying process, the Contractor shall install all permanent fittings using new gaskets. The tank shall finally be inspected and closed to prevent ingress of any foreign material.
- The Contractor shall provide all necessary equipment to determine the electrical resistance from tank earthing bosses and any installation of static earths.

8.5 Guarantee

- All equipment shall be guaranteed in accordance with conditions given in the Special conditions of Contract / as specified in the commercial section.
- The Contractor shall guarantee that the chemical and physical properties of materials used are in accordance with the specifications.
- Any part of the tank found defective within 24 months from date of its receipt at site in good condition or 12 months from the date of commissioning having been subjected to faulty operations or incorrect service, shall be promptly replaced / repaired by the Contractor at his own cost, failing which the owner has the right to get the same replaced / repaired by others and charge the cost incurred, to the Contractor.

8.5.1 Letter of Conformance

- The Contractor has to submit a signed statement indicating compliance with the relevant Material Standard and Technical Specification

8.5.2 Annexure –

- Data sheet - 322538-MSB-0001-01 (Tank Data Sheet)
- DAFFPL-MMD-322538-RSD-02 (Pump Data Sheet)

9 Specification of Downgraded ATF Transfer Pump (Centrifugal)

9.1 Scope of Work

- This specification covers the minimum requirements for the design, selection, engineering, obtaining approval from client/consultant, manufacturing, supply, guarantee, inspection, testing as per the approved Quality Assurance Plan at work, coating as applicable, packing, transportation and delivery of pump sets to site in compliance with the mechanical data sheet, specification and standards attached to these specifications along with all other associated auxiliaries like motor, bearing base plate, coupling, foundation bolts, etc. and mountings. The scope also includes supervision during erection, testing and commissioning and providing performance guarantee.
- The Vendor shall provide electrically driven Centrifugal Pump set in accordance with this specification, the duties and conditions listed in the relevant data sheet, and the documents included in the bid documents.
- The scope of supply includes:
 - Electric Motor Driven Pumps with effective sealing system.
 - Flameproof Electric Motors as the prime mover having class F insulation.
 - Flexible Coupling System between prime movers (electric motors) and driven (centrifugal pumps).
- The Vendor should ensure technical feasibility of their tender offer, after inspecting the site. It must be understood that the vendor shall be required to Supply & execute/s every such items of work which is considered necessary for satisfactory performance of the pump sets, though such items is required are not specified in the tender documents.

9.2 Construction Method

- The Centrifugal pump sets shall be designed, engineered and constructed to conform to the latest issue of the API codes mentioned in the specifications.
- The Vendor shall specify and recommend materials class for pump sets parts as suitable for Jet A1 fuel in accordance with API Standard 610 and Data Sheet of each type of pump sets.
- All wetted areas must NOT contain any zinc, cadmium, bronze, copper, brass or other yellow metals.
- The material specification of all components of the downgraded ATF fuel pump sets unit/(s) shall be clearly stated in the Vendor's proposal.
- Welding and weld repairs shall be performed in accordance with the procedures qualified to the requirements of Table 10 of the API Standard 610.
- Major parts of rotating elements, such as impellers and balancing drums etc., shall be individually statically balanced. In addition to the static balancing, impeller, balancing drums, shafts and other rotating assemblies shall also be dynamically balanced.
- Impellers shall be made in one piece and preferably shall have solid hubs; fabricated impellers shall not be used. Impellers shall be secured to the pump shaft and shall be retained against circumferential movement by keying or lock rings. Means shall be provided to prevent loosening during operating including rotation in reverse direction. On pumps with overhung shafts impellers shall be secured to the shaft by a locknut or cap screw which tightens in the direction of normal rotation. Cap screws shall be of high strength material.

- Shafts shall be of ample size to transmit the full driver output, accurately machined throughout their entire length and properly finished at the bearing surfaces. Shafts shall be provided with sleeves locked to the shaft. The sleeves shall be furnished of wear, corrosion and erosion resistant material suitable for the fluid handled. Shafts shall have adequate stiffness to with stand any hydraulic thrust imbalance that may occur over entire range of the pump characteristic curve.
- The hard facing of the shaft sleeve shall be carried under the throat bushing, in order to prevent galling between the shaft sleeve and the throat bushing. Alternatively, the throat bushing shall have sufficient clearance to accomplish the same objective. Replaceable shaft sleeves shall be provided to protect the shaft where it passes through stuffing boxes.
- Coupling shall be a flexible spacer type. The bidder shall indicate make and supplier. Coupling shall be dynamically balance after full machining and key way cut. Vendor shall deliver the fully machined coupling assembly along with the pump sets. The driver shaft dimensions and tolerances shall be as per the standards applicable. Removable coupling guard, non-sparking type shall be supplied and mounted so that they cover rotating parts to within 15 mm of stationary housing and shall be open at the bottom to permit manual shaft rotation. Guards shall be designed to prevent contact with coupling or shaft as a result of bodily contact. Guards shall be of spark proof material.
- Common base plate with trolley arrangement shall be supplied for pumps and motors by the pump vendor. Base plate shall be fabricated mild steel drain-rim type and shall be provided with sloping surface to avoid any accumulation of liquid. The base plate shall extent beyond pump and driver feet. The base plate shall be fully machined to receive pump and driver. Base plate, pump supports and pumping unit shall be constructed so to minimise misalignment caused by mechanical forces such as normal piping strains, internal differential thermal expansion and hydraulic piping thrust.
- The Centrifugal pump shall be easily removable from motor.
- The pumps shall be self-priming type centrifugal pump.
- Tie in points for all disciplines shall be located at the Jet A1 fuel pump sets unit/(s) extremities at those locations agreed with the Purchaser. The Vendor shall route systems to these points on board of the packages.
- Head Vs capacity curve shall preferably be flat but in no circumstance the shut off head be less than the total dynamic head at any capacity of the pump.
- Similar pumps shall have the same shut off head and shall have characteristics suitable for capacity sharing.
- Pumps with constant speed driver shall be capable of at least head at rated conditions by installing a new impeller considering effective speed of motor. Similarly, it should also be possible to achieve 5% head decreased by adding another new impeller. However this should not less than the minimum diameter of impeller for the service.
- Pumps of self-venting type are preferred and casing drain connections are required for all pumps. Casing vent connections are required for pumps, except those with top suction nozzle, which may be considered as self-venting. Pressure gauge connection in pump nozzles shall not be furnished, unless specifically noted on the data sheets.
- Unless otherwise specified, all CS outside surfaces of the parts shall be suitable cleaned and coated as per code requirement and site climate condition by vendor.
- A nameplate of 18 Cr and 8 Ni stainless steel, securely attached by stainless steel pins at an easily accessible point on the pump sets shall be furnished. The nameplate shall be stamped with the following information.
 - DAFFPL Tag No. :
 - Serial No. mode of pump and year of manufacture :
 - Service :

- Capacity (m³/hr) :
- Pumping head (m) :
- Specific gravity of liquid :
- Revolutions per minute :
- Motor rating :
- Weight of pump set unit :
- The maximum permissible noise level shall not exceed 85 dBA, when measured at 1 metre from pump discharge.
- For the classification of hazardous areas, Vendor to follow the IP "Model Code of Safe Practice in the Petroleum Industry" (Part 15 3rd Ed: 2005 "Area classification Code"); IEC 60079, "Electrical Apparatus for Explosive Gas Atmospheres" (Part 10, "Classification of Hazardous Areas").
- Jet A1 fuel pump set unit(s) shall be located in a Hazardous Area Div. 2. All instrumentation and electrics shall be suitable for Class 1, Div. 2, and Group D hazardous area, temperature Class T4 to NEC standard or equivalent IEC standard.
- The design of electrical equipment shall be such as to minimise the risk of explosion or fire due to the use of electricity in areas where flammable liquids, vapour and gases will always be present.
- The Vendor shall ensure all supplied equipment and assemblies should conform to the ATEX 95 Directive and associated guidelines.
- The Vendor shall ensure all supplied equipment and assemblies conform to the electromagnetic compatibility requirements [EMC] and associated guidelines.
- Low Voltage Directive 72/23/EEC
- Machine Directive 89/392/EEC
- The vendor shall furnish details of motors as listed in data sheets. For each pump set, the vendor shall furnish the above details with Tag Nos., for each pump clearly. The pump set vendor shall stand guarantee for the satisfactory performance of the pump set. The performance of the pump set shall be tested without overloading the motors. Motor shall be subject to test run.
- All pumps and motors shall be properly aligned, bolted and doweled to the base plates by pump set vendor. Trial runs of pump sets shall be carried out for 72 hours continuous duty at site.
- Electrical motors shall confirm to IE2 standard for high efficiency electric motors.
- 100% of load, then Insulation Class - F temperature rise limited to class F.
- 85% of load, Insulation Class - F temperature rise limited to class B.
- The Vendor shall submit a detailed procedure for welding and weld repairs, for approval by the Purchaser before commencement of work. Pre-qualified procedures shall be permitted, subject to approval by the Purchaser.
- Welding and welds repairs shall be in accordance with a written procedure, duly approved by the Purchaser.
- All NDT procedures shall be in accordance with the ASME design code applicable to the Jet A1 fuel pumping unit(s) and shall be submitted by the Vendor for approval by the Purchaser. However, pre-qualified procedures shall be permitted, subject to approval by the Purchaser.
- Post Weld Heat Treatment (PWHT) shall be in accordance with the requirements of the API Standard 610.

