



**MAZAGON DOCK SHIPBUILDERS LIMITED**

(Formerly known as Mazagon Dock Ltd.)

CIN : U35100MH1934GOI002079

(A Government of India Undertaking)

Shipbuilders to the Nation

Dockyard Road, Mazagon,

Mumbai 400 010.

INDIA

**Replacement of existing Compressed Air and  
Salt Water Pipelines in MDL Yards, Mumbai.**

**VOLUME-IV**

**TECHNICAL SPECIFICATION**

**&**

**PREFERRED MAKE LIST**

**I N D E X**

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**SECTION -I**

**GENERAL**

## **STANDARD TECHNICAL SPECIFICATIONS**

1. **SCOPE:**

This specification gives a general description of the works to be executed and a detailed description of the materials and workmanship to be used therein. The specification shall be read in conjunction with the other documents forming part of the contract as these documents are jointly explanatory and descriptive of the works included in the contract.

2. **CONTRACT DRAWINGS :**

2.1 The drawings referred to in the Conditions of Contract are listed in List of Drawings annexed herewith but they shall be held to include also all further modified and additional drawings that may be issued to the Contractor by the Employer/Consultants from time to time or approved by him under the terms of the contract.

2.2 The Contractor shall note that the drawings are secret and the property of the employer and hence shall be treated with the requisite confidentiality and shall not be passed on to any third party either in whole or in part. This restriction shall apply even after the works are complete.

3. **AS-BUILT DRAWINGS:**

The Contractor shall prepare and submit the Client / Consultants for approval detailed Shop drawings of All Architectural and Structural drawings on completion of contract/work.

4. **BENCH MARKS :**

For the setting out and levelling of the works, the Employer/Consultant shall prior to the commencement of the works provide one levelling bench mark and base line. It shall be the responsibility of the Contractor thereafter to protect these from damage and movement during the entire duration of the contract.

5. **PUBLIC BODY FORMALITIES:**

Set of approved plans would be displayed at site and work would be strictly in accordance with the same. The requirements of all public bodies like keeping the site clean, free from mosquitoes and all other ancillary requirements like labour insurance, maintenance of various registers for labourers, fair wages etc. will be the sole responsibility of the contractor. The Contractor shall assist owner/consultant in obtaining statutory permissions.

6. **CO-OPERATION WITH OTHER AGENCIES:**

The Contractor is reminded that the work to be carried out by him under this contract is the complete work and it is his full responsibility to co-ordinate with any other specialized agencies as may be engaged on work such as electrical, fire fighting agency in the neighbourhood of and even on the site, which work is essential to the progress and may form a continuation. The Contractor must therefore take into consideration and make all allowances, which he may have to undergo in consequence thereof, and for the time, which other persons may require to complete section of their work, which are essential to his progress. The Contractor must accordingly plan and arrange his work and proceed therewith in such a way as to cause the least possible interference and delay from the operations of others, or cause the least possible interference or delay to such others.

7. **LABOUR CAMP:**

No labour camp shall be allowed in MDL premises. Only temporary toilet arrangement should provide by contractor inside the premises with proper drainage facility. The same is to be dismantled after completion of work.

**8. PLAN OF OPERATIONS:**

Before commencing the works the Contractor shall apply to the Consultant for his approval:-

- a. General information of all constructional, pumping, washing of sand and aggregate, excavating, haulage, erection and other plant and equipment.
- b. Drawings showing the general arrangements of his temporary buildings, access roads and other temporary works.
- c. Provisions for dealing with water encountered on the works.
- d. Order in which he proposes to execute the temporary and permanent works to be indicated by diagrams and descriptions. This will be subject to adjustment and approval by the Consultant Bar charts and PERT CPM charts.
- e. Any other item of specific relevance to the contract if requested by the Consultant.
- f. Contractor has to make schedule on weekly basis and get it approved from consultant/client which will be monitored at regular intervals.
- g. Before starting of any excavation activity, contractor has to obtain permission for excavation from Infra Project and Maintenance department.

**9. STANDARD SPECIFICATIONS:**

Unless specifically mentioned otherwise all the relevant codes and standards published by the Indian Standards Institution and all other codes/standard which may be published by them before the acceptance of the contract shall apply and govern in respect of design, workmanship, quality and properties of materials and testing.

**10. SAFETY REGULATIONS:****10.1 GENERAL:**

Contractor shall adhere to safe construction practice and guard against hazardous and unsafe working conditions and shall comply with Employer's safety rules as set forth herein.

**10.2 SAFETY REGULATIONS:**

In respect of all labour, directly or indirectly employed in the work for the performance of Contractor's part of this agreement, the Contractor shall at his own expense arrange for all the safety provisions as per safety codes of Indian Standards Institution, statutory requirements of Factory Building Act and all other statutory requirements, Regulations, Rules, and orders made there under and such other acts as applicable. Special attention shall be given to the various provisions of safety codes of Factories Act, 1948 & statutory amendments or modifications enforced time to time.

The Contractor shall observe and abide by all safety, fire safety regulations adopted by the Employers. Before starting construction work, Contractor shall consult Employers safety Security officer and must make good to the satisfaction of the Employer any loss or damage due to fire to any portion of the work done or to be done under this contract or to any of the Employer's existing property.

The Contractor shall organize his operations in a workmanlike manner and take all necessary precautions to provide safety and prevent accidents on the site to both person and property. The Consultant shall have the power to require the Contractor to adopt from time to time such measures as he may consider necessary to ensure the above requirement.

**Safety Regulations:**

- (i) All personnel of the Contractor working within the plant site shall be provided with safety helmets, safety shoes, goggles, gloves and Safety Harness for working at height. All welders shall wear welding goggles while doing welding work and all metal workers shall be provided with safety gloves. Persons employed on metal cutting and grinding shall wear safety glasses.

- (ii) Adequate precautions shall be taken to prevent from electrical equipment. No materials on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or the public.
- (iii) Contractor shall provide and maintain first aid facilities for his employees and those of his sub-Contractors.
- (iv) All critical, industrial, reportable and fatal injuries shall be reported promptly to Employers first and then to Factory Building inspector's office and police department and a copy of Contractor's report covering each personal injury requiring the attention of a physician shall be furnished to the Employers. A Contractor shall take all necessary action via a vies the compliance of statutory requirements of said authorities. Contractors shall settle all such incidences and keep the Employer indemnified against complications arising out of the same.

#### 10.3 **GENERAL RULES:**

Smoking within the Work Area, is strictly prohibited Violators of the "No Smoking" rules shall be discharged immediately.

#### 10.4 **CONTRACTOR'S BARRICADES:**

- i) Contractor shall erect and maintain at his own cost barricades required in connection with his operation to guard or protect the entire working area including storage, sea fronts and site offices etc.
- ii) Barricades and hazardous areas adjacent to but not located in normal routes of travel shall be marked by red flasher lanterns at night.
- iii) Complete Construction site/ part of site where work is in progress shall be barricaded by contractor without any extra cost. Temporary barricading shall be done for minimum 1.5 mt height using Colour coated GI sheets with proper supporting system and shall have wicket gate and material gate. Security shall be provided to all gates to control the entries without any extra cost. (If required/ instructed by MDL/ Engineer in charge)
- iv) The Contractor shall also comply with the provisions of Environment Protection Act with regards to air, water & noise pollution.
- v) The contractor shall provide suitable safety net to prevent damage to man / material at site.
- vi) Contractor's employees and those of his sub-Contractors shall become acquainted with Employer's barricading practice and shall respect the provisions thereof.

#### 10.5 **SCAFFOLDING: ALL SCAFFOLDS ARE STEEL DOUBLE LEG WITH HORIZONTAL MEMBERS AT EVERY THREE FEET AND PROPERLY TIED Laterally WITHOUT MAKING HOLES IN THE MASONRY.NO EXTRA PAYMENTS SHALL BE ENTERTAINED TOWARDS THIS AND CONTRACTOR'S RATES SHALL BE INCLUSIVE WITH THESE CONDITIONS.**

- i) Suitable scaffoldings shall be provided for workmen for all works that cannot safely be done from the ground or from solid construction except such short period works as can be done safely form ladders. When a ladder is used a Mazdoor shall be engaged for holding the ladder and if the ladder is used for carrying materials as well suitable foot-holds and handholds shall be provided on the ladder and the ladder shall be given an inclination not steeper than 1 in 4 (1 horizontal and 4 vertical)

- ii) Scaffolding or staging more than 4 meters above the ground or floors swing or suspended from an overhead support or erected with stationary support shall have a guard rail properly attached, bolted, braced and otherwise retarded at least one meter high above the floor or platform of such scaffolding or staging and extending along with entire length of the outside the ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure. Only steel scaffolding with 'H' frames and double support, properly braced shall be allowed to be used.
- iii) Working platform, gangways and stairways shall be so constructed that they should not sag unduly or unequally and if the height of the platform of gangway or the stairway is more than 4 meters above ground level or floor level, they should be closely boarded, should have adequate width and should be suitable fastened as described in (ii) above.
- iv) Every opening in the floor of a building or in a working platform is provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be 1 meter.
- v) Safe means of access shall be provided to all working platforms and other working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 meters in length. The width between the side rails in run ladder shall in no case be less than 30 cm for ladder up to and including 3 meters in increased at least 15 mm for each additional meter of length. Uniform step spacing shall not exceed 30cms. Adequate precautions shall be so stacked or placed as to cause danger or inconvenience to any person or public. The Contractor shall also provide all necessary fencing and lights to protect the workers and staff from accidents, and shall be bound to bear the expenses of defence of every suit action or other proceedings of law that may be brought by any person for injury sustained owing to neglect of the above precautions and to pay any damages and cost which may be awarded in any such suit or action or proceedings to any such person or which may with the consent of the Contractor be compromise any claim by any such person.
- vi) The Contractors shall give all technical details about scaffolding systems before erecting the same and only after obtaining specific sanction from Client/client/consultants shall erect the same. In any case all the responsibility of safety aspect shall be borne by Contractors only.