9.2.1 Pump Technical Details

- The suction specific speed (N_{ss}), calculated at the best efficiency point (bep) for the maximum impeller diameter of the casing, shall not exceed 13,000 (rpm, m³/hr, m).
- The impellers, shaft and couplings shall be dynamically balanced to the required grade as per applicable codes.
- Pumps shall be equipped with mechanical seals unless otherwise specified on the pump data sheet.
- The pump model shall be selected so that required margin (minimum 1 m) between NPSH available and NPSH required is maintained for prescribed configuration throughout the entire operating range from minimum continuous stable flow up to and including rated capacity. Further up to 125% of the BEP capacity, the NPSH required shall be less than the NPSH available.
- The base plate shall incorporate a sloping drip collecting area under the pump unit (as a minimum) including a drain point and flange at the lowest point. Flanged drain valve with a blind flange shall be provided.
- Bearings shall be of the antifriction type and shall have a bearing design life of L10 - 25,000 hours minimum in continuous operation at rated pump conditions. Bearings for horizontal pumps shall be oil lubricated.
- No part of the equipment mounted on the base plate shall overhang the edge i.e. all equipment shall be within the dimensions of the base plate.
- The base plate shall be provided with lifting lugs for a single point lift, installed such that the centre of gravity of the package is midway between opposite lugs. In addition, none of the slings shall bear against any of the equipment on the pump base plate.
- In the pump performance curve, the Rated flow shall be lying within a range of 80% to 110% of best efficiency flow rate.
- Impellers shall be dynamically balanced with wear rings, if installed. Pumps shall be provided with replaceable casing wear rings (and if specified on data sheet, impeller wear rings) of compatible materials with non-galling characteristics. The wear rings shall be positioned and rigidly attached to prevent loosening. Spot/Tack welding is not considered an acceptable means of rigidly attaching wear rings. If open bladed impellers are offered and accepted a means shall be provided to compensate for wear between the impeller blades and the cover plate.
- Shafts shall be designed to carry loads without exceeding normal limits of combined stress, taking into account fatigue stress due to change in load or speed. The shaft stiffness shall limit the total deflection to 0.002 in (50µm) at the primary seal faces under the most severe dynamic conditions for the entire operating range of the pump with maximum diameter impeller and the specified speed and fluid.
- Oil lubricated bearings shall be provided with oil level indicators.
- Bearing housings shall be equipped with labyrinth type end seals where the shaft passes through the housing.
- Lifting lugs or eyes shall be provided on the pump base plate or mounting plate. Earthing lugs (2 off) shall also be provided.
- All flanged connections shall be in accordance with ASME B16.5. Bolt holes on all flanges shall straddle the horizontal and vertical centre lines. Vendor shall provide mating flanges with nuts, bolts and gaskets in case of non-standard sizes.

- Vent, if required, and drain connections shall be provided at suitable points on the pump casing, with isolation valve, flanged connection & termination @ the base plate edge.
- Motor shall have power ratings, including the service factor (if any), at least equal to the following percentage of pump rated brake horse power.

| Motor nameplate rating (KW) | Percentage of Rated Pump Power (%) |
|-----------------------------|------------------------------------|
| <22 | 125 |
| 22-55 | 115 |
| >55 | 110 |

- Pump couplings shall be supplied by the pump vendor. Spacer type flexible all-steel couplings shall be provided for all pumps. Rigid all-steel, axially adjustable, couplings shall be supplied for vertical pumps with bearings integral with driver.
- The performance of pumps handling more viscous than water shall be corrected in accordance with the Hydraulic Institute standard.
- Pump performance testing, when specified on data sheet, shall be done at a minimum of five points, which will be:
 - Closed valve (where practical otherwise at minimum thermal flow)
 - Minimum stable flow
 - Rated flow
 - Best efficiency point
 - Maximum operating point
- When performance test is specified on the data sheet, bearings temperature and vibration shall be measured at all points of the performance test, including closed valve when acceptable and jointly agreed by Purchaser and Vendor.
- Hydrostatic test pressure shall be 1.5 times the design pressure of the component and shall be for a minimum of 30 minutes. Hydro testing shall apply to all pressure retaining components.
- Each pump will be tagged with a permanent corrosion-resistant nameplate that is completely visible after installation of the equipment. The following information, as a minimum, shall be shown on the nameplate:
 - Purchaser's order number
 - Pump serial number
 - Purchaser's item number (if provided)
 - Capacity at rated conditions
 - Differential pumping head at rated conditions
 - Speed
- Modifying the impeller to meet performance by under filing, or overfilling is not allowed. An increase of 5% in head at rated flow shall be possible by fitting an increased diameter impeller in the pump.
- The underside of the base plate shall be painted by vendor such that the package can be installed without further preparations. Holes in the base plate for grouting shall be located to allow ease of installation. The base plate shall be designed such as to keep the volume of grouting to a minimum.

- The noise level of all equipments shall not exceed the limit as specified. The maximum permissible noise level (sound pressure level) at a distance of 1 m from the complete pump package shall be 85 dB (A). Vendor shall submit the guaranteed sound power levels and sound pressure levels of the equipment. The equipment shall meet the maximum noise limits by design and not by corrective measures. Vendor shall submit Equipment Noise data sheet in accordance with the format provided in Appendix G.
- The motor rating shall be based on the end of curve power requirement (considering maximum fluid density and viscosity)

9.2.2 Sealing System

- The seal system shall be provided in its entirety by one of the approved Seal Vendors. The seal system shall be in accordance with API 582. The seal selection, piping plan and leakage detection system shall be in accordance with codes.
- Mechanical seal guarantees shall be in accordance with applicable codes.
- For single seals, the seal leakage detection system shall be based on a pressure transmitter operation, fitted on the seal cavity upstream of the leakage line orifice.
- To ensure selection of the optimum mechanical seal and seal auxiliary facilities for the duty specified, the pump manufacturer shall be responsible for the engineering coordination, installation, and performance of its auxiliary facilities such as circulation, injection, quenching and cooling, as required for the seal selected by the seal manufacturer.
- The seal system and the seal facing materials shall be robust against entrained solids in the process media.
- The Vendor, in conjunction with the seal vendor, shall guarantee three years of trouble free operation for double mechanical seals and one year of trouble free operation for single mechanical seals. Vendor shall replace any failed components or alternatively, the entire seal system if repeated failures occur within this period. The technical bid shall propose how this warranty can be implemented, preferably in the form of a maintenance bond.

9.2.3 Painting of the Jet A1 Fuel Pump set Units

- Detailed proposed procedures for painting and repair system shall be submitted by the Vendor for approval by the Purchaser. The painting shall preferably be carried out with following procedure for 4 coat system having a total DFT, of not less than 300 microns:
 - Surface preparation by sand /grit blasting to SA 21/2.
 - Surface primer followed by corrosion resistant layer of paint.
 - Final top layer over and above the corrosion resistant layer of paint.
 - Layer for protection during transit.
 - Colour shade of final coat of paint shall have prior approval of Purchaser.
 - All electrical and instrumentation items shall be masked during painting.
 - External Stainless steel components shall be solvent cleaned and left bare.

9.2.4 Tagging of the downgraded ATF Pump set Units

- The Vendor shall supply & tag all equipment with its appropriate ID number.

- The Vendor shall fix to each pump set, a plate detailing the design, operating and test conditions for individual equipment items and the pumping unit as a whole.
- The Vendor shall supply and install a range of safety signs, agreed with the Purchaser pertaining to the function of Down Graded ATF fuel pumping unit/(s).
- All tags, labels and signs shall be compatible with the environmental conditions.
- All tags shall be stainless steel engraved with black text in English.

9.2.5 Accessories for Downgraded ATF fuel pump set unit

- Following accessories of Down Graded ATF Fuel Pump set Units shall be in accordance with API Standard 610 and the data sheet:
 - Prime Movers for the pump set unit.
 - Coupling and guards between prime mover and pump set unit.
 - Base plate for the pump set unit.
 - Piping & Appurtenances.
 - Special Tools.

9.3 Applicable Codes and Standards

- Latest published issue or amendment shall be followed unless stated otherwise.
- Specified standards may be replaced by equivalent standards that are internationally or otherwise recognised provided that it can be shown to the satisfaction of the Purchaser that they meet or exceed the requirements of the latest edition of the Specified standards.
- All standards, codes or specifications proposed by the Vendor shall be the latest issue of internationally recognised, and agreed with the Purchaser before implementation.

| Heading Left | Heading Right |
|---------------------------------------|--|
| API 610 | Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries. |
| ASME B31.3 | Process piping. |
| ASME B16.34 | Valves – Flanged, Threaded and Weld Ended |
| API 598 | Inspection and Test of Valves |
| ASME B16.5 | Steel Pipe Flanges and Flange Fittings |
| ASME B16.11 | Forged Steel Fittings, Socket-Welding and Threaded. |
| ASME B16.20 | Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral-Wound, and Jacketed. |
| API 582 | Mechanical Seals of Centrifugal Pumps for Jet A1. |
| ASTM A193 | Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service |
| ASTM A194 | Standard Specification for Carbon and Alloy Steel Nuts for Bolt for High Pressure or High Temperature Service, or Both |
| ISO 9001:2008 | Quality Management Systems |
| IS 1571:2008 | Jet A1 Fuel Specifications |
| DEF STAN 91-91 Issue 8 (amendment 3) | |

9.4 Acceptance Criteria

The following shall be minimum acceptance criteria

- "Vendor" shall submit a detailed Quality Assurance Plan incorporating the stages of inspection to be carried out by "DAFFPL Representative", if any, for approval, prior to commencement of work.
- Access to the "Vendor" manufacturing shop, at all reasonable times shall be available to "DAFFPL Representative". All raw materials to be used in fabrication shall be offered for inspection and shall be used only if duly approved by the "DAFFPL Representative".
- "Vendor" shall arrange for inspection & testing of the equipment at his own cost which shall be witnessed by "DAFFPL Representative".
- "Vendor" shall furnish all the material test certificates.
- "Vendor" shall issue a call for inspection to "DAFFPL Representative" intimating readiness of the equipment / components for inspection / witnessing test giving 7 days prior notice.
- No surface / parts shall be painted or sandblasted until the inspection is completed.
- "Vendor" shall extend all the required testing equipment / facilities to "DAFFPL Representative".
- Centrifugal pump testing and inspection shall strictly as per the American Petroleum Institute Codes. "Vendor" shall provide the compliance certificate.
- The "Vendor" shall submit the testing procedures to "DAFFPL Representative".
- The following tests shall be carried out as minimum requirement for testing:
 - Material test
 - Final Dimensional Check
 - Hydro Testing : @ 1.5 times the design pressure
 - Performance Testing
 - Fresh tap water may be used for hydrostatic testing. However, immediately after completion of the test the water shall be drained off and the vessel shall be thoroughly dried with hot air. The "Vendor" shall take adequate precaution, such that no scaling or rusting occurs inside the pump or any part thereof.
 - Type, routine & acceptance test of electrical items.
 - All welds shall be flush ground and sharp edges shall be rounded off.
 - All bolt holes shall be straddle centre line of unit.
 - Site performance test for pump sets to be carried out.
 - Trial runs of pump sets shall be carried out for 72 hours continuous duty at site.
 - Upon successful completion of testing operation and after the "DAFFPL Representative" "has satisfied that the equipment installed is functioning as intended, the "DAFFPL Representative" shall issue to the "Vendor" a "Taking Over Certificate" as a proof of the final acceptance of the system by the "DAFFPL Representative". Such certificate shall not be unreasonably withheld nor shall the "DAFFPL Representative" delay issuance thereof, on account of minor omissions or defects, which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the "Vendor" of any of his obligations which otherwise survive by the terms and conditions of the contract after issuance of such certificate.
 - "Vendor" shall arrange test certificates for all the accessories being provided with pump sets.
 - "2 sets of detailed O&M manual shall be provided.