#### 10.6 **EXCAVATIONS AND TRENCHING:**

All trenches 1.2 meters or more in depth shall at all times be supplied with at least one ladder for each 5 M length or fraction thereof.

Ladder shall be extended from bottom of the trenches to at least 1 meter above the surface of the ground. The sides of the trenches which are 1.5 meters in depth shall be stepped back to give suitable slope, or securely held by timber bracing, so as to avoid the danger of sides to collapse. The excavated materials shall not be placed within 1.5 meters of the edge of the trench or half of the trench width whichever is more. Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be done.

#### 10.7 **GENERAL SAFETY:**

- i) Before any demolition work is commenced and also during the process of the demolition work,
  - a. All roads and open areas adjacent to the work site shall either be closed or suitably protected.

- b. No electric cable or apparatus, which is liable to be a source of danger, shall remain electrically charged.
  - c. All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render it unsafe.
  - d. All persons connected with the execution of works shall wear safety helmets, safety shoes, gloves, safety belts, shields, goggles and protective appliances, safety ladders, platforms etc. to the specific requirements of the work.
  - e. Suitable screens, curtains (plastic mesh hassion) shall be provided. The same shall be maintained in good condition at all the times.
- ii) All necessary personal safety equipments as considered adequate by the CLIENT/CONSULTANTS shall be kept available for the use of the persons employed at the site and maintained in condition suitable for immediate use, and the Contractor shall take adequate steps to ensure proper use of equipment by persons concerned as outlined below:
- a. Workers employed on mixing asphaltic materials, cement and lime mortars shall be provided with protective footwear and protective gloves.
  - b. Those engaged in white washing and mixing or stacking of cement bags or any materials, which are injurious to the eyes, shall be provided with protective goggles.
  - c. Those engaged in welding and cutting works shall be provided and protective face and eye-shields, hand gloves etc.
  - d. Stone breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.
  - e. When workers are employed in sewers and manholes which are in use, the Contractor shall ensure that the manhole covers are opened and are ventilated at least for an hour before the workers are allowed to get into the manholes, and the manholes so opened shall be cordoned off with suitable railing and providing with warning signals or board to prevent accident to the public.
  - f. The Contractor shall not employ men below the age of 18 years and woman on the work of painting with products containing lead in any form. Wherever men above the age of 18 years are employed on the work of lead painting, the following precautions should be taken.
    - 1. No paint containing lead or lead product shall be used except in the form of paste or ready-made paint.
    - 2. Suitable face masks shall be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint dry rubbed and scrapped.
    - 3. Overall shall be supplied by the Contractor to the workmen and adequate facilities shall be provided to enable the working painters to wash them on cessation to work.
- iii) When the work is done near any place where there is a risk of drowning all necessary safety equipments shall be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provision should be made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.
- iv) Use of hoisting machines and tackles including their attachments, anchorage and supports shall conform to the following standard or conditions: -



- a. These shall be of good mechanical construction, should materials and adequate strength and free from patent defects and shall be kept in good working order.
  - b. Every rope used in hoisting or lowering materials or as means of suspension shall be of durable quality and adequate strength and free from patent defects.
  - c. Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years should be in charge of any hoisting machine including any scaffolding winch or give signals to the operator.
  - d. In case of every hoisting machine and of every chain ring hook, shackle swivel and pulley block used in hoisting or lowering or as means of suspension, the safe working load shall be ascertained by adequate means. Every hoisting machine and all gear referred to above shall be marked with the safe working load and the conditions under which it is applicable shall be clearly indicated. No part of any machine or any gear referred to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing.
  - e. In case of departmental machine, the safe working load shall be notified by the CLIENT/CLIENT/CONSULTANTS. As regards Contractor's Machine, the Contractor shall notify the safe working load of the machine to the CLIENT/CLIENT/CONSULTANTS whenever he brings any machinery to site of work.
- v) Motors, gears, transmission lines, electric wiring and other dangerous parts of hoisting appliances shall be provided with efficient safeguards. Hoisting appliances shall be provided with such means as to reduce to the minimum the accidental descent of the load, adequate precautions should be taken to reduce the minimum the risk of any part or parts of a suspended load becoming accidentally displaced. When workers are employed on electrical installations, which are already energized, insulating mats, wearing apparel such as gloves sleeves and boots as may be necessary shall be provided. The workers shall not wear any rings, watches and carry keys or other materials, which are good conductors of electricity.
- vi) All scaffoldings, ladders and other safety devices mentioned or described herein shall be maintained in safe conditions and no scaffoldings, ladder or equipment shall be altered or removed while it is in use. Adequate washing facilities shall be provided at or near place of work. The Contractor shall indemnify the Employer against any damages whatsoever arising due to injury sustained by any person because of no provision of adequate barricades/fencing and lighting arrangements.
- vii) These safety provisions shall be brought to the notice of all concerned by displaying on a notice board at a prominent place at the work spot. The person responsible for compliance of the safety code shall be named therein by the Contractor.
- viii) All safety measures for constructional activities shall be as per BIS, unless and otherwise as stated.
- ix) All ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangements made by the Contractor shall be opened to inspection by the welfare officer of the company or CLIENT/CLIENT/CONSULTANTS or their representatives.
- x) Notwithstanding the above clauses there is nothing in these to except the Contractor from the operations of any other ACT or rules in force in the Republic

of India. The works throughout, including any temporary works, shall be carried out in such a manner as not to interfere in any way whatsoever with the traffic in any roads or footpaths at the site or in vicinity thereto or any existing works whether the property of the Employer or of a third party.

10.8 **CARE IN HANDLING INFLAMMABLE GAS:**

The Contractor has to ensure all precautionary measures and exercise utmost care in handling the inflammable gas cylinders / inflammable liquids / paints etc, as required under the laws and/or as advised by the security officer of the Employers.

10.9 **TEMPORARY COMBUSTIBLE STRUCTURES:**

Temporary combustible structures will not be built near or around work site.

10.10 **PRECAUTIONS AGAINST FIRE:**

The Contractor will have to provide adequate Fire Extinguishers / Fire Buckets and drums at work site as recommended by Client/client/consultants representative. They will have to ensure all precautionary measures and exercise utmost care in handling the inflammable gas cylinders/inflammable liquid/paints etc. as advised by CLIENT/CLIENT/CONSULTANTS. Temporary combustible structures will not be built near or around the work site.

10.11 **EXPLOSIVES:**

Explosives shall not be stored or used on the works or on the site by the Contractor without the permission of the Client/client/consultants representative in writing and then only in the manner and to the extent to which such permission is give. When explosives are required for the works they shall be stored in a special magazine to the provided at the cost of the Contractor in accordance with the Explosive Rules. The Contractor shall obtain the necessary license for the storage and the use of explosives and all operations in which or for which responsibility of the Contractor shall indemnify the Employer against any loss or damage resulting directly or indirectly.

10.12 **PRESERVATION OF PLACE:**

The Contractor shall take requisite precautions and use his best endeavours to prevent any riotous or unlawful behaviour by or amongst his workmen and others employed on the works and for the preservation of peace and protection of the inhabitants and security of property in the neighbourhood of the work. In the event of the Employer requiring the maintenance of special police force at or in the vicinity of the site during the tenure of works, the expense thereof borne by the Employer shall be recoverable from the Contractor.

10.13 **OUTBREAKS OF INFECTIOUS DISEASES:**

The Contractor shall remove from his camp such labor and their families as refuse protective inoculation and vaccination when called upon to do so by the Client/consultants representative. Should cholera, plague or other infections diseases break out the Contractors shall burn the huts, beddings, clothes and other belongings of or used by the infected parties and promptly erect new huts on the sites as required by Client/consultants representative failing which within the time specified in the Consultant's requisition, the work may be done by the Employer and the cost thereof recovered from the Contractor.

10.14 **USE OF INTOXICANTS:**

The sale of adent spirits or other intoxicating beverages upon the work in any of the buildings encampments or tenements owned, occupied by or within the control of the Contractor or any of his employees is forbidden and the Contractor shall exercise his influence and authority to the utmost extent to secure strict compliance with this condition.

In addition to the above, the Contractor shall abide by the safety code provision as per CPWD safety code and Indian Standard Safety Code framed from time to time.

10.15 **BREACH OF SAFETY REGULATIONS:**

Breach of safety regulations will be viewed very seriously and the Contractors shall be liable for punitive action as will be recommended by the safety officer of the Employers.

11. **REMOVAL OF IMPROPER WORK AND MATERIALS:**

- 1) The client/consultant shall during the progress of the Works have power to order in writing from time to time.
  - (a) The removal from the site within such time or times as may be specified in the order of any materials which in the opinion of the client/consultant are not in accordance with the Contract.
  - (b) The substitution of proper and suitable materials and
  - (c) The removal and proper re-execution (not withstanding any previous test thereof or Interim payment thereof) of any work which in respect of materials or workmanships not in the opinion of the client/consultant in accordance with the Contract.

2) Default of Contractor in compliance:

In case of default on the part of the Contractor in carrying out such order the Client shall be entitled to employ and pay other persons to carry out the same and all expenses consequent thereon or incidental thereto shall be borne by the Client and shall be recoverable from him by the Client or may be deducted by the Client from any monies due or which may become due to the Contractor. Appropriate deductions may be made in the payment due to the contractor if in the opinion of the client/consultant any part of the work has not been carried out by the contractor in accordance with the contract and the specifications. Amount of such deductions will be decided by the client/consultant.