9.5 Exclusion from "Vendor" scope

- All civil works. However, necessary civil loading data shall be furnished by "Vendor" within 15 days of the purchase order date for the design of civil foundation, etc.

9.5.1 Deviations

There shall be no deviations to this bid specification. However, if any special deviation from this technical requisition is must, the same supported by adequate technical back-up data shall be furnished separately during submission of offer by the "Vendor". In the absence of any such indications, it shall be assumed that the offer complies with all the requirements and such assumptions shall be strictly binding on the "DAFFPL Representative".

9.6 Contractor Quality Control

- Unless accepted otherwise by the "DAFFPL Representative", "Vendor" shall employ a Quality Management System complying with the program described in ISO 9001-2008. The Vendor shall prove and satisfy the Purchaser that his obligations within the scope of this document are in accordance with the relevant section of BS EN ISO 9001. Prior to commencement of work, the Vendor shall submit a Quality Plan and procedural specifications for Purchaser's review and approval.
- Jet A1 Fuel specifications are as per IS 1571:2008 and DEF STAN 91-91 Issue 8 (amendment 3).
- The Quality Plan shall define scope of work of all the sub-vendors associated with the work. This Specification shall only indicate a general requirement and shall not relieve the Vendor of his obligations to comply with the requirements of the Contract.
- Work which, in the opinion of the "DAFFPL Representative", is not in accordance with the Drawings or this Specification shall be rejected. Any delay caused by such rejection shall not in any way relieve the "Vendor" of his obligations under the Contract.

9.7 Guarantee

Unless otherwise specified in General purchase conditions regarding guarantee, the following shall govern and the following are covered by the guarantee clause:

- Quality of components used.
- In case of any defect / non-performance, the "Vendor" shall undertake necessary modification / replacement work at site in order to set right the defect.
- "Vendor" shall guarantee that all materials used in the equipment are new and have been submitted to regular acceptance procedure and are free from any defect regarding quality, form and appearance.
- Pump set unit shall be guaranteed for design, materials, workmanship and satisfactory performance for a period of 12 months from the date of commission or 18months from the date of receipt at site, whichever is earlier. The "Vendor" shall be completely responsible for any design work carried out by him. "DAFFPL Representative" approval of his design shall not relieve him of his responsibility from the satisfactory performance of such item.
- Compliance with this specification or approval of work by "DAFFPL Representative" or release of units for shipment shall in no way release or relieve the "Vendor" of any responsibility for carrying out all provisions of this specification.
- The guarantee for performance shall cover individual items, bought-out items and systems including any electrical for their ratings / outputs as well as for the integrated operation of the equipment and its auxiliaries as a whole.

9.8 Documentation/Information to be furnished

The Contractor shall submit all necessary Completely filled-in data sheets, G.A. of all pump sets, Pump foundation drawings with loading details along with offer and documentation relating to the Works as

stated in the Project Specifications and Drawings or as otherwise requested by the "DAFFPL Representative ".

- Complete technical particulars & General Arrangement scheme and terminal details drawing of pumps with overall dimensions.
- QA/QC plan
- List of Erection & commissioning spares. Special tools and fixtures for installations of the pumping unit/(s) shall be included in the quotation and furnished as part of the initial supply. The requirements for quantities shall be agreed upon by the Purchaser and the Vendor
- The Vendor shall provide a list with prices of specialist tools and operational spare parts for Jet A1 fuel pumping unit/(s) and instrumentation for start-up, commissioning and for twenty four (24) months operation.
- All spares shall be suitably marked and numbered, for easy identification with the maintenance manuals and with the particular item and shall be suitably packed and preserved to prevent deterioration during transport and / or storage at DAFFPL Fuel Farm, Shabad Mohammadpur IGI Airport, New Delhi.
- Following documents for motors also to be submitted by vendor-
 1. Torque - Speed Curve
 2. Thermal Withstand Curves (Cold & Hot)
 3. Load – Efficiency Curve
 4. Starting Current - Time Curve
 5. Motor Data Sheets / Technical Particulars
- Operation & Maintenance Manual.
- Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of engineers and owners, and other information specified.
- Product Test Reports: Certified reports of manufacturers design and production tests indicating compliance of unit and accessories with referenced standards.
- Field test reports indicating and interpreting test results relative to compliance with performance requirements specified. Include certified copies of field test records.
- "Vendor" shall submit the drawings and documents in required number of copies to the "DAFFPL Representative ", for approval, as per the schedule given below.

| | | | After order placement |
|--------|--|--------------|-----------------------|
| S. No. | Drawing / Documents | For Approval | Prior to dispatch |
| 1 | G.A. drawings showing location of suction & discharge connections, auxiliary piping details, direction of rotation, when viewing from the coupling end, model no., dimension, weights etc. | 7 | 6 |
| 2 | Cross-sectional drawings with parts numbered with MOC and list of parts, which agreed with the pumps, furnished. | 7 | 6 |
| 3 | Description & literature of all accessories including make, model, capacity, etc. | 7 | 6 |
| 4 | Allowable forces and moments, Performance curves which include diff. Head, efficiency, water NPSH req. BKW all expressed as function of capacity at peak efficiency. In addition, the head curve for max. & min. | 7 | 6 |

| After order placement | | | |
|-----------------------|--|----|---|
| | These curves shall indicate viscosity corrections, if any. | | |
| 5 | Completely filled in pump data sheets and separate deviation list, if any. | 7 | 6 |
| 6 | Material Test certificates. | -- | 6 |
| 7 | Test certificates for tests carried out at vendor/sub-vendor's shop. | -- | 6 |
| 8 | List of recommended spare parts, prices and delivery dates. | 7 | 6 |
| 9 | Operating and maintenance manuals. | -- | 6 |
| 10 | Drawing showing mechanical seal installation and other setting dimensions. | 7 | 6 |
| 11 | Installation drawings. | 7 | 6 |

Vendor shall furnish the final record documents as listed above along with or immediately after the supply/despatch of the equipment. The reports and other documents shall be grouped for each equipment and all the documents shall be provided in a folder.

9.9 Testing the Down Graded ATF Fuel Pumping Units

9.9.1 Purchaser's Requirements

- The Vendor will perform following scope of activities in seriatim to fulfill Purchaser's Requirement for Testing the Down Graded ATF Fuel Pumping Unit/(s):

9.9.2 General

- Preparation of all testing processes and procedures and submit the same for approval by the Purchaser. These should be in line with the design codes and international standards.

9.9.3 Pre Test Inspection

- The Purchaser shall undertake a visual and dimensional inspection of the pumping units and produce a list of items. Any deviation from the standards shall have to be corrected by the Vendor prior to commencement of any test.

9.9.4 Testing of Strength

- Hydrostatic Testing of the pumping units shall be conducted in accordance with applicable Design Code. A stabilised test pressure test shall be held for the specified time. During testing, pre tested items unsuitable to be in the test system may be removed.

9.9.5 Cleaning & Drying

- The pumping units shall be cleaned and dried thoroughly on completion and acceptance of the strength test.

9.9.6 Leak Testing

- The pumping units shall be fully assembled and pneumatically leak-tested on completion of cleaning and drying. Leaks, if any, shall be rectified.

9.9.7 Functional Testing

The pumping units shall be assembled and functionally tested on completion of leak testing.

9.9.8 Factory Acceptance Test

- Upon satisfaction of the Vendor that the pumping units are fully functional, the Vendor shall inform the Purchaser with 10 days advance notice for Factory Acceptance Test, which shall be undertaken in the presence of the Purchaser.

9.9.9 Post Test Inspection

- Purchaser shall undertake visual inspection of the pumping units after completion of the FAT. The purchaser will produce a list of his observations, which shall be attended by the Vendor prior to commencing any activity for packing.

9.9.10 Dossiers

- The Vendor shall prepare a detailed dossier/(s) for manufacturing, inspection and testing and submit the same to the Purchaser.

9.10 Packing, Protection, Preservation & Delivery

- The Vendor will perform following activities for packing & transportation of the Down Graded ATF Fuel Pumping Unit/(s):

9.10.1 Packing, Protection & Preservation

- On completion and acceptance of testing and FAT, the pumping units shall be preserved, protected, packaged keeping in view the outer maximum dimension of the package acceptable for transportation either by land/rail to DAFFPL Fuel Farm at Shabad Mohammadpur, IGI Airport, New Delhi for its storage.

9.11 Method of Measurement

The item shall be measured in numbers.

9.12 Basis of Payment

Payment terms shall be as per "DAFFPL" terms and conditions.

9.13 Reference documents

Refer Document no. "DAFFPL-MMD-322588-RSD-02" for combined Pump/Motor Datasheet appendices 1.2.

10 Pre Commissioning and Commissioning

10.1 General

After erection / installation / testing of the equipment, it shall be the responsibility of the Contractor to start up and commission all the facilities. Contractor shall ensure that all the necessary pre commissioning activities applicable for each component of the facility shall be carried out as per the good engineering practices and manufacturer's recommendations.

Contractor shall ensure that all necessary pre-commissioning activities applicable for each component of the facilities shall be carried out as per the general specification laid down elsewhere in the bidding document, in accordance with the good engineering practices and as per Contractor's / manufacturer's recommendations.

A pre commissioning activity shall be considered to be completed, only when it has been witnessed by Client's representatives and the pre commissioning formats have been signed by client's representatives, Contractor's representatives, Third party's representatives (wherever applicable) and others as indicated on the approved formats as a token of successful completion of the said activity.

10.2 Mechanical Completion

Mechanical completion of a system means that all installation work of that system as described in the scope of work of the bid package have been completed in accordance with approved for construction drawings, specifications, applicable codes as defined in the bid package and good engineering practices, all tie in connections have been made, all pre commissioning activities defined later required for the system have been completed and the system / facilities are ready for commissioning and witnessed by CLIENTS/Third party representative (wherever specified).