**SECTION -II**

**CIVIL WORKS WITH PREFERRED MAKE**

**TECHNICAL SPECIFICATIONS FOR CIVIL WORKS****1. EXCAVATING FOUNDATIONS.**

**(a) Trenches for foundations, footings/cesspits, drains etc. to be excavated to the exact width length and depth shown or figured on the drawings or as may be directed by the Engineer. If taken out to a greater width, length, or depth than shown or required the extra work occasioned thereby shall be done at the Contractor's expense. Extra depth shall be brought up by sound masonry or concrete filling and extra length or width filled in by rammed earth or muram or, if the Engineer thinks it necessary for the stability of the work, by masonry or concrete as may be directed. The excavated material shall be used to fill in on each side of the masonry or to form the filling in of floors or it shall be placed or spread elsewhere on or near the side of the works as may be ordered free of charge. The Contractor shall at his own expense and without extra charge, make provision for all shoring, pumping, dredging, bailing out or draining water, and the trenches shall be kept free of water while the masonry or concrete is in progress and till the Engineer considers that the mortar is sufficiently set. The sides of the trenches to be kept vertical and the bottom horizontal, and to be run at the same level throughout or properly stepped as may be desired by the Engineer. The Contractor shall also, at his own cost remove such portions of boulders or rock as are required to make the bottom of the trench horizontal and level. He shall also make level and hard the bed of all the trenches and consolidate the earth about the same and against all walls, pits, drains etc. The foundation trenches to be inspected and passed by the Engineer before any masonry work is commenced and the Contractor shall hold an order in writing to this effect, otherwise he shall be liable to have his work removed for inspection.**

All the excavated materials belong to the MDL and therefore shall be property of MDL. It will be mandatory on the part of contractor to use this material in the execution of works under contract if the quality of material available is as per the specification. The contractor shall have to sort out the material in separate stacks and transport the same at his cost. No transportation charges or any other charges will be paid to the contractors. The rate of excavation is deemed to include the cost of transportation and disposal of surplus excavated materials to any location as directed by the Engineer in Charge. However, if the contractor is directed to dump the material to the outside of the MDL premises, tipping charges for which the contractor has to quote the rate as per tender.

All water that may accumulate in excavations during the progress of the work from springs, tidal or river seepage, broken water mains or drains (not due to the negligence of the contractor), and seepage from subsoil aquifer shall be bailed, pumped out or otherwise removed. The contractor shall take adequate measures for bailing and/or pumping out water from excavations and/or pumping out water from excavations and construct diversion channels, bunds, sumps, coffer dams etc. as may be required. Pumping shall be done directly from the foundation trenches or from a sump outside the excavation in such a manner as to preclude the possibility of movement of water through any fresh concrete or masonry and washing away parts of concrete or mortar. During laying of concrete or masonry and for a period of at least 24 hours thereafter, pumping shall be done from a suitable sump separated from concrete or masonry by effective means. Capacity and number of pumps, location at which the pumps are to be installed, pumping hours etc. shall be decided from time to time in consultation with the Engineer-in-Charge.

Pumping shall be done in such a way as not to cause damage to the work or adjoining property by subsidence etc. Disposal of water shall not cause inconvenience or nuisance in the area or cause damage to the property and structure nearby.

To prevent slipping of sides, planking and strutting may also be done with the approval of the Engineer-in-Charge.

**(b) The measurement of the work will be the exact length and width of the lowest step of the footing according to drawings or the Engineer's instructions and the depth measured vertically. The contractor shall make every effort to carry out the excavation in rock to the correct formation levels as far as practicable. However, under cut and over cut up to 8 cm. of the formation levels shall be permitted. As far as payment is concerned quantities shall be worked out with respect to formation levels only. Under cut in excess on 8 cm. shall be removed by chiselling and over cuts for above 8 cm. shall be filled in with M-15 concrete without any extra cost.**

## **2. FILLING IN WITH CONTRACTOR'S EARTH OR MURUM.**

### **Scope:**

This part of the specifications deals with general requirements for earthwork and filling of different materials, filling in areas shown in drawings, back filling around foundations, plinths and approach ramps, conveyance and disposal of excess soil if any or stacking them properly as directed by the Engineer-in-Charge and all operations covered within the intent and purpose of these specifications.

### **Applicable Codes:**

The provisions of the latest Indian Standards listed below in addition to those mentioned in tender document, but not restricted to, shall form part of these specifications:

IS: 1200 : Method of measurement of building and civil engineering works  
 Part 1 : Earth work  
 IS: 1498: Classification and identification of soil for general Engineering purposes.  
 IS:2720 : Method of test for soils (All Parts)  
 IS:2809 : Glossary of terms and symbols relating to soil engineering  
 IS:3764 : Safety code for excavation work  
 IS:4988 : Glossary of terms and classifications of earth moving Machinery (All Parts)

### **Filling in with Contractor's Earth or Murum.**

(a) The earth or murum, whenever required to be supplied by the Contractors for filling in the low lying ground and wells or in the embankment of the road, shall be dry, friable, and free from mud sludge, vegetable matter or rotten material of any kind, or material likely to decay and of a quality to be approved by the Engineer. All big lumps or clod shall be broken before spreading the earth or muram on the ground.

- (b) The filling in of wells and low-lying grounds shall be done in such layers as may be directed from time to time by the Engineer, and no fresh layer shall be allowed to be put on unless the previous one is properly spread, trimmed, levelled, and thoroughly consolidated by rammers or rollers, as the case may be, or as may be ordered by the Engineer.
- (c) The embankment shall be raised in regular layers slightly concave in section, beginning from the bottom and gradually raised to the full height, layer by layer not exceeding 230 mm. in thickness in a loose state. Each layer shall be thoroughly consolidated by watering where necessary and rolling it with an approved steam or diesel roller before the next layer is put on. The rolling and consolidation should be done to the entire satisfaction of the Engineer and no rubble packing or metal should be laid on it until the Engineer is satisfied that the earthwork has been thoroughly consolidated and written certificate is given to them effect by the Engineer.
- (d) The rates for embankment or filling in with Contractors earth or murum shall include the cost of materials, fencing, lighting, watching haulage, spreading, levelling, watering, rolling and consolidating and testing of materials and compaction (proctor density) as per relevant IS codes.

**Compaction on Earth or Murum:**

1. Compaction is carried out using rolling. For ordinary consolidation of soft stone, 6 to 8 tonnes roller is good.
2. Rolling should commence at the edges and progress towards the centre except in super elevated portions where it should proceed from the inner edge to outer. Each pass of the roller should uniformly overlap not less than one third of the track made in the preceding pass. The number of passes required of a roller to give good compaction of any material should also be determined by actual test at site.
3. The types of roller that can be used are pneumatic tyred, vibratory rollers etc and should be operated at the minimum speed while consolidating base and soling courses.
4. For clayey soils, sands the weight of rollers that can be used are 6 to 8 Tonnes, 230 mm will be the maximum thickness of loose material that can be compacted while 10 to 18% moisture content has to be maintained.

**Tests on Earth or Murum:**

1. The density / moisture content of a soil needs to be determined using various tests.
2. The water content of the soil is determined by methods like oven drying, Pycnometer, sand bath methods etc.

Range of Optimum Water Content

Sand	Sandy Silt or silty sand	Silt	Clay
6 to 10 %	8 to 12 %	12 to 16 %	14 to 20 %

3. There are main field methods used for measuring compaction such as Core cutter method, Sand replacement method etc.
4. Proctor Density test is made to determine the moisture content at which the soil should be compacted to obtain the maximum dry density and the dry density likely to be achieved by compaction in the field. The dry unit weight achieved in the field using field tests are is compared with the maximum dry unit weight obtained in the standard proctor test. The dry unit weight of the order of 95 % of the maximum dry unit weight of the standard proctor test needs to be achieved.
5. The methods of tests carried out for soils shall be strictly as per the IS 2720.

### **3. DRY RUBBLE PACKING.**

The dry rubble packing shall consist of a layer of uniform thickness of blue trap stone rubble, or any other approved stone carefully set as close as possible on ground properly formed for the purpose. The width of the upper part of the stone shall not be more than 200 mm. or less than 150 mm. and the packing shall consist of large stones. The interstices between the rubble stones shall be filled up with stone chips, removing the projection of the upper part of the packing with care, as not to loosen the whole, the whole should be thoroughly rammed, watered, settled to place and made compact.

### **4. CEMENT CONCRETE IN FOUNDATION AND BEDDING.**

- (a) Cement concrete in foundation and bedding shall be mixed in the proportion of M-15 as directed using Portland cement, sand and metal. In case of ordinary / nominal grade concrete, mix is required to be arrived at by preliminary tests, proportions of cement, fine aggregates and coarse aggregates are specified by mass as given in Table - 2

In the designation of a concrete mix, letter 'M' refers to the mix and the number to the specified 28 days works cube compressive strength of that mix on 150 mm cubes, expressed in N/mm<sup>2</sup>.

- (b) The ground to be thoroughly levelled and well rammed before laying the concrete on the work. The concrete shall consist as described above. In case of hand mixing the metal, sand and cement, etc. as the case may be to be stacked, before mixing, in measured layers. The materials to be then thoroughly mixed in small quantities at a time with sufficient quantity of fresh water and laid in the work in layers, each not exceeding 300 mm. in depth and repeated one above the other. Salt or brackish water will not be allowed to be used. Each layer to be well rammed with heavy wooden or iron rammers. The work to be ground with thin mortar, while ramming, until it fills in all the spaces between stones and cream to the surface. The ramming operation to be continued until the whole work becomes solid and compact to the entire satisfaction of the Engineer. The measurement of the work will be the exact length, breadth and depth ordered by the Engineer or shown or figured on the drawing and after the concrete is consolidated.