10.2.1 List of Minimum Activities to be Carried Out after Installation and Hook Up

- Calibration check of instruments and loop checking of all the systems / equipment including packaged items
- Testing of PSV's / TSV's/ Breather valves/ PV valves
- System flushing and system leak test.
- Recommended pre-commissioning checks for Switchgear, MCC and other packaged items.
- Checking of electrical equipment for proper earthing, continuity, insulation resistance and secondary injection test of relays after insulation resistance test.
- During the pre-commissioning / commissioning of electrical system stability of differential relays, illumination level checking and battery capacity test shall also be carried out
- Internal inspection of all tanks / vessels
- Flushing and leakage testing of the lines

10.3 Pre-Commissioning Activities

Pre-commissioning activities are defined as the activities to be performed after erection / installation of an equipment / system to make it "READY FOR COMMISSIONING". This includes but not limited to

the activities like system checking, site modifications, internal inspection of the tanks /vessels, flushing / cleaning of tanks / vessels and piping, calibration of PSV's / TSV's, system leak check up to the normal operating pressure, purging of the system using inert gas, calibration of all the instruments and thereafter loop checking, electrical equipment's for proper earthing, continuity, Insulation resistance, secondary inspection of relays after insulation resistance, complete checking of the safety system, operability test of equipment's and system as whole plus recommended checks on electrical system. Manufacturer's recommendations should be followed during testing.

10.3.1 Execution of Pre-Commissioning Activities

It shall be Contractor's responsibility to complete all the pre-commissioning activities before start-up. Contractor shall formulate necessary procedure and obtain approval from CLIENTS's representative and shall carry out as per approval procedure.

10.3.2 Pre-Commissioning Documents

It shall be the responsibility of the Contractor to prepare detailed format of checklist of pre-commissioning and commissioning activities for each equipment and system. Contractor shall submit the said format for CLIENTS's approval. This checklist in addition to indicating the check/test to be carried out in each equipment / system shall also indicate the sequence and schedule of the activities.

All the checklist points shall be dealt by the Contractor to the CLIENTS's satisfaction. System readiness for pre-commissioning shall be determined based on the completion of relevant portion of checklist by Contractor as per the approved format. Contractor shall submit a detailed schedule for carrying out the pre-commissioning activities in a network form.

Pre-commissioning documents shall contain the following:

- System, sub system identification
- Detailed procedure for various pre-commissioning activities such as system check, flushing, purging, blowing, leak test, system tightness, instruments / MOV operability test, internal inspection, etc with formats to record the observations of each of the activities carried out.
- Procedure and formats of operability tests for different equipment / systems.
- List of commissioning spares
- List of spares recommended for one- year operation.
- Contractor shall submit the draft of the above mentioned pre-commissioning documents 90 days before the activities are to be carried out. The documents shall be submitted to CLIENTS for review and approval and comments, if any shall be incorporated by the Contractor.

10.4 Operating Manual

The Contractor shall prepare a draft start up and operation manual of the plant / facility and submit it to CLIENTS at least 90 days prior to start of commissioning activities. In particular the following minimum information shall be covered as a minimum:

- Description of facility.
- Pre-start checks
- Start-up procedure.
- Normal operating procedure.
- Shut down procedure. (Normal / Emergency)
- Contractor instruction/ operating manual for all equipment for start-up, shut down, normal operation, maintenance and spares.
- Operating parameters and set points of different alarms and trips
- Reduced size Copies of line lists.

- Equipment and instrument data sheet.
 - Electrical single line diagram.
 - Area classification drawings and control scheme logics.
 - Piping and instrumentation drawings.
 - All shut down schemes.
 - Fabrication drawings of oil storage tanks.
 - Calibration sheet for oil storage tanks for tank sounding.
 - As built drawing of the complete facility.
- Review of operating manual shall be done by the CLIENTS and all the changes, additions, deletion, if required shall be incorporated in the final start up and operating manual. Sub Contractor operating manuals shall form a part of final operating manual.
 - In case of any revisions due to any reasons, the same should be submitted as revised sheets during the start-up and commissioning stage. However, the same shall be incorporated and submitted as final total manual.

10.5 Commissioning

30 days in advance of starting of commissioning, Contractor. shall submit a proposal to CLIENTS giving complete detail of the program / procedures to be followed during commissioning. These documents shall be approved by CLIENTS

Commissioning shall be started only when all the utilities and other auxiliary facilities of the tank system are fully operational and the pre commissioning activities as specified / recommended have been successfully completed. Commissioning means un-interrupted operation of tank system with all its utilities and safety systems for 72 hours as per process scheme at its design conditions. CLIENTS would like to run all facilities together or part as per their requirement.

The log sheets suitably prepared for different equipment / system shall be provided by Contractor which shall be reviewed / approved by CLIENTS. These approved log sheets shall be used during pre-commissioning and commissioning of the plant.

At the end of 72 hours of the stable operation of tank system all the log sheets shall be signed by CLIENTS & Contractor. Whether commissioning has been successful or not shall be decided by the CLIENTS, based on the 72 hours observations recorded in the log sheets and the test results of sampling wherever required.

After the successful commissioning of the tank system, it shall be handed over by the Contractor to CLIENTS for normal operation and maintenance.

The Contractor shall also associate himself during performance guarantee run of the tank systems.

10.5.1 Commissioning Procedure

Contractor shall prepare this document (30 days before the start of commissioning) to detail out the procedure for commissioning of tank systems. Contractor shall have required inputs from CLIENTS and the Contractor's representative. The document shall include the shift rosters for the Contractor's personnel deployed during commissioning operations of the tanks.

10.5.2 Manpower for Commissioning

For pre-commissioning and commissioning of the facilities, Contractor shall deploy personnel with experience in operation of similar facilities; it shall be round the clock uninterrupted operation. The Contractor shall arrange and provide all categories of personnel i.e. shift engineers, operators, technicians, etc.

The Contractor the Contractor shall submit the organization chart with bio-data of key personnel for approval to CLIENTS.

10.6 Spares and Consumables

The Contractor shall be responsible for the supply of all spares and consumables till all the units are handed over to CLIENTS.

The utilities like air, power and water for pre-commissioning / commissioning shall be provided to the Contractor

It shall be the Contractor's responsibility to supply lubes, chemicals, desiccant or other similar materials. It shall be the Contractor's responsibility to repair any damage to the system occurred during storage, installation, pre-commissioning and commissioning stages.

The Contractor shall maintain a record of start-up spares consumed during pre-commissioning and hand over the balance items to CLIENTS.

10.7 Inspection

CLIENTS reserve the right to inspection / tests (including stage inspection) of any of the equipment / items at any stage of manufacturing. Contractor shall intimate to CLIENTS of readiness for final inspection of respective item

11 List of Approved Vendors

11.1 Civil Work

Table 11.1: List of Approved Civil Vendors

| Sr. No | Material | Manufacturers / Brand / Make |
|--------|--|---|
| | Cement OPC / PPC / SRC | Ultra Tec, Ambuja, |
| | White Cement | Birla Cement, J K Cement |
| | Reinforcement Steel Bars | SAIL, TATA, RINL |
| | Fine aggregates | Good Quality River Sand with approved sample by EIC |
| | Coarse aggregates , Rubble for soling | Good Quality, sample to be got approved before Use. |
| | Clay brick Bricks | Good Quality from Chimney Bhatha, sample to be got approved before Use. |
| | Structural Steel, H beam, I beam, Channel, Angle, Plate, flat, round pipe, chequered plate | SAIL, TATA, JINDAL, RINL, JINDAL |
| | Welding electrodes | ADVNI, ESAB, D & H |
| | Admixture, non-shrink cementitious Grout, epoxy grout, Tile fixing adhesive, floor Hardener, Bonding Agents etc. | Fosroc, BASF, BAL Endura, JBA, Dr. Fixit, |
| | Internal / External paint - Primer weather proof external paint | Berger paints India ltd, Asian paints, godless Nerolac, ICI, Shalimar |
| | Cement paint | Snowcem, Indocem, |

NOTE:

Bidder to follow the above mentioned makes. Makes of Items not listed here or In case none of the above makes are available, bidder to follow the equivalent makes with prior approval from client. Deviation from approved make list is not allowed.

It will be the responsibility of the bidder to provide all supporting documents to establish that the brand/make offered by them is equivalent to the specified make and client's decision regarding approval of equivalent make shall be final and binding

11.2 Mechanical/Piping

Table 11.2: List of Approved Mechanical equipments Vendors

| Sr. No. | Mechanical ITEM | Makes |
|---------|-----------------|--|
| 1 | Pumps | Mather & Platt / Kirlosker |
| 2 | Motor | ABB / Simens / CGL |
| 3 | Diesel Engine | Cummins / KEOL |
| 4 | M.S. ERW Pipes | Jindal / Surya Roshni / TATA / Welspun |
| 5 | Pipe Fitting | Tube Products / Teekey Tubes / Pipe fit/ Topaz / Tube Product / Fit Tech |

| Sr. No. | Mechanical ITEM | Makes |
|---------|----------------------------------|---|
| 6 | Strainer | GujaratOtofilt / Flair / Jaypee |
| 7 | Gate valve | H sarkar / KBL / Advance / Audco / BDK / GM ENGINEERING |
| 8 | Globe valve | Leader / Sant / GM ENGINEERING |
| 9 | Butterfly Valve | Advance / Audco / GM ENGINEERING |
| 10 | Non return Valve | H sarkar / Advance / KBL / GM ENGINEERING |
| 11 | Wrapping coating | Pypecote / Rusto-Seal, Asian Paints, STP |
| 12 | Primer & Paint | Jotun /Sigma / Akzonoble |
| 13 | Hydrant Valve | SBJ / Winco / Sukan |
| 14 | Branch pipe with Nozzle | SBJ / Winco / Sukan |
| 15 | Fire hose | CRC / Jay Shree / Newage |
| 16 | Hose Coupling | SBJ / Winco / Sukan |
| 17 | Water Monitor | HD / SBJ / Winco |
| 18 | Pressure Gauge | H Guru /General Instruments |
| 19 | Pressure Gauge | Indfos / Denfoss |
| 20 | Fire Extinguishers | Safex / Zenith / Kanex |
| 21 | Level Transmitter & Level switch | Sigma / Levcon |
| 22 | Welding rod | Ador / Esab / D&H,OVERLINCON, HONAVAR |
| 23 | HDPE Pipe | Dutorn / Jain irrigation / Parixit |
| 24 | LHS Cable | Kidde/Honeywell/Protectowire |
| 25 | MVW nozzle | HD / kidde |
| 26 | Q B detector | HD / Tyco / Kiddey |
| 27 | Deluge Valve | HD/ darling mousco |
| 28 | Foam equipment | HD / SBJ/ New age |
| 29 | Mechanical contractor | Credential shall be approved by Client |
| 30 | NDT Agency | Credential shall be approved by Client |
| Sr. No | Piping Item Description | Approved Brand |
| 1 | Structural steel | SAIL / TISCO or equivalent brand with prior approval of Engineer-in-charge |
| 2 | MS Pipe | Maharashtra Seamless Indian Seamless Tubes Ratnamani Metals & Tubes Surya Roshni Ltd. Jindal Pipes MAN Industries Welspun Gujarat Stahl Mahalaxmi Seamless |
| 3 | SS Pipes | Ratnamani Metals & Tubes Sandvik Asia ltd Jindal Saw Pipes |
| 4 | Pipe Fitting | Topez EBY Industries Sanghvi Gujarat Infra pipes PipeFit Tube Products Incorporate |

| Sr. No. | Mechanical ITEM | Makes |
|---------|-----------------|---|
| | | Fittech |
| 5 | Flanges | Chaudhry Hammer |
| | | Echjay Industries |
| | | Echjay Forgings |
| | | Paramount Forge |
| | | Shraddha Forgings, WESTERN FORGINGS, GHAZIABAD ISPAT, KISHAN STEELS |
| 6 | Valves | BDK Engineering Industries |
| | | Larsen & Toubro |
| | | Fouress Engineering |
| | | KSB Ltd |
| | | Niton Valves |
| | | Oswal Industries |
| | | Econo valves P Ltd |
| | | NecoSchubrtSulzer (NSSL) |
| | | Advance Valves |
| | | Tyco valves & Controls |
| | | Intervalve I Ltd |
| | | BHEL (Trichy) |
| | | Hawa Engineers Ltd |
| 7 | Gaskets | IGP Engineers Ltd |
| | | Madras Industrial Products |
| | | Star Flex Sealings |
| | | Goodrich Gaskets |
| | | Champion Jointings |
| | | Uni Klingler Ltd |
| 8 | Fasteners | AEP Company |
| | | Fasteners & Allied Products |
| | | Pioneer Nuts & Bolts P Ltd |
| | | Sundaram |
| | | Unbrako |
| | | TVS |
| | | Multi fasteners |
| | | Ashvin Fasteners |
| 9 | Electrodes | ESAB India Ltd |
| | | Honawar Electrodes |
| | | D & H Welding electrodes |
| | | Advani-Orlicon |
| | | Phillips |
| | | GEE |
| | | Lincoln USA |

NOTE:

- Bidder to follow the above mentioned makes. Makes of Items not listed here or In case none of the above makes are available, bidder to follow the equivalent makes with prior approval from client. No change or introduction of new make shall be permitted during execution of contract.

- It will be the responsibility of the bidder to provide all supporting documents to establish that the brand/make offered by them is equivalent to the specified make and client's decision regarding approval of equivalent make shall be final and binding.

11.3 Electrical

Table 11.3: List of Approved Electrical Equipments Vendors

| | | |
|----|---------------------------------|---|
| 1 | MCCB/MCB/ELCB/MPCB | Siemens/ L&T/ ABB / Schneider |
| 2 | CONTACTORS | Siemens/ L&T/ ABB / Schneider |
| 3 | SWITCH FUSE UNIT | Siemens/ L&T/ ABB / Schneider |
| 4 | NEUTRAL LINK | GE/ C&S /SIEMENS |
| 5 | PROTECTIVE RELAY | SIEMENS/L&T/ABB/GE |
| 6 | INDICATING LAMPS(LED TYPE) | Siemens/ Schneider/ Telemechanic |
| 7 | PUSH BUTTON AND PUSH BUTTON SET | Omron/Siemens/ L&T/ Telemechanic / Vaishno |
| 8 | TERMINALS | ELMEX/CONNECTWELL |
| 9 | PVC & XLPE Cables LT | KEI/ AVOCAB / POLYCAB/ HAVELLS / Lapp / Nicco |
| 10 | FLEXIBLE WIRE (FRLS) | Finolex / HAVELLS/ANCHOR/LAPP |
| 11 | SELECTOR SWITCH | Salzer / Kaycee |
| 12 | TIMER | Siemens/ L&T/ Selectron /HANGSLER |
| 13 | LUGS & SOCKETS | Dowell's/ 3D/ Comet |
| 14 | BIMETALLIC LUGS | Dowell's/ Comet/ Ismal/ HMI |
| 15 | CONNECTORS | Salzer/ Connectwell / Elemax |
| 16 | PVC CONDUITS AND ACCESSORIES | Precision/ Polycab/ Anchor |
| 17 | ROTARY SWITCH | Siemens/ Keycee / Salzer/ ABB |
| 18 | FRP cable tray | Kemrock/ Ercon/ EPP/ Sumip / Satyam |
| 19 | Junction Box | Hensel/ Sintex/RITTAL |

11.4 Instrumentation

Table 11.4: List of Approved Instrument Vendors

| | | |
|---|-----------------------|--|
| 1 | Pressure gauge | General Instruments, WIKA, WAREE, H Guru |
| 2 | Pressure Safety Valve | Nirmal, Kingshley |

NOTE:

Bidder to follow the above mentioned makes. Makes of Items not listed here or In case none of the above makes are available, bidder to follow the equivalent makes with prior approval from client. Deviation from approved make list is not allowed.

It will be the responsibility of the bidder to provide all supporting documents to establish that the brand/make offered by them is equivalent to the specified make and client's decision regarding approval of equivalent make shall be final and binding

Appendices

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Appendix A. Standard Welding Procedure Specification (Sample)

(To be submitted by contractor)

Appendix B. Procedure Qualification Records (PQR) Sample

(To be submitted by contractor)

Appendix C. Welder Qualification Test Record (Sample)

(To be submitted by contractor)

Appendix D. Welder's Identification Card

(To be submitted by contractor)

Attached herewith

Name :

Identification : Photograph

Date of Testing :

Valid Until :

Approval for :

Welding Position :

Approval by
(Owner's representative)

Contractor's Signature
(with seal)

Appendix E. Radiographic procedure for pipe welding

(To be submitted by contractor)

Location :
Date of Testing :
Name of Contractor :
Material : Carbon Steel/Alloy Steel/Stainless Steel
Diameter and Thickness :
Type of Weld Joint :
Radiation Source :
Intensifying Screens :
Lead Screens :
Geometric Relationship :
Limit of Film Coverage :
Film type and make :
Exposure Time :
Processing :
Density :
Sensitivity :
Type Penetrameter :

Approval of Owner's Inspector

Signature of Contractor

(with seal)

Appendix F. Flushing Report

(To be submitted by contractor)

Client _____ Located _____ Date _____

Table F.1: Flushing Report

| Line no | Service | From | To | Operating pressure | Test pressure | Flushing medium | Remarks |
|---------|---------|------|----|--------------------|---------------|-----------------|---------|
| | | | | | | | |
| | | | | | | | |
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| | | | | | | | |

Owner's Representative

Contractor's Representative

Date

Date

Appendix G. Test Report

(To be submitted by contractor)

Client _____ Located _____ Date _____
 Medium _____ Time _____

Table G.1: Test Report

| Line no | Service | From | To | Design pressure | Test pressure | Duration of test | Remarks |
|---------|---------|------|----|-----------------|---------------|------------------|---------|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
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| | | | | | | | |

Approved by _____

Owner's Representative

Contractor's Representative

Date

Date

Appendix H. Welding Electrodes selection Chart

Note: Client approved WPS/PQR shall be followed, below detail are only for guide line.

| WELDING ELECTRODES SELECTION CHART | | | | |
|------------------------------------|--------------------|---------------------|--|--|
| SR. | BASIC | ELECTRODE | ELECTRODE | REMARKS |
| NO. | MATERIAL | SPECIFICATION | FOR | FOR FILLER |
| | | | ROOT RUN | PASSES |
| 1 | STRUCTURAL STEEL | CONFORMING TO | - | AWS-E-6013 (Thickness up to 14 mm) |
| | | IS-2062 / ASTM A-36 | | |
| 2 | M.S. ERW PIPES | CONFORMING TO | | |
| | | IS-1239,IS-3589 | AWS-E-6010 | - |
| | | AND ASTM A-53 | - | AWS-E-6013 (Use in utility piping) |
| 3 | C.S.PIPE | CONFORMING TO | AWS-E-6010 | AWS-E-6010 (Not to be used without client written approval) |
| | | API-5L | | |
| 4 | C.S.SEAMLESS PIPES | CONFORMING TO | | |
| | | ASTM-A-106 GR.B | AWS-E-6010 (Not be used without client written approval) | - |
| | | ASTM-A-53 | - | AWS-E-7018 (Not be used without client written approval) |
| 5 | S.S. PLATE / PIPE | TP-304 | AWS-ER-308-16 | AWS-E-308-16 |
| 6 | S.S. PLATE / PIPE | TP-304L | AWS-ER-308L-15 | AWS-E-308L-15 |
| | | | AWS-ER-308L-16 | AWS-E-308L-16 |
| 7 | S.S. PLATE / PIPE | TP-316 | AWS-ER-316-15 | AWS-E-316-15 |
| | | | AWS-ER-316-16 | AWS-E-316-16 |
| 8 | S.S. PLATE / PIPE | TP-316L | AWS-ER-316L-15 | AWS-E-316L-15 |

| WELDING ELECTRODES SELECTION CHART | | | | | |
|------------------------------------|--------------------------------------|--|---------------------------------|--------------------------------|--|
| | & PIPE FITTINGS | | AWS-ER-316L-16 | AWS-E-316L-16 | |
| 9 | S.S. PLATE / PIPE & PIPE FITTINGS | TP-321 | AWS-ER-347-15 AWS-ER-347-16 | AWS-E-347-15 AWS-E-347-16 | |
| 10 | S.S. PLATE TO C.S. PLATE | A 240TP304/304L /316/316L TO SA 515GR 60/70 | AWS-ER-309 AWS-ER-309-L | AWS-E-309-L | |
| 11 | S.S. PIPE TO C.S. PIPE | A 312TP304/304L /316/316L TO SA 106GR B/A-53GR.B | AWS-ER-309 AWS-ER-309-L | AWS-E-309-L | |
| 12 | Ni 201,Sch.40 | Nickel 201 (UNS-02201) | AWS ERNi-1 (UNS-02061) | AWS ERNi-1 (UNS-02201) | Nickel welding electrode-141 Nickel filler metal -61 |
| 13 | Inconel-600,Sch.40 | Inconel alloy -600 | AWS ERNiCrFe-3,6 (UNS-06600) | AWS ENiCrFe-3,6 (UNS-06600) | Inconel welding electrode 182 |
| 14 | S.S. FITTINGS TO C.S. FITTINGS | A 182F304/304L /316/316L TO SA 105 GR B | AWS-ER-309 AWS-ER-309-L | AWS-E-309-L | |

Appendix I. Drawings

11.5 Mechanical & Piping Drawings

- 322538-MLB-0003-01 Rev 0--U/G Tank Layout and section of equipment
- 322538-MPB-0104-01 Rev 0--U/G Tank Piping Layout and section
- 322538-MPE-0100-01 Rev 02--Layout for proposed enclosure modification in existing aviation fuelling facility.
- 322538-MSB-0001-01 Rev B—Tank Datasheet
- 322538-PIC-0003-01 Rev 2—P&ID for downgraded ATF Transfer System.