- (c) The stone metal to be made of good hard blue rubble stone from quarried to be approved of by the Engineer. The metal to be such as to pass through a ring 40 mm. diameter. Larger size metal or chips will not be accepted.
- (d) The contractor shall adopt every precaution towards guarding the concrete from admixture with dust or dirt of any kind and shall use properly constructed and impervious brick masonry or wooden platform for mixing and keeping it until laid in the work and protect it from rain and sun.

#### **5. SAND AND MORTAR.**

The cement mortar shall be mixed in the proportion as described in the BOQ items.

#### **6. STONE AND BRICK MASONRY WORK IN GENERAL.**

(a) The work to be built plumb, curved, or batters, as may be required by the design and to be carried out in a thoroughly workman like manner and to the entire satisfaction of the Engineer. The Contractor to provide at his own expense all moulds, templates, centering, scaffolding etc. as may be required for the proper execution of the work which shall be included in the prices of the work, as no separate change to be made for them.

(b) All stones or bricks to be thoroughly cleaned and wetted with fresh water before being put into the work and the mortar to be used stiff.

(c) The work to be kept wet while in progress to the entire satisfaction of the Engineer till the mortar is properly set. On Sundays and other holidays also when the work is stopped, the top of all unfinished masonry to be kept flooded and labourers to be employed for this purpose. Watering to be done carefully so as not to wash the mortar out of the joints. The Engineer shall be at liberty to employ labourers to water the work should the contractors fail to do the same to his (the Engineer's) satisfaction.

(d) Should the mortar perish that is becomes dry, white or powdery through neglect of watering, the work shall be pulled down and rebuilt at the contractor's expense.

(e) As a rule the whole of the masonry work in any structure to be carried up at one uniform level throughout but where breaks are unavoidable the joint to be made in good long steps, so as to prevent cracks arising between the new and old work. All junctions of walls to be formed at the time the walls are being built, and cross walls to be carefully bonded into the main walls.

(f) When new work is to be added to existing structure, the old work must be prepared to receive the new and both must be carefully bonded together.

(g) During the rains, the work to be carefully covered without extra charge, so as to avoid the fresh mortar being washed away.

(h) Where the word cement is used it is to be understood Portland cement of the best description, specified under the head of the Cement.

## **7. BRICKS & BRICK WORK IN GENERAL.**

(a) Bricks shall conform to the latest Indian standard specifications (I.S.S.). Bricks to be whole, sound, well burnt free from cracks to ring when struck and not to crack or break when soaked in water regular in shape and uniform in size. They should be of the best of description obtainable in the market and of the best quality and colour, and in every respect to be approved by the Engineer unless otherwise specified they should be of English pattern 230mm. x 115 mm. x 63.5 mm. No bricks to absorb water more than one fifth of their own weight when dry for use in load bearing wall. For bricks used in panel walls, the water absorption shall not exceed  $\frac{1}{4}$  of their dry weight. Bricks to be thoroughly cleaned, well wetted or soaked in fresh water before being used on the work and no broken bricks to be used except as closures. Crushing strength of the dry bricks shall be not less than 35 kg./cm.<sup>2</sup>

(b) The mortar should be as described under the head of good quality carefully mixed and used stiff. For joints of face work only Cement and screened sand should be used in specified proportion.

(c) A good bond should be preserved throughout the work both laterally and transversely. All bed joints should be perpendicular to the pressure upon them, i.e. horizontal in vertical walls, radial in arches and at right angles to the slope in battering walls.

(d) In walling the courses shall be kept perfectly horizontal and rise in plumb. The vertical joints shall break joints with the courses immediately below and above, but they shall be directly over one another in alternate courses to prevent the necessity of bats. The joints shall not exceed 10 mm. thick shall be fully of mortar close, well flushed up and neatly struck or pointed as may be required.

(e) English bond to be used throughout in walling. In arching such bond shall be used as directed by Engineer.

(f) Facing of brick work to be specially selected brick of the same colour throughout. All external brick walls of thickness 25 mm. and above, shall be constructed in plumb from the outside face with the help of scaffolding erected on the external side.

(g) In other respects, the work should comply with the general specification for brick work as per relevant IS code.

## **8. CEMENT PLASTER.**

All joints in brick masonry work shall be raked out to a depth of at least 10mm and all RCC and concrete surfaces shall be thoroughly roughened to the entire satisfaction of the Consultant and

they are to be plastered shall be washed and wetted thoroughly before plastering is commenced. Render with a mortar of specified parts of Portland cement and fine sand of specified thickness and rough but do not beat. Float or set with a thin coat 3 mm of Portland Cement and polished well immediately with a trowel or flat board. The cement mortar to be used within 30 minutes after it leaves the mixing board or mill. Before work is started patches of plaster 150 x 150 mm. should be put on about 3 meters apart as gauges. By this means an even thickness is ensured. Cement plaster must be in even squares or stripe. Care shall be taken to keep the whole surface thoroughly wetted for at least a week. The finishing surface should be as specified and directed.

#### **9. SAND FACED CEMENT PLASTER.**

All joints in brick masonry work shall be raked out to a depth of at least 10mm and all RCC and concrete surfaces shall be thoroughly roughened to the entire satisfaction of the Consultant and they are to be plastered shall be washed and wetted thoroughly before plastering is commenced.

Sand faced plaster; shall be carried out in two coats as specified. Two coats and sand faced plaster shall be applied as follows: The first coat of cement mortar in the proportion as specified in item shall be applied uniformly all over the surface to be plastered to a thickness of 14 mm. with a trowel and flat board in exact plumb. This coat shall be allowed to rest for not less than half an hour. Indentations shall then be made in the form of waves by a wire broom over the surface to form a key for the second coat. The plastered surface shall be allowed to cure for at least four days. First coat will be with addition of water proofing compound in proportion as specified in item.

The second coat of cement mortar shall be applied in the proportion of as specified in item using clean and screened through a mesh of not less than 1.5 mm. and not more than or 3 mm. equal size to a uniform thickness of 6.5 mm by trowel and flat board in exact plumb. The surface shall be trapped with a cork piece to give a desirable uniform granular appearance.

Care shall be taken to keep the whole surface thoroughly wetted for at least a week.

#### **10. SPECIFICATIONS FOR PLAIN, REINFORCED AND PRESTRESSED CONCRETE:**

##### **10-1. GENERAL**

These specifications cover the requirements of plain, reinforced and pre-stressed concrete for use in various components of structures.

For all items of concrete in any portion of the structure or its associated works controlled concrete shall be used unless otherwise specified. Normal / ordinary concrete mix as shown on the drawing or as directed by the Engineer-in-charge, may be used.

The provisions of the latest revisions of the following I.S Codes shall form a part of this specification to the extent they are relevant.

IS-226	Specification for structural steel (standard quality).
IS-269	Specification for ordinary and low heat portland cement
IS-280	Specification for mild steel wire for general engineering purpose.
IS-303	Plywood for general purposes.
IS-383	Specification for coarse and fine aggregate.
IS-432(All Parts)	Specifications for mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement. Part-I – Mild steel and medium tensile bars. Part-II – Hard drawn steel wire.
IS-455	Specification for portland blast furnace slag cement.
IS-456	Code of practice for plain and reinforced concrete (IS:456-2000)
IS-460	Specification for test sieves.
IS-516	Methods of test for strength of concrete.
IS-650	Standard sand for testing of cement.
IS-1139	Hot rolled mild steel, medium tensile steel and HYSD bars for concrete reinforcement.
IS-1199	Sampling and analysis of concrete.
IS-1200	Method of measurement of building works.
IS-1343	Code of practice for pre-stressed concrete.
IS-1489	Specification for portland pozzo-lana cement.
IS-1542	Sand for plaster.
IS-1566	Specification for hard-drawn steel wire fabric
IS-1732	Dimensions for round & square steel bars for structural & general engineering purposes.
IS-1785	Plain hard drawn steel wire for pre-stressed concrete (Part-I) Cold drawn stress-relieved wire.
IS-1786	Specification for high strength deformed steel bars & wires for concrete reinforcement.
IS-1791	Batch type concrete mixers.
IS-2062	Specification for structural steel (fusion welding quality)
IS-2386(All Parts)	Method of test for aggregates for concrete.
IS-2502	Code of practice for bending and fixing of bars for concrete reinforcement
IS-2505	Immersion type concrete vibrators.
IS-2506	Screed board concrete vibrators.
IS-2722	Specification for portable swing weigh batcher (single and double bucket type).
IS-2751	Code of practice for welding of M.S. bars.
IS-2911	Code of practice for design and construction of pile foundation (Part-I & IV).
IS-3366	Pan vibrators
IS-3370(All Parts)	Code of practice for concrete structure for the storage of liquids.
IS-3558	Code of practice for the use of immersion vibrators for consolidating concrete.

IS-4656	Form vibrators for concrete.
IS-5525	Recommendation for detailing of reinforcement in reinforced concrete works.
IS-5640	Method of test for determining aggregate impact value of soft, coarse aggregate.
IS-5816	Method of test for splitting tensile strength of concrete cylinder.
IS-6006	Uncoated stress relieved strand for pressurised concrete.
IS-6461	Cement concrete: glossary of terms.
IS-8041	Specifications for rapid hardening portland cement.
IS-8043	Specifications for hydrophobic portland cement.
IS-8112	Specifications for high strength ordinary portland cement.
IS-9103	Admixtures for concrete.

### **1.1 OTHER CODES AND SPECIFICATIONS**

Other IS codes pertaining to the items of cement concrete work in structural work not listed above shall also be deemed to come under the purview of this clause. All Indian Roads Congress Standards, specifications and codes of practice also come under this purview.