11.6 Pump/Motor Datasheet

- Refer Document no. “DAFFPL-MMD-322588-RSD-02” for combined Pump/Motor Datasheet

11.7 Civil Drawings

- 322538-CCB-0022-01 Rev .0 45KL UG Tank Layout & Details of RC Wall Foundation and Pedestal



DELHI AVIATION FUEL FACILITY PRIVATE LIMITED

ANNEXURE II – DEVIATION SHEET

| EXCEPTION AND DEVIATIONS STATEMENT | | | | |
|------------------------------------|-----------------------------|------------|---------|------------|
| S.NO. | PAGE NO. OF TENDER DOCUMENT | CLAUSE NO. | SUBJECT | DEVIATIONS |
| | | | | |

Bidder shall list all the deviations in the following given format only on their Letterhead. The Deviation sheet should be submitted along with technical bid.

In case no deviation sheet is submitted along with technical bid, it would be concluded that bidder has accepted all specifications, terms and conditions.

Sign & Stamp of Bidder



DELHI AVIATION FUEL FACILITY PRIVATE LIMITED

ANNEXURE III – DECLARATION SHEET

Date:

DECLARATION

We, M/s _____ hereby, unconditionally accept all terms & conditions of TENDER NO.: DAFFPL/MOD/FF/2015-16/07 (JOB: TENDER FOR EPC of 45 M³ MS horizontal cylindrical underground tank) including Scope of job, quantities, completion period, terms & condition without any deviations.

Sign & Stamp of Bidder

Note: In case of deviations (whether technical or commercial) the above declaration should not be submitted and the deviations should be mentioned separately on bidders letter head with the heading "DEVIATION SHEET". In absence of "DEVIATION SHEET", it would be concluded that bidder has submitted his offer as per tender specifications, terms & conditions. Corrections in tender booklet will not be accepted.

Sign & Stamp of Bidder



DELHI AVIATION FUEL FACILITY PRIVATE LIMITED

ANNEXURE-IV

PROFORMA OF BANK GUARANTEE (EARNEST MONEY DEPOSIT)

(On Non-Judicial Stamp paper for appropriate value)

BANK GUARANTEE NO. :

BANK GUARANTEE AMOUNT:

CLAIM:

(Till 120 days from date of submission of Proposal)

TENDER NO. /DATE:

JOB DESCRIPTION/

LOCATION:

Tender Security No. [*]

Name and Address of the Beneficiary: Delhi Aviation Fuel Facility (Private) Limited
Aviation Fuelling Station, Shahabad Mohammadpur, IGI Airport, New Delhi – 110 061, India

We [*name and address of the issuing bank*] have been informed that [*Name of the Interested party*] (hereinafter called the “Interested Party”) is submitting a proposal for the Award of the Works in response to a Request for Proposal (“RFP”) by Delhi Aviation Fuel Facility (P.) Ltd. (“DAFFPL” or ‘Beneficiary’) for [*Insert description of work*] (“Works”). The conditions of the RFP, which are set out in a documents entitled Request for Proposal dated [*Please insert*] require its offer to be supported by a Tender Security.

At the request of the Interested Party, we hereby irrevocably undertake to pay you without demur, the Beneficiary, any sum or sums not exceeding Rs. _____ [*Please insert*].

Upon receipt by us of your demand in writing and your written statement (in the demand) stating that:

- 1) The Interested Party has, without written consent of DAFFPL, withdrawn its offer after the latest time specified for its submission and before the expiry of its period of validity; or
- 2) The Interested Party has refused to accept the correction of errors in nits offer in accordance with the instructions to Interested parties contained in the RFP; or

Sign & Stamp of Bidder



DELHI AVIATION FUEL FACILITY PRIVATE LIMITED

- 3) DAFFPL entered in to the contract with the Interested party but the Interested party has failed to deliver the **COMPOSITE BANK GUARANTEE (SECURITY DEPOSIT & PERFORMANCE)** in compliance with the Contract conditions; or
- 4) The Interested Party has failed to enter into the Contract within 30 (Thirty) days of being required to do so by the Tender Officer.

Any demand for payment must contain your signature(s). The demand must be received by us at this office on or before the expiry of the earliest of the following dates, when this security guarantee shall expire and shall be returned to us:

- a) Date of issue of letter communicating to the Interested Party that it has not qualified for the contract or the Proposal submitted by the Interested Party is unsuccessful or the TENDER is withdrawn and/or cancelled by the Beneficiary; or
- b) 7 (seven) days after the date of delivery of an acceptable performance bond complying with the Contract conditions and execution of the Contract after the award of the works to the Interested Party; or
- c) 120 (One hundred twenty) days from the last date of submission of Proposal in accordance with the TENDER.

Date:

Signature:

Designation:

Name of the Branch

Sign & Stamp of Bidder



DELHI AVIATION FUEL FACILITY PRIVATE LIMITED

ANNEXURE-V

PROFORMA OF COMPOSITE BANK GUARANTEE (SECURITY DEPOSIT & PERFORMANCE)

(On Non-Judicial paper of Rs. 100/-value)

To,

DAFFPL

Dear Sirs,

M/shave taken tender for the workfor DAFFPL,.

The tender Conditions of Contract provide that the Contractor shall pay a sum of Rs. (Rupees) as security deposit & performance guarantee in the form therein mentioned. The form of payment of security deposit & performance guarantee includes guarantee executed by Scheduled Bank at New Delhi, undertaking full responsibility to indemnify DAFFPL, in case of default. The said party have approached us at and their request and in consideration of the premises we having our office at have agreed to give such guarantees as hereinafter mentioned.

1. We -----hereby undertake and agree with you that if default shall be made by M/s. -----in performing any of the terms and conditions of the tender or in payment of any money payable to Daffpl. We shall on demand pay to you, without demur, protest or requiring you to seek recourse to M/s _____, in such matter as to you may direct the said amount of Rupees ----- only or such portion thereof not exceeding the said sum as you may from time to time require.
2. You will have the full liberty without reference to us and without effecting this guarantee, postpones for any time or from time to time the exercise of any of the powers and rights conferred on you under the contract with the said -----and to enforce or to forbear from endorsing any powers of rights or by reason of time being given to the said -----which under law relating to the sureties would but for provision have the effect of releasing us.
3. Your right to recover the said sum of Rs. ----- (Rupees -----) from us in manner aforesaid will not be affected or suspended by reason of the fact that any

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DELHI AVIATION FUEL FACILITY PRIVATE LIMITED

dispute or disputes have been raised by the said M/s. -----
-----and/or that any dispute or disputes are pending before any officer, tribunal or court.

4. The guarantee herein contained shall not be determined or affected by the liquidation or winding up dissolution or change of constitution or insolvency of the said -----but shall in all respect and for all purposes be binding operative units payment of all money due to you in respect of such liabilities is paid.
5. Our liability under this guarantee is restricted to Rupees -----our guarantee shall remain in force until -----unless a suit or action to enforce a claim under Guarantee is filed against us within six months from -----(which is date of expiry of guarantee) all our rights under the said guarantee shall be forfeited and we shall be relieved and discharged from all liabilities there under.
6. NOT WITHSTANDING anything hereinbefore contained our liability under this Bank Guarantee is restricted to Rupees -----(Rupees -----).This Bank Guarantee shall be valid up to -----and we are liable to pay the guaranteed amount or any part thereof under this Bank Guarantee only and only if you serve upon us a written claim or demand on or before.
7. This guarantee is to be returned to us within fifteen (15) days from the date it ceases to be in force. If the guarantee is not returned to us within the date of aforementioned it shall be automatically cancelled.
8. We have power to issue this guarantee in your favour under Memorandum and Articles of Association and the undersigned has full power to do under the Power of Attorney dated -----granted to him by the Bank.

Yours faithfully

-----Bank
By its Constituted Attorney
Signature of a person duly
Authorized to sign on behalf of the bank

Sign & Stamp of Bidder



DELHI AVIATION FUEL FACILITY PRIVATE LIMITED

Annexure- VI

Form of Letter of Undertaking

[On the letterhead of the Interested Party]

Letter of Undertaking

Date:

Delhi Aviation Fuel Facility (Private) Limited
Aviation Fuelling Station, Shahabad Mohammadpur,
IGI Airport, New Delhi – 110 061, India

Re:

The undersigned Interested Party acknowledges that the TENDER issued is confidential and personal to the undersigned Interested Party and hereby undertakes and agrees as follows:

1. **“Confidential Information”** means the TENDER and everything contained therein, all documentation, data, particulars of the Works and technical or commercial information made by (or on behalf of) Delhi Aviation Fuel Facility (Private) Limited or obtained directly or indirectly from Delhi Aviation Fuel Facility (Private) Limited or its representatives by the undersigned Interested Party or which is generated by the undersigned Interested Party or any information or data that the undersigned Interested Party receives or has access to, as a result of the TENDER, as being confidential information of Delhi Aviation Fuel Facility (Private) Limited, provided that such term does not include information that (a) was publicly known or otherwise known to undersigned Interested Party prior to the time of such disclosure, (b) subsequently becomes publicly known through no act or omission by undersigned Interested Party or any person acting on its behalf.
2. The undersigned Interested Party shall maintain the confidentiality of Confidential Information in accordance with procedures adopted by the undersigned Interested Party in good faith to protect confidential information of third parties delivered to it, provided that the undersigned Interested Party may deliver or disclose Confidential Information to its authorized representatives who agree to hold confidential the Confidential Information substantially in accordance with the terms of this Undertaking.
3. The undersigned Interested Party shall not at any time whatsoever:
 - (i) Disclose, in whole or in part, any Confidential Information received directly or indirectly from the Delhi Aviation Fuel Facility (P) Limited to any third party.

Sign & Stamp of Bidder



DELHI AVIATION FUEL FACILITY PRIVATE LIMITED

(ii) Reproduce, publish, transmit, translate, modify, compile or otherwise transfer the Confidential Information.

4. In case the Proposal of the undersigned Interested Party is not accepted and immediately upon the acceptance of the Proposal of any of the other Interested Party, the undersigned Interested Party, shall:

(i) Return all Confidential Information including without limitation, all originals, copies, reproductions and summaries of Confidential Information; and

(ii) Destroy all copies of Confidential Information in its possession, power or control, which are present on magnetic media, optical disk or other storage device, in a manner that ensures that the Confidential Information is rendered unrecoverable.

5. The undersigned Interested Party shall certify to Delhi Aviation Fuel Facility (Private) Limited that it has returned or destroyed such Confidential Information to the Delhi Aviation Fuel (Private) Limited within two (2) days of such a request being made by Delhi Aviation Fuel (Private) Limited.

Name of Interested Party's

Signature of Authorized Representative

Sign & Stamp of Bidder



DELHI AVIATION FUEL FACILITY PRIVATE LIMITED

Annexure VII

DECLARATION to be submitted along with Technical Bid

(M/s. _____) hereby declare / clarify that we have not been banned or delisted by any government or quasi Government agencies or Public Sector Undertakings.

Stamp & Signature of the bidder

NOTE: If a bidder has been banned by any Government or quasi Government agencies or PSUs, this fact must be clearly stated with details. If this declaration is not given along with the technical bid, the tender will be rejected as non-responsive.

Sign & Stamp of Bidder

| Sl. No | Item | UOM | Qty Per Tank | No Of Tank | Total | Unit price of supply items (or any items manufactured & completed in all aspects) inclusive of necessary testing, taxes and duties (As Applicable) transportation, handling, storage and safe custody at site & incidental cost | Sub-total (Rs.) (F X G) | Unit rate for fabrication, erection, installation, testing, calibration, etc for items mentioned in column-2, inclusive of all applicable taxes and duties(As applicable) | Sub-total (Rs.) (F X I) | Total Amount (Rs.) (H + J) |
|---------|---|------|--------------|------------|-------|---|-------------------------|--|-------------------------|----------------------------|
| A | B | C | D | E | F | G | H | I | J | K |
| 1 | Electrical | | | | | | | | | |
| | Supply, install, test and commission of following items inclusive of all miscellaneous material required to make it complete working system as per Technical specifications, Single line diagram and layout drawings. | | | | | | | | | |
| 1.1 | To Supply, install, test and commission the Single Starter Control panel suitable for 415 volts, 3 phase, 4 wire, 50Hz system, which shall include MCCB/MPCB's, Contactor, Overload relay, Auxillary contacts etc. on readymade trenches / floors as per the locations decided in the plant. Works shall include all hardwares required for grouting / mounting on floor / base channels etc. | | | | | | | | | |
| 1.1.1 | Single starter control panel | No. | | | 1 | | | | | |
| 1.2 | Motors | | | | | | | | | |
| | Supply, installation, Cable Termination, Testing and commissioning of 415V, 3 phase FLP induction motors of following ratings. The work includes the checking of the direction of rotation, rotation of the terminal box if required, greasing of bearings and cheking of the insulation resistance of motor windings, no load current and temperature rise of the motors. Testing should be done as per the relevant I.S. and as per the directions of Engineer-in-charge. | | | | | | | | | |
| 1.2.1 | 5.5 KW and including 15 KW | No. | | | 1 | | | | | |
| 1.2 | To Supply, install Test & commission the following XLPE insulated, galvanized steel strip / Wire armoured, Aluminium/Copper conductor, PVC sheathed, 1.1kV grade LT Cables. | | | | | | | | | |
| 1.3.1 | 4C-6mm ² (XLPE/SWA/PVC/CU) | M | | | 50 | | | | | |
| | Laying | M | | | 50 | | | | | |
| | Termination | No's | | | 4 | | | | | |
| 1.3.2 | To install the following XLPE insulated, galvanized steel strip / Wire armoured, PVC insulated, copper conductor PVC sheathed, 1.1kV grade control cables. | | | | | | | | | |
| | 4C-1.5mm ² | M | | | 50 | | | | | |
| | Laying | M | | | 50 | | | | | |
| | Termination | No's | | | 4 | | | | | |
| 1.4 | To supply Install, test and commission the following sizes of cable trays which shall be galvanized as per IS : -2629 or as per ASME-123. Ladder type cable trays complete with straight bends, inner / outer bends 90° each jointing pieces, (Splice plates), tees with GI hardware etc. to make it a complete working system. | | | | | | | | | |
| | GI Perforated Type Cable Tray for Power & Control cable | | | | | | | | | |
| 1.4.2 | 150mm wide x 25mm height x 1.6mm thick | M | | | 10 | | | | | |
| 1.4.3 | 100mm wide x 25mm height x 1.6mm thick | M | | | 15 | | | | | |
| 1.5 | EARTHING | | | | | | | | | |
| 1.5.1 | To supply, install, test and commission of copper plate earth electrode including supply and installation of 600x600x3.15 mm thick copper. Plate. CI cover funnel with wire mesh excavation and refilling of soft/hard soil. Charcoal, salt etc. complete with all necessary materials and accessories as per IS 3043. Installation shall include supply and installation of all materials, required for brick chamber and shall also include testing of earth resistance after completion. | R/O | | | | | | | | |
| 1.5.2 | To supply, install, test and commission GI Plate earth electrode including supply and installation of 600x600x6.3mm GI Plate with watering GI pipe having funnel with wire mesh, CI cover, excavation and refilling of soft / hard soil charcoal, salt etc. complete with all accessories as per IS-3043. Installation shall include supply and installation of all required material for brick chamber etc. and shall also include testing of earth resistance after completion. | R/O | | | | | | | | |
| 1.5.3 | To supply, install, lay, test and commission following hot dipped G.I./copper as main earthing grid & equipment earthing, run on wall / column buried underground including excavation, back filling, sand bedding etc. (Installation shall include drilling, cutting, welding, consumables, necessary hardwares, spacers and saddles etc. in an approved manner.) | | | | | | | | | |
| 1.5.3.1 | 50x6 mm GI strip | Mtr | | | 60 | | | | | |
| 1.5.3.2 | 25 x 3 mm GI strips | Mtr | | | 25 | | | | | |

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|----------|--|--------------|--------------|------------|------------|---|-------------------------|--|-------------------------|----------------------------|
| A | B | C | D | E | F | G | H | I | J | K |
| 1.5.4 | To supply laying,install,test and commission following flexible copper conductor PVC insulated green colour unarmoured cables for equipment earthing. | | | | | | | | | |
| 1.5.4.1 | 1C-4Sq.mm | Mtr | | | 20 | | | | | |
| 1.5.4.2 | 1C-6Sq.mm | R/O | | | | | | | | |
| 1.6 | To supply & installation of GI pipes of following sizes for cable protection / earthing strips or buried in concrete including cutting, bending, grouting, threading and other accessories etc. complete in all respects. | | | | | | | | | |
| 1.6.1 | 50 mm dia | R/O | | | | | | | | |
| 1.6.2 | 65 mm dia | R/O | | | | | | | | |
| 1.7 | Cable Route Marker | | | | | | | | | |
| 1.7.1 | Supply and erecting LT cable route marker including starter panel base as required. Cable route marker to be as per approved design of local electric supply authority. | Nos | | | 5 | | | | | |
| 1.8 | Push button station | | | | | | | | | |
| 1.8.1 | Supply, installation, connection, testing and commissioning of Wall / M.S. channel mounted type, start/stop push button station & on - trip indication lamp with or without ammeter with IP 65 ingress protection in LM6 alloy casting with lockable type stop push button, including transportation from from the Owner's site store to the place of erection and supply of all necessary hardware as per specifications, drawings and directions of Engineer - in - charge (Supply of the required structural steel is covered else where in this tender) | | | | | | | | | |
| 1.8.1.1 | Start / Stop Push button Station without Ammeter (Weather proof type) | R/O | | | | | | | | |
| 1.8.1.2 | Start / Stop Push button Station without Ammeter.(Flame proof type) | No. | | | 1 | | | | | |
| B | 2 MECHANICAL / TANK FABRICATION WORK | | | | | | | | | |
| 2.1 | SUPPLY, FABRICATION & ERECTION OF PLATE WORKS | | | | | | | | | |
| | Supply, Fabrication, laying/ erection and welding of the following components of the tanks. Rates to include cutting the plates as per the approved drawing, squaring, making V grooves wherever required, marking the plates for identification, lifting & placing the plates in position by any approved methods and welding complete as per specifications.Rate shall also include transportation of materials to work place. Rate to include DP test and other tests as per code.Low Hydrogen electrodes to be used for shell joint, End Plate joints. Specifications for Storage Tanks. Radiography of shell joints shall be carried out including supply of films for the tanks and the same shall be included in the rate. Procedure and extent of radiographic inspection and testing of radiographs shall be as stipulated in ASME SEC.IX / IS 10987 & good engineering practice. Work shall be carried out in accordance with technical Specifications for Storage Tanks and Scope of Work attached with tender. | | | | | | | | | |
| 2.2 | TANK SHELL | | | | | | | | | |
| | Shell thickness 6 mm . inline with technical specifications for storage tanks of tender document, mechanical datasheets as well as scope of work. Materials shall be supplied by Contractor. | | | | | | | | | |
| | Tank as above - 1 No. | | | | | | | | | |
| | Total | MT | 3 | 1 | 3 | | | | | |
| 2.3 | TANK END PLATES | | | | | | | | | |
| | End plates thickness of 12 mm as per as technical specification and Data Sheet | | | | | | | | | |
| | Tank as above -1 No. | | | | | | | | | |
| | Total | MT | 1.8 | 1 | 1.8 | | | | | |
| 2.4 | Miscellenuous steel plates for saddle support | MT | 2.4 | 1 | 2.4 | | | | | |
| 2.5 | STEEL STRUCTURES IF REQUIRED | | | | | | | | | |
| | Supply, Fabrication & Erection of Steel Structures for End Plates, top Railing with Platform as per Tender specification. | | | | | | | | | |
| | Tank as above - 1 No | | | | | | | | | |
| | Gratings / Chequered Plates for Platform | MT | 1 | 1 | 1 | | | | | |
| | Railing pipe (40NB.MG.GI PIPE) length | Meter | 15 | 1 | 15 | | | | | |
| | Others (Angles/Channels etc.) | MT | 1 | 1 | 1 | | | | | |