## **10-2 GRADE OF CONCRETE**

### **2.1 CONTROLLED CONCRETE**

For controlled concrete, design of the mix shall be carried out for the respective target strength and in its production all necessary precautions shall be taken to ensure that the required works cube strength is attained and maintained.

The controlled concrete grades are designated as M 20, M 25, M 30, M 35, M 40, M 45 and M 50 and as per the technology used for such designation in IRC codes of practice.

### **2.2 ORDINARY CONCRETE (Concrete Grades M:15 & below)**

In case of ordinary / nominal grade concrete, mix is required to be arrived at by preliminary tests, proportions of cement, fine aggregates and coarse aggregates are specified by mass as given in Table - 2

In the designation of a concrete mix, letter 'M' refers to the mix and the number to the specified 28 days works cube compressive strength of that mix on 150 mm cubes, expressed in N/mm<sup>2</sup>.

## **10-3 STRENGTH REQUIREMENT OF CONCRETE**

Where Ordinary Portland Cement conforming to IS:269 or Portland Blast Furnace Cement conforming to IS:455 is used, the compressive strength requirements for various grades of concrete controlled as well as nominal shall be as given in Table 1. Where rapid hardening portland cement is used, the 28 days compressive strength requirements shall be met at 7 days.

For controlled concrete, the mix shall be so designed for the so called Target strength as to attain in preliminary tests a strength at least 33 per cent higher than that required on work tests, for concrete strength upto and including M-25 and 25% higher for higher strengths.

**Table 1**

Grade of Concrete	Compressive Works Test Strength in N/Sq. mm on 150 mm Cubes after Testing Conducted in accordance with IS : 516	
	Min. at 7 days	Min. at 28 days
M 10	7	10
M 15	10	15
M 20	13.5	20
M 25	17	25
M 30	20	30
M 35	23.5	35

**Note :** In all cases, the 28 days compressive strength Should be 20% than specified in Table 1 shall alone be the criterion for acceptance or rejection of the concrete.

#### **10-4 MATERIALS :**

##### **4.1 CEMENT:**

Fresh quality cement shall be procured only from approved manufacturer / supplier and shall be subject to prior approval of the Engineer-in-Charge. Following types of cement shall be used :

- i) All cement used for the work shall be ordinary portland cement or such other cement as may be permitted by the Engineer-in-charge. Portland cement shall comply with the requirements of the latest issue of IS 269. High alumina cement, rapid hardening cement and portland Slag cement etc., can be used only when permitted by the Engineer-in-charge. Such cements shall be in accordance with relevant IS Codes. Portland Pozzolana cement when permitted by the Engineer-m-charge shall conform to IS 1489 Part I but it shall not be used or RCC structural member.
- ii) Cement which has remained in bulk storage at the mill for more than 6 months or which has remained in bags at the dealers storage for over 3 months, or which has been stored at project site for more than 3 months shall be re-tested before use. Cement shall also be rejected if it fails to conform to any of the requirements of these specifications.
- iii) Different types of cement shall not be mixed.

##### **4.2 FINE AGGREGATES**

Fine aggregates shall consist of natural sand, manufactured sand or an approved combination thereof and shall conform to IS : 383. The grading zone of

sand proposed for use shall be supplied by the contractor and got approved by the Engineer-in-Charge.

The sand shall be siliceous material, sharp, hard, strong and durable and shall be free from adherent coatings, clay, dust, alkali, organic material, deleterious matter, lumps, etc.

Either natural or manufactured sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter. Natural sand shall be washed, unless specific written authority is given by the Engineer-in-charge to use sand that meets specifications and standards of cleanliness without washing. The cost of screening and washing must be borne by the contractor. The fine aggregate shall be taken from a source approved by the Engineer-in-charge.

#### **4.3 COARSE AGGREGATES**

Coarse aggregates shall consist of hard, strong, durable particles of crushed stone and shall be free from thin elongated soft pieces, organic or other deleterious matter. It will be from a source approved by the Engine charge. Coarse aggregate shall conform to IS: 383.

Coarse aggregate shall be washed if necessary to remove all vegetable and other perishable substances and objectionable amounts of other foreign matter, the cost of washing and screening being borne by the contractor.

#### **Size of Coarse Aggregates**

Following shall be the maximum nominal size of coarse aggregate for the different items of work if not specified in the item of works or their respective specifications:

<b>Sr. No.</b>	<b>Item of Construction</b>	<b>Max. Nominal Size of Coarse Aggregate</b>
(i)	RCC well steining concrete, RCC well curb & RCC piles in plum concrete	40 mm
(ii)	Well cap or pile cap, solid type piers, abutments and wing walls, and, footing of open foundation and general items of work in bridge and building construction.	20 mm
(iii)	RCC works in girders, deck slab, wearing coat, kerbs, light posts, ballast walls, approach slab etc. and piers, returns, wing walls and retaining walls.	20 mm
(iv)	RCC bearings, shells and other thin walled members and in zones of congestion.	20 mm
(v)	For any other item of construction not covered by items (i) to (iv)	As specified in the drawings or as desired by the Engineer-in-Charge in case it is not specified on the drawing.

For heavily reinforced concrete members as in the case of ribs of main beams, the nominal maximum size of aggregate shall usually be restricted to 5 mm less than the minimum lateral clear distance between the main bars, or 5 mm less than the minimum cover to the reinforcement, whichever is smaller.

#### 4.4 REINFORCING STEEL (Refer Clause 302.5 of IRC:21)

Reinforcing steel shall be clean and free from loose mill scales, dust, loose rust and coats of paints, oil, grease or other coatings which may impair or reduce bond.

- a) Fe 240 - Mild steel shall conform to the latest edition of IS: 432 Part 1.
- b) Fe 415 & Fe-500 high strength deformed bars shall conform to IS: 1786, **TMT bars conforming to IS: 1786 shall only be used.**
- c) Structural steel sections and plates shall conform IS : 226 and IS : 2062.

#### I. PERMISSIBLE LIMIT FOR SOLIDS

	<b>Tested as per</b>	<b>Permissible limit max.</b>
Organic	IS : 3025 (Pt.18)	200 mg/lit.
Inorganic	IS : 3025 (Pt. 18)	3000 mg/lit.
Sulphates (as SO <sub>3</sub> )	IS : 3025 (Pt. 28)	400 mg./lit.
Chlorides (as Cl)	IS : 3025 (Pt. 32)	2000 mg. lit. for concrete work not containing embedded steel and 500 mg./lit. for prestressed /reinforced concrete work.
Suspended matter	IS : 3025 (Pt. 7)	2000 mg./lit.

**Note : The reinforcement steel to be used for the construction shall be Corrosion Resistant Steel with Grade of Fe – 500 only (for all RCC structures).**

#### 4.5 HIGH TENSILE STEEL :-

The strands to be used for pre-stressed concrete structures shall conform to Class-II of I.S. 6006-1983. Low relaxation steel conforming to I.S. : 14268 : 1995 is also permitted with relaxation losses given therein.

#### 4.6 WATER

Water used mixing and curing shall be free from injurious amounts of deleterious material. pH value of water shall not be less than 6. Potable water are generally considered satisfactory for mixing and curing concrete. Water shall be got tested before use in concrete and curing. The cost for the same shall be borne by the contractor. Permissible limits for solid shall be as below :

#### PERMISSIBLE LIMIT FOR SOLIDS

	<b>Tested as per</b>	<b>Permissible limit max.</b>
Organic	IS:3025 (Pt.18)	200 mg/lit.
Inorganic	IS:3025 (Pt.18)	3000 mg/lit.



Sulphates (as SO <sub>3</sub> )	IS:3025 (Pt.28)	400 mg/lit.
Chlorides (as Cl <sub>1</sub> )	IS:3025 (Pt.32)	2000 mg/lit. for concrete work not containing admixtures

#### 4.7 ADMIXTURES

No materials other than essential ingredients i.e., cement, aggregate and water, shall ordinarily be used in the manufacture of concrete or mortar. But the Engineer-in-Charge may permit the use of approved admixtures for improving the workability of the concrete, if so specified on satisfactory evidence that its use does not in any way adversely affect the properties of concrete particularly its strength, volume changes, durability and has no deleterious effect on the reinforcement. Admixture where allowed shall conform to relevant IS : 9103.

Chloride content in admixture shall be independently tested for each batch before acceptance.

#### 4.8 MATERIALS FOR REPAIR WORK

The use of epoxy for bonding fresh concrete used for repairs will be permitted on written approval of the Engineer-in-Charge. Epoxies shall be applied in accordance with the instructions of the Manufacturer. The cost of such repair when approved by the Engineer-in-Charge shall be borne by the contractor

#### 4.9 STORAGE OF MATERIALS

##### i) **Cement**

The contractor shall make arrangements to the satisfaction of the Engineer-in-Charge for the storage of cement to prevent deterioration due to moisture and/or intrusion of foreign matter. Bulk cement shall be stored in approved water-proof bin or silo. Bagged cement shall be stored in a suitable weather tight warehouse in a manner to provide easy access for identification and inspection of each consignment. Stored cement shall meet the test requirements as per IS-269 at any time after storage, when a retest is ordered by the Engineer-in-Charge. Each consignment shall be stacked separately with the date of receipt flagged on it, not more than 12 bags being stacked in height, the bags being arranged with headers and stretchers. Normally consignments shall be used in the order of receipt at site unless otherwise directed. In the case of large concrete pours the Engineer-in-Charge will decide on the batch of cement to be used taking into consideration the quantity of cement with particular reference to the concerned concrete pours. Any additional work in handling and storage of cement contingent upon this requirement shall be to the contractors' account and no extra claim will be entertained. Cement shall be protected from closure to moisture in transit, in storage at the works and until it enters the concrete mixers. The contractor shall keep accurate records of the deliveries of the cement and of its use in the work.

##### ii) **Aggregates**

Coarse and fine aggregates shall be stacked separately in such manner as to prevent contamination by foreign materials. All aggregates shall be stored on concrete or masonry platforms, each size shall be kept separate with wooden, steel, concrete, or masonry bulk heads, or shall be stored in separate stacks, taking care to prevent the materials at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart. The aggregates shall be stored in easily measurable stacks of suitable heights as may be directed by the Engineer- in-Charge.

**iii) Reinforcing Steel**

Reinforcing steel shall not be stored directly on the ground. These shall be stored under cover and shall be protected from rusting, oil, grease and distortions as directed by the Engineer-in-Charge.

**iv) High Tensile steel**

The high tensile shall be stored in humidity controlled godowns and shall not be stored for long period. The procurement of H.T. steel shall be made just before actual use and shall be stacked on wooden platform.

**10-5 PROPORTIONING CONCRETE**

**5.1 CONTROLLED CONCRETE**

Concrete mix shall be designed for 33% higher strength than the grade of concrete specified. The proportions for ingredients chosen shall be such that concrete has adequate workability for conditions prevailing on the work in question and can be properly compacted with the means available.

Except where it can be shown to the satisfaction of the Engineer-in-Charge that a supply of properly graded aggregate of uniform quality can be maintained till the completion of work, grading of aggregate should be strictly controlled. The different sizes, shall be stocked in separate stock piles. Required quantity of material shall be stock-piled several hours, preferably a day, before use. Grading of coarse and fine aggregate shall be checked as frequently as possible, frequency for a given job being determined by the Engineer-in-charge to ensure that the suppliers are maintaining the uniform grading as approved for samples used in the design mix.

The quantity of both cement and aggregate shall be determined by weight. Water shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean and serviceable condition. Their accuracy shall be periodically checked.

It is most important to keep the specified water-cement ratio constant and at its correct value. To this end, the moisture content in both fine and coarse aggregates shall be determined by the Engineer-in-charge according to the weather conditions. The amount of mixing water shall then be adjusted to

compensate for variations in the moisture content. For the determination of moisture content in the aggregates, IS: 2386 (Part III) shall be referred to. Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weights of aggregates due to variation in their moisture content. The minimum cement and maximum water cement ratio and minimum grade of concrete is given below :-

- A)** For bridges with pre-stressed concrete / RCC decking or those with individual spans greater than 30 mtrs. or those that are built with innovative design / construction.

**TABLE - A**

**Minimum cement content, maximum water-cement ratio and minimum grade of concrete for different exposures with Normal weight aggregates of 20 mm nominal maximum size.**

[ Ref : Table : 5 of IS-456-2000 ]

Sr. No.	Exposure	Plain Concrete			Reinforced Concrete		
		Minimum Cement Content Kg/m <sup>3</sup>	Maximum Free Water-Cement Ratio	Min. Grade of Concrete	Minimum Cement Content Kg/m <sup>3</sup>	Maximum Free Water-Cement Ratio	Min. Grade of Concrete
1	2	3	4	5	6	7	8
1	Mild		0.60	-		0.55	M-20
2	Moderate		0.60	M-15		0.50	M-25
3	Severe		0.50	M-20		0.45	M-30
4	Very Severe	260	0.45	M-20	340	0.45	M-35
5	Extreme	280	0.40	M-25	360	0.40	M-40

**Adjustments to Minimum Cement Contents for Aggregates other than 20 mm Nominal Maximum Size [ Ref : Table:6 of IS-456-2000]**

Sr. No.	Nominal Maximum Aggregate Size (mm)	Adjustment to minimum Cement Content in above table (kg/ m <sup>3</sup> )
(1)	(2)	(3)
1	10	+ 40
2	20	0
3	40	-30

**Limits of Chloride Content of Concrete**

[ Ref : Table : 7 of IS-456-2000 ]

Sr. No.	Type or Use of Concrete	Maximum Total Acid Soluble Chloride Content

		<b>expressed as kg/m<sup>3</sup> Concrete</b>	<b>as of</b>
<b>(1)</b>	<b>(2)</b>	<b>(3)</b>	
1	Concrete containing metal and steam cured at elevated temperature and prestressed concrete	0.4	
2	Reinforced concrete or plain concrete containing embedded metal	0.6	
3	Concrete not containing embedded metal or any material requiring protection from chloride	3.0	

**Condition of Exposure :**

**i) Severe - Marine Environment :** Alternate wetting and drying due to sea spray, alternate wetting and drying combined with seeping, buried in soil (having corrosive effect); members in contact with water where the velocity of flow and the bed material are likely to cause corrosion of concrete.

**ii) Moderate - Condition other than 'severe'**

- a) The minimum cement content is based on 20 mm size aggregates. For larger size aggregates, it may be reduced suitably by not more than 10%. Similarly for smaller size aggregates, it may be suitably increased, but not more than 10%.
- b) The cement content shall not exceed 540 kg/cu.m. of concrete.

**iii) Ordinary / Nominal Concrete :**

The ordinary / nominal concrete mix shall also be specified by mass. Proportioning of sand shall be as per its dry volume and in case it is damp, allowance for 'bulking' shall be made as per IS : 2386 (Part III).

Ingredients required for nominal mix concrete containing one 50 Kg. bag of cement for different proportions of mix shall be as given in Table-2.

**PROPORTION OF NOMINAL MIX CONCRETE**

**TABLE - 2**

<b>Grade of Concrete</b>	<b>Total quantity of dry aggregates by mass per 50 Kg. of cement, to be taken as the sum of the individual masses of fine &amp; coarse aggregates, (Kg.), Max.</b>	<b>Proportion of fine aggregate to-coarse aggregate by mass.</b>	<b>Qty. of water per 50 Kg. of cement Max. (Ltrs.)</b>

<b>II.</b>			Generally 1:2 for fine aggregate to coarse aggregate by volume but subject to a upper limit of 1:1 ½ and a lower limit 1.2 ½	
III.	M-	625		45
7.5		480		34
M-10		330		32
M-15				

Note No. 1: The proportions of the aggregates shall be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer and the maximum size of coarse aggregate becomes larger.

Note No.2 : The amount of water should be kept minimum required for proper workability. The quantity given in Col. 4 is not to be exceeded.

Example

For an average grading of fine aggregate (that is Zone the proportions shall be 1:1 ½ , 1:2 and 1:3, for maximum size of aggregates 10 mm, 20 mm and 40 mm respectively.

Note No.3 : A mix leaner than M 10 may be used for non-structural parts if specified on the drawing or provided in the contract. In such case grading of aggregates shall be as specified in the contract or on the drawings. Other requirements for mixing, placing and curing shall be the same as specified in this section.

**iv) Quantity of Water**

The quantity of water shall be just sufficient to produce a dense concrete of required workability and strength for the job. An accurate and strict control shall be kept on the quantity of mixing water.

In the case of reinforced concrete work, workability shall be such that the concrete surrounds and properly grips, all reinforcements. The degree of consistency, which shall depend upon the nature of work and the methods of vibration of concrete, shall be determined by regular slump tests. The following slump shall be adopted for different types of works or as directed by the Engineer-in-charge.

<b>Sr. No .</b>	<b>Type of Work</b>	<b>Where Vibrators are Used</b>	<b>Where Vibrators are not Used</b>
i)	Mass Concrete in RCC Foundations, Footings and Retaining Walls	25 mm to 40mm	80 mm
ii)	Beams, Slabs & Columns Simply Reinforced	35 mm to 40 mm	100 – 120 mm
iii)	Thin RCC Section or Section with Congested Steel	40 mm to 50 mm	125 – 150 mm

Note: With use of ordinary concrete the slump requirement specified above would not be applicable.

**11 SPECIFICATIONS FOR THE USE OF PLASTIC COVER BLOCKS: -  
As per I.S. 456-2000(p. 47) clauses no 26.4.2 table no. 16.**

Nominal cover to meet durability requirements

<b>Exposure</b>	<b>Nominal concrete cover in mm. not less than</b>
Mild	20
Moderate	30
Severe	45
Very Severe	50
Extreme	75

Notes: -

For main reinforcements up to 12 mm. dia. bar for mild exposure the nominal cover may be reduced by 5 mm.

Unless specified otherwise, actual concrete area shall not deviate from the required nominal cover by +10 mm.

For exposure condition 'severe' & 'very severe' reduction of 5 mm. may be made where concrete grade is M-35 and above.

Cover blocks shall be as small as possible, consistent with their purpose, of type and shape acceptable to the Engineer, and designed so that they will not overturn when the concrete is placed.

Cover blocks shall either be an acceptable proprietary brand of spacer, or they shall be made of concrete with 10 mm maximum aggregate size and mix proportions to produce the same strength as the adjacent concrete.

Concrete spacer blocks shall not be used until at least 7 days old.

Proprietary plastic spacer blocks shall be capable of supporting the weight of the reinforcement and construction loads without excessive deformation and must be well perforated to a minimum of 25% of its area.

The Contractor shall provide sufficient mild steel chairs to support in position top reinforcement in slabs, caps and rafts, vertical wall reinforcement and the like. Steel chairs should be supplied with plastic-coated feet or approved anti-rust treatment if not properly protected by concrete.

**12. MIXING AND PLACING OF CONCRETE**

**INGREDIENTS AND MEASUREMENTS OF MATERIALS**

The concrete shall be comprised of water, Portland cement, sand and coarse aggregate. If required by the Consultant the Contractor shall have to add approved brand of plasticizer in required quantities to facilitate easy flow of concrete. No extras shall be paid for providing and adding plasticizer.