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|---------------|---|-------|--------------|------------|--------|---|-------------------------|--|-------------------------|----------------------------|
| A | B | C | D | E | F | G | H | I | J | K |
| 3.1 | Pipes | | | | | | | | | |
| | 15 NB (SCH 80) | Meter | 1 | 1 | 1 | | | | | |
| | 20 NB (SCH 80) | Meter | 1 | 1 | 1 | | | | | |
| | 25 NB (SCH 80) | Meter | 4 | 1 | 4 | | | | | |
| | 80 NB (SCH 40) | Meter | 24 | 1 | 24 | | | | | |
| | 100 NB (SCH 40) | Meter | 4 | 1 | 4 | | | | | |
| 3.2 | Bends (Elbows) | | | | | | | | | |
| | 25 NB (SCH 80) | Nos | 2 | 1 | 2 | | | | | |
| | 80 NB (SCH 40) | Nos | 9 | 1 | 9 | | | | | |
| | 100 NB (SCH 40) | Nos | 3 | 1 | 3 | | | | | |
| 3.3 | Coppanion Flange (SORF) | | | | | | | | | |
| | 80 NB (150 #) | Nos | 4 | 1 | 4 | | | | | |
| | 100 NB (150 #) | Nos | 3 | 1 | 3 | | | | | |
| 3.4 | Coupling (Half) | | | | | | | | | |
| | 15 NB (3000 #) | Nos | 1 | 1 | 1 | | | | | |
| 3.5 | Reducer (Eccentric) HOLD | | | | | | | | | |
| 3.6 | Pipe Cap | | | | | | | | | |
| | 15 NB | Nos | 1 | 1 | 1 | | | | | |
| 3.7 | Basket Type Strainer | | | | | | | | | |
| | 80 NB | Nos | 1 | 1 | 1 | | | | | |
| | 100 NB | Nos | 1 | 1 | 1 | | | | | |
| 3.8 | Hose | | | | | | | | | |
| | 80 NB (4 Nos. of 1 Meter Length) | Meter | 4 | 1 | 4 | | | | | |
| 3.9 | Ball Valves (800#) | | | | | | | | | |
| | 15 NB | Nos | 2 | 1 | 2 | | | | | |
| | 20 NB | Nos | 2 | 1 | 2 | | | | | |
| 3.10 | Ball Valves (150#) | | | | | | | | | |
| | 80 NB | Nos | 2 | 1 | 2 | | | | | |
| | 100 NB | Nos | 1 | 1 | 1 | | | | | |
| 3.11 | Check Valves (150#) | | | | | | | | | |
| | 80 NB | Nos | 1 | 1 | 1 | | | | | |
| | 100 NB | Nos | 1 | 1 | 1 | | | | | |
| D | 4 CIVIL WORKS | | | | | | | | | |
| 4.1 | Earth Work | | | | | | | | | |
| 4.1.1 | Excavation by mechanical or manually in all type of soil or hard strata except rock up to a required depth including bailing out of water/ oil mixed water if encountered, shoring, back filling and compacting the excavated earth by layer in 150mm to 200mm in the trenches, sides of foundations. Rate to include carting away surplus excavated earth, spreading, levelling and compacting, inside/outside the terminal in approved dump yard as directed by EIC (Engineer In Charge). | | | | | | | | | |
| 4.1.1a | Excavation up to 1.5 M below the existing ground level. | Cu.M | 106.00 | 1 | 106.00 | | | | | |
| 4.1.1b | Excavation beyond 1.5 M to 3 M below the existing ground level. | Cu.M | 106.00 | 1 | 106.00 | | | | | |
| 4.1.1c | Excavation beyond 3 M to 4.5 M below the existing ground level. | Cu.M | 45.00 | 1 | 45.00 | | | | | |

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|--------|--|------|--------------|------------|--------|---|-------------------------|--|-------------------------|----------------------------|
| A | B | C | D | E | F | G | H | I | J | K |
| 4.2 | Providing and filling approved local coarse sand of grading zone III in trenches of foundation pit, plinth and surrounding areas. Including watering, consolidating, transporting, loading, unloading, spreading, etc. complete as directed by Engineer-In-Charge. | Cu.M | 96.00 | 1 | 96.00 | | | | | |
| 4.3 | Providing and laying in compact manner 230 mm thick (average) rubble soling in plinth, foundations, plinth protection, Including filling in the visible voids with largest possible chips, covering and levelling the surface with layer of well watered and consolidated sand, compaction etc. complete including supply and spreading cost of sand at site. | Cu M | 17.00 | 1 | 17.00 | | | | | |
| 4.4 | Concrete & Allied Work | | | | | | | | | |
| 4.4.1 | Providing and laying machine mixed Plain cement concrete of all heights in volumetric proportion 1:4:8 (1 Cement: 4 Sand : 8 Aggregate) with 40mm and down stone aggregates of specified thickness, mix and gradation. Including centring, shuttering if required, laying, spreading, ramming consolidating, curing etc. complete as directed for all levels & all types of foundations below footings, walls, rafts, plinth beams, terrace, cable trenches, pile caps. duct, in flooring etc. complete as directed by Engineer-In-Charge. | Cu.M | 11.00 | 1 | 11.00 | | | | | |
| 4.4.2 | Providing & laying in position machine mixed and machine vibrated or Ready mixed M25 controlled Grade reinforced cement concrete for structural elements for any shape and size viz. column, raft slab, plinth beam, retaining wall, cable trenches, machine foundations. As per structural design and as directed in specified compressive strength in N/mm2 at 28 days confirming to IS 456-1978 using 20mm maximum size aggregates. Including mix design of concrete, weigh batched proportioning, poring with concrete pump, compaction, finishing concrete surfaces, curing, wastage, lead, etc. complete but | Cu.M | 40.00 | 1 | 40.00 | | | | | |
| 4.4.3 | Providing and erecting in position Steel plate or Plywood form work shuttering and boxing using shuttering materials of approved quality shuttering, for concrete elements vertical, horizontal or inclined in all shapes except circular shape, column foundations, pedestals, wall footings, plinth beams, cable trenches, compound wall, U.G. water tank, fins, copings, etc. as per drawing. Including necessary Scaffolding, fastener nails, wires, keeping in position till concrete is laid and concrete members have acquired required strength, removal, thereafter, applying de-shuttering oil etc. complete as directed by structural consultant / Engineer-In-Charge. At all levels in foundation and above FFL. | Sq.M | 215.00 | 1 | 215.00 | | | | | |
| 4.4.4 | Providing, fabricating and fixing in position Thermo mechanically Treated deformed steel bars. (TMT) (Having 0.2% proof stress not less than 415 / 500 N/mm2) at all heights for steel reinforcement. For all types of RCC structures as per design including loading transporting steel to the work site and incidental charges for loading /unloading handling cutting, bending, providing & binding with double 18 gauge annealed Iron wires, welding if necessary, wastage etc. complete as directed. Payment will be made on the weight basis for the length converted into weight by using standard IS Coefficient. (Having yield stress | M.T. | 2.60 | 1 | 2.60 | | | | | |
| 4.5 | Painting Work | | | | | | | | | |
| 4.5.1 | Providing and applying exterior paint minimum two coats of approved shade of Asian Apex Ultima / ICI Weather Shield/ Nerolac Excel paint in or equivalent approved make over one coat of exterior primer of Asian/ICI/Nerolac to all type of external surfaces of plastered work (I.e. sand faced plaster, smooth cement plaster and rough cast plaster etc.) or concrete surfaces at all levels including Scaffolding, cleaning the surfaces, curing etc. complete as per manufacturers specifications & as directed by Engineer/ Owner. | Sq.M | 18.00 | 1 | 18.00 | | | | | |
| 4.6 | Structural Steel Work | | | | 0.00 | | | | | |
| 4.6.1 | Providing and laying in exact position mild steel holding down bolts with base plate nut, washer, upper 100mm portion threaded etc. complete. Rate to include for placing the bolts in position as per details, etc. and providing necessary templates for keeping the bolts in position complete as per drawing to satisfaction of Engineer-in-charge. The payment will be made on kg basis of wt. of bolts & Nut is included in the weight. | Kg | 33.00 | 1 | 33.00 | | | | | |
| 4.7 | Misc. Work | | | | | | | | | |
| 4.7.1 | Breaking, demolishing & removing existing flooring any size / thickness including removing debris out side of terminal / site or as directed by Engineer-In-Charge. | Cu.M | 79.00 | 1 | 79.00 | | | | | |
| 4.7.2 | Providing & fixing in position 80mm dia M S Pipe sleeve for Rain water outlets in RCC walls at top levels, including cutting, bending, fixing in exact required level, slopes, peddle plates, leak proof joints etc. complete as Directed. | No | 1.00 | 1 | 1.00 | | | | | |
| 5 | INSTRUMENT WORK | | | | | | | | | |
| 5.1 | Supply Erection, calibration, testing and commissioning of Pressure gauges Bourdon type 1/2"NPT (M) connection, Scope including supply and installation fabrication of manifold with fittings, valves etc. as per technical specification. | No | 1.00 | 1 | 1.00 | | | | | |

E

Project: Modernization of existing Fuel farm facility
 Project Number: 322538
 Client Name: Delhi Aviation Fuel Facility Pvt. Ltd.
 Consultant: Mott MacDonald Pvt. Ltd.

Combined SOQ for EPC Tender



| Sl. No | Item | UOM | Qty Per Tank | No Of Tank | Total | Unit price of supply items (or any items manufactured & completed in all aspects) inclusive of necessary testing, taxes and duties (As Applicable) transportation, handling, storage and safe custody at site & incidental cost | Sub-total (Rs.) (F X G) | Unit rate for fabrication, erection, installation, testing, calibration, etc for items mentioned in column-2, inclusive of all applicable taxes and duties(As applicable) | Sub-total (Rs.) (F X I) | Total Amount (Rs.) (H + J) |
|--------|--|-----|--------------|------------|-------|---|-------------------------|--|-------------------------|----------------------------|
| A | B | C | D | E | F | G | H | I | J | K |
| 5.2 | Supply Erection, calibration, testing and commissioning of thermal relief Valve size 1"x 3/4"NPT (M) connection, . as per technical specification. | No | 1.00 | 1 | 1.00 | | | | | |

Cost Summary

| | | |
|-----------------------|--|--|
| A | Total Cost of Electrical Work | |
| B | Total Cost of Mechanical / Tank Fabrication Work | |
| C | Total Cost of Piping Work | |
| D | Total Cost of Civil Work | |
| E | Total Cost of Instrumentation Work | |
| Grand Total A+B+C+D+E | | |

GRAND TOTAL IN WORDS:

SIGNATURE OF THE BIDDER ALONG WITH COMPANY SEAL