All sand and coarse aggregate used on the works shall be carefully and accurately measured in suitable gauge boxes and in quantities to the entire satisfaction of the Consultant and the cement to be added to the aforesaid mix shall be either by one or two full scale bags, the water being added to the dry mix in a manner in which it can be properly controlled and measured. The cement shall be measured by weight or by bags. One bag of cement weighing 50 kg. shall be considered equal to 0.034 Cu.m. (1.20 cft) in volume. Volumetric measurement of cement will not generally be permitted. If loose cement is used it shall be weighed and 40.8 kg. shall be considered as 0.0283 Cu.m (1 cft). The contractor shall provide an accurate weighing apparatus on the work for this purpose. If he wants to use volumetric batching, he would have to prove the correct weights of cement bags.

The maximum quantity of mixing water per 50 kg. bag of cement shall be 25 liters which shall include free water carried by the Aggregate, corrections being made to this quantity of water according to the wetness of aggregate, as instructed by the Consultant. The consistency of the concrete shall be tested by the standard slump for concrete and shall be between 38mm to 64mm (1.5" to 2.5") or as directed. Contractor shall have to use approved plasticizer in required quantity at his own cost to achieve necessary workability. Water Cement Ratio should be as per the design mix and it should be strictly adhered to.

The proportioning of concrete as per design mix shall be used for mixes of grade M-20 and above. For this the Contractor shall supply the different ingredients such as cement, sand, aggregate, admixtures etc. and the required slump approved by Engineer Incharge. If any of the ingredients are altered in respect of the source of production, quality or any other parameter the same will be got approved by the Engineer Incharge and fresh design mix shall be done for the proportioning of the different ingredients to the satisfaction of the Engineer Incharge and no parameters of the design mix for the concrete ingredients shall be altered from that submitted for the design of the concrete mix.

The concrete shall be mixed in an efficient power driven batch mixer. The capacity of the drum shall as far as possible be such that only whole bags of cement are used in each batch. Mixing shall continue for atleast 1.5 minutes after all the materials including water, are placed in the drum and before any part of the batch is discharged. The drum shall be revolved not less than 14 and not more than 18 revolutions per minute. The drum shall be completely emptied before receiving materials for each batch shall not exceed the mixer manufacture's rated capacity of the drum. The drum shall be thoroughly washed out when mixing operation cease for any period longer than one hour. Hand mixing of concrete, if permitted by the consultant shall be carried out in the following manner.

The specified quantity of sand shall be spread out first making a level heap about 150mm deep on a water tight platform or trough, atleast 2.7m x 3.7m in size, with 3 sides of sufficient depth to prevent the material being shoveled off during the

operation of mixing. On the top of sand the specified quantity of cement, with an addition of 10% to allow for hand mixing, shall be spread. All the dry sand and cement shall be turned over with square ended shovels atleast 3 times until the mixture is of uniform colour. Each shovel full should leave the shovel with a spreading action as well as turning. The specified quantity of coarse aggregate shall now be added and the whole mixture shall be turned over as before. The mixing shall be continued until the whole batch has reached an even consistency and the mortar is spread evenly through the batch. The mixing should not take more than 15 minutes after the addition of water. One whole bag of cement with an addition of 10% shall be used in each batch.

Ready mix concrete of specified grade and consistency namely water cement ratio, slump, cement content etc. shall be used to the extent possible particularly where the quantity of concrete required at one time is sufficiently large. The source of supplier and specifications of the concrete including the admixtures, retarders, setting time, transit time, method of placement of concrete on the job such as pumping etc., quality assurance from the supplier etc. should be got approved from the Engineer Incharge before ordering of the ready mix concrete for the job. The test cube strength specified in the drawings shall be closely monitored for ensuring the required strength of the concrete.

Mortar or concrete which has partially set before having been placed in-situ shall not be taken into use again either by itself or after mixing with additional materials or water.

All concrete shall be deposited in the forms within 15 minutes after leaving the mixer and shall be worked round the various reinforcement carefully by means of tamping and rodding as well as suitable vibrations.

As far as possible no joints shall be provided in any RCC work. However, if need arises the same shall be provided as per the instructions of Consultant, in which case the face of the construction joints shall be made rough by hacking and thoroughly cleaned and which before proceeding with further concrete work it shall be wetted and covered over with thick cement paste or "Hack-Aid-Plast" as directed by the Consultant.

Concrete after it has been placed in the forms should be allowed to set and should not be disturbed. The concrete shall be thoroughly cured by ponding or inundation or by means of hezzian cloth covered, maintain in a wet condition. Where 53 grade cement is used curing of exposed surface of concrete shall commence within 4 hrs. of its placing. In no case shall the centering to any concrete work be removed without obtaining the permission of the Consultant. Great care shall be exercised while removing the centering to avoid jarring the structure or throwing away the forms on the floor.

The stripping time of form work shall be generally followed as per relevant I.S. Specification. However, the discretion of the Consultant shall be final. The form work of all RCC and PCC work shall be as to bring out the exposed surfaces to a smooth and clean finish. Immediately after the removal of the form work the exposed surface of all such RCC work shall be thoroughly roughened by making deep and



closely spaced indentations with a pointed steel tool (Basuli) to the entire satisfaction of the Consultant. The exposed surface of RCC and concrete work wherever directed shall be finished with cement and sand plaster - smooth sand faced or rough cast as directed.

### 13 REMOVAL OF CENTERING

In no case shall the centering of any concrete work be removed without obtaining the special permission of the engineer or his Assistant.

Proper care shall be exercised while removing the centering to avoid jarring the structure or throwing heavy form from the floor.

Generally nothing less than the following times should elapse between the filling in of the concrete and removal of the forms: -

Type of formwork	Minimum period before striking formwork
Vertical formwork to columns, beams and slabs	16-24 hrs.
Soffit formwork to slabs (Props to be re-fixed immediately after removal of formwork.)	3 days
Soffit formwork to beams (Props to be re-fixed immediately after removal of formwork.)	7 days
Props to slabs Spanning up to 4.5 m	7 days
Spanning over 4.5 m	14 days
Props to beams and arches Spanning up to 6.0 m	14 days
Spanning over 6.0 m	21 days

After removal of the centering any roughness or irregularity on the exposed surface of the work shall be made good by thin grouting of cement or a cement wash and the whole surface shall be so finished as to present an even and uniform appearance. No plastering will be permitted on the surface.

### 14 STRUCTURAL STEEL:

#### 14.1. DEFINITIONS/ TERMINOLOGY

##### **Bead**

A single run of weld metal deposited on surface.

##### **Butt Weld**

A weld in which the weld metal lies substantially within the extension of the planes are the surfaces *on* the parts joined.

##### **Crater**

A depression left in weld metal where the *arc* was broken or the flame was removed.

**End Crater**

A crater at the end of a weld or at the end of a joint.

**Fillet Weld**

A weld of approximately triangular cross-section joining two surfaces approximately at the right angles to each other in a lap joint, tee joint or corner joint. It is of two types:

- (1) Continuous
- (2) Intermittent.

**Fusion Welding**

Any welding process in which the weld is made between metals in a state of fusion without hammering or pressure.

**Non- fusion Welding**

A term applied to the deposition, by the Oxy-Acetylene process of filler metal on parent metal without fusion of the latter.

*Oxy-Acetylene Pressure Welding*

Pressure welding in which any Oxy-Acetylene flame is used to make the surface to be united plastic. No filler metal is used.

**Run**

The metal deposited during one passage of the electrode or blow pipe in the making of a joint.

**Weld**

A union between two pieces of metal at faces rendered plastic or liquid by heat or pressure, or both, Filler metal may be used to affect the union.

**14.2. MATERIALS**

**Micro-Alloying Elements**

Elements such as niobium, boron, vanadium and titanium added singly or in combination to obtain higher strength to weight ratio and better toughness, formability and weldability as compared to unalloyed steel of similar strength level. CPWD SPECIFICATIONS 2009 400

**Weldability**

A metallic substance is considered to be weldable by a given process and for the given purpose, when metallic continuity to a stated degree can be obtained by welding using a suitable procedure, so that the joints comply with the requirements specified in regard to both their local properties and their influence on the construction of which they form a part.

**Controlled Rolling**

A hot rolling process in which the temperature of the steel and its reduction ratio are controlled, particularly during the final rolling passes, in order to achieve fine grain micro structure and optimum mechanical properties.

**Normalizing Rolling**

A hot rolling process in which the final rolling passes are carried out at a suitable higher temperature, followed by cooling in natural air to a temperature below the transformation temperature, in order to produce a structure, analogous to that obtained by a separate normalizing treatment of hot rolled product.

**2.1 Steel**

**2.1.1 Supply of Material :** General requirements relating to supply of structural steel shall conform to IS 8910.

**2.1.2 Grades :** There shall be nine grades of steel as given in Tables 10.1 and 10.2. While placing the order the steel should be designated by 'Designation' (See Table 10.1 and 10.2).

**2.1.3 Manufacture :** The processes used in the steel making and further hot rolling into steel plates, strips, sections, flats, bars, etc., are left to the discretion of the manufacturer/supplier. If required, secondary refining may follow steel making, as also normalizing rolling/controlled rolling during manufacturing of sections or as per the agreement between the purchaser and the manufacturer/ supplier.

#### **2.1.4 Freedom from Defects**

**2.1.4.1** All finished materials shall be well and cleanly rolled to the dimensions, sections and masses specified. The finished material shall be reasonably free from surface flaws; laminations; rough/ jagged and imperfect edges and all other harmful defects.

**2.1.4.2** Minor surface defects may be removed by the manufacturer/supplier by grinding provided the thickness is not reduced locally by more than 4 percent below the minimum specified thickness. Reduction in thickness by grinding greater than 4 percent but not exceeding 7 percent may be made subject to mutual agreement between the client/ consultant and manufacturer/supplier.

**2.1.4.3** Subject to agreement with the client/ consultant, surface defects which cannot be dealt with as in 10.1.1.4.2 may be repaired by chipping or grinding followed by welding and inspection by a mutually agreed procedure such that:

(a) After complete removal of the defects and before welding, the thickness of the item is not to be reduced by more than 20 percent at any place.

(b) Welding is carried out by procedure APPROVED by competent authority with approved electrodes and the welding is ground smooth to the correct nominal thickness; and

(c) Subsequent to the finish grinding, the item may be required to be normalized or otherwise heat treated at the client's/ consultant's discretion.

**2.1.4.4** Welding as mentioned in 10.1.1.4.3 is not permissible for grade designation E 250 material.

**2.1.5 Chemical Composition :** Ladle Analysis the ladle analysis of the steel, when carried out by the method specified in the relevant part of IS 228 or any other established methods which as approved by client/ consultant. In case of dispute, the procedure given in IS 228 and its relevant parts shall be the referee method and where test methods are not specified shall be as agreed to between the client/ consultant and the manufacturer/supplier.

## **2.2 Rivets**

Rivets shall be made from rivet bars of mild steel as per IS 1148.

## **2.3 Bolts**

These are of two types namely turned and fitted bolts and black bolts. Turned & fitted bolts are turned to exact diameter in automatic lathe. For these bolts, whether reamed or drilled bolts, the same unit stresses are allowed as for rivets. In case of black bolts which are not finished to exact sizes, a lower working stress other than for turned bolts

is adopted. They shall conform to IS 1367 – Technical supply conditions for threaded steel fasteners.

## **2.4 Electrodes**

The electrodes required for metal arc welding shall be covered electrodes and shall conform to IS 814.

## **14.3 STEEL WORK IN SINGLE SECTION FIXED INDEPENDENTLY WITH CONNECTING PLATE**

**14.3.0** The steel work in single section of R.S. joists, flats, Tees Angles fixed independently with or without connecting plate, is described in these clauses.

### **14.3.1 Fabrication**

The steel sections as specified shall be straightened and cut square to correct lengths and measured with a steel tape. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of member. All straightening and shaping to form, shall be done by pressure. Bending or cutting shall be carried out in such a manner as not to impair the strength of the metal.

### **14.3.2 Painting**

All surfaces which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust. Surfaces not in contact but inaccessible after shop assembly, shall receive the full specified protective treatment before assembly. This does not apply to the interior of sealed hollow sections. Part to be encased in concrete shall not be painted or oiled. A priming coat of approved steel primer such as Red Oxide/Zinc Chromate primer conforming to IS 2074 shall be applied before any member of steel structure are placed in position or taken out of workshop.

### **14.3.3 Erection**

Steel work shall be hoisted and placed in position carefully without any damage to itself and other building work and injury to workmen. Where necessary mechanical appliances such as lifting tackle winch etc. shall be used. The suitability and capacity of all plant and equipment used for erection shall be upto the satisfaction of the Engineer-in-charge.

### **14.3.4 Measurements**

The work as fixed in place shall be measured in running metres correct to a millimetre and weights calculated on the basis of standard tables correct to the nearest kilogram. The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852. Tolerance in weight shall be as per IS code. Steel sections shall be acceptable within tolerance limits. Payment for steel sections shall be made as per actual weight within tolerances. Sections having weight on higher side than permissible tolerance, may be acceptable but payment shall be made on the basis of standard weight only.

Steel sections having weight variations lower side than permissible variation shall not be acceptable. Unless otherwise specified, weight of cleats, brackets, packing pieces, bolts, nuts, washers, distance pieces, separators, diaphragm gussets (taking overall square dimension) fish plates, etc. shall be added to the weight of respective items. In riveted work allowance is to be made for weight of rivet heads. Unless otherwise specified an addition of 2.5% of the weight of structure shall be made for shop and site rivet heads in riveted steel structures.

No deduction shall be made for rivet or bolt holes (excluding holes for anchor or holding down bolts). Deduction in case of rivet or bolt hole shall however be made if its area exceeds 0.02 sqm.

The weight of steel sheets, plates and strips shall be taken from relevant Indian standards based on 7.85 Kg/m<sup>2</sup> for every millimetre sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

#### **14.3.5 Rate**

Rate includes the cost of labour and materials required for all the operations described above.

### **14.4 STEEL WORK IN BUILT UP SECTION (WELDED)**

**14.4.0** The steel work in built up sections (welded) such as in trusses, form work etc. is specified in this clause.

#### **14.4.1 Laying out**

It shall be as specified in 14.3.1.

#### **14.4.2 Fabrication**

**14.4.2.1** Straightening, shaping to form, cutting and assembling, shall be as per 14.3.2 as far as applicable, except that the words "riveted or bolted" shall be read as "welded" and holes shall only be used for the bolts used for temporary fastening as shown in drawings.

**14.4.2.2 Welding :** Welding shall generally be done by electric arc process as per IS 816 and IS 823. The electric arc method is usually adopted and is economical. Where electricity for public is not available generators shall be arranged by the contractor at his own cost unless otherwise specified. Gas welding shall only be resorted to using oxyacetylene flame with specific approval of the Engineer-in-charge. Gas welding shall not be permitted for structural steel work Gas welding required heating of the members to be welded along with the welding rod and is likely to create temperature stresses in the welded members. Precautions shall therefore be taken to avoid distortion of the members due to these temperature stresses. The work shall be done as shown in the shop drawings which should clearly indicate various details of the joint to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbol for welding on plans and shops drawings shall be according to IS 813. As far as possible every efforts shall be made to limit the welding that must be done after the structure is erected so as to avoid the improper welding that is likely to be done due to heights and difficult positions on scaffolding etc. apart from the aspect of economy. The maximum dia of electrodes for welding work shall be as per IS 814. Joint surfaces

which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter, which adversely affect the quality of weld and workmanship.

**14.4.2.3 Precautions :** All operation connected with welding and cutting equipment shall conform to the safety requirements given in IS 818 for safety requirements and Health provision in Electric and gas welding and cutting operations.

**14.4.2.4** Operation, Workmanship and process of Welding is described in Appendix B,

**14.4.2.5** Inspection and testing of welds shall be as per IS 822.

**14.4.2.6 Assembly :** Before welding is commenced, the members to be welded shall first be brought together and firmly clamped or tack welded to be held in position. This temporary connection has to be strong enough to hold the parts accurately in place without any disturbance. Tack welds located in places where final welds will be made later shall conform to the final weld in quality and shall be cleaned off slag before final weld is made.

**14.4.2.7 Erection :** The specification shall be as described in 14.3.3 except that while erecting a welded structure adequate means shall be employed for temporary fastening the members together and bracing the frame work until the joints are welded. Such means shall consists of applying of erection bolts, tack welding or other positive devices imparting sufficient strength and stiffness to resist all temporary loads and lateral forces including wind. Owing to the small number of bolts ordinarily employed for joints which are to be welded, the temporary support of heavy girders carrying columns shall be specially attended. Different members which shall be fillet welded, shall be brought into as close contact as possible. The gap due to faulty workmanship or incorrect fit if any shall not exceed. 1.5 mm if gap exceeds 1.5 mm or more occurs locally the size of fillet weld shall be increased at such position by an amount equal to the width of the gap.

**14.4.2.8 Painting :** Before the member of the steel structures are placed in position or taken out of the workshop these shall be painted as specified in para 14.2.2.

#### **14.4.3 Measurements**

The mode of measurements shall be the same as specified in 14.2.4 except that weight of welding material shall not be added in the weight of members for payment and nothing extra shall be paid for making and filling holes for temporary fastening of members during erection before welding.

#### **14.4.4 Rate**

The rate shall include the cost of all labour and materials involved in all the operations described above.

### **14.5 STEEL WORK WELDED IN BUILT-UP SECTIONS USING STRUCTURAL STEEL**

(A) In Stringers, Treads, Landing etc. of Stair cases including use of Chequered Plate wherever required

(B) In Grating, Frames, Guard Bar, Ladder, Railings, Brackete, Gates and similar work.

**14.5.1** General specifications for these items to be same as for steel work welded in built-up sections as mentioned in para 14.4 except that steel used for fabrication of these items to be of type used for structural use/purposes.

**14.5.2** Steel members used for fabricating these items to be designed structurally to withstanding the all loads to be carried out by the members during erection, fixing and functional use in designed life. Work to be executed as per structural drawings.

#### **14.6 WELDING PROCESS**

(a) The work shall be positioned for downward welding wherever possible.

(b) Arc length voltage and amperage shall be suited to the thickness of material, type of groove and other circumstances of the work. The welding current and electrode sizes for different types of joints shall be as per IS 9595.

(c) The sequence of welding shall be such as will avoid undue distortion and minimize residual shrinkage stresses. Recommendation of IS 9595 shall be followed.

#### **Process of Welding**

The electrode manipulation during welding shall be such as to ensure that:

(1) The parent metal is in a fused stage when the filler metal makes contact with it.

(2) The weld metal does not overflow upon any unfused parent metal forming overlapping.

(3) The parent metal is not under-cut along the weld toes.

(4) The flowing metal floats, the slag, the oxides, and the gas bubbles to the surface behind the advancing pool. In case any of these requirements is unattainable by manipulation, the current shall be adjusted or the electrode size changed. Each time the arc is started the electrode shall be moved in such a way that the fusion of base metal at the starting point is assured. At the completion of a run the movement of electrode shall be slowed down to fill the arc crater.

After every interruption of the arc except at completion of a run, the arc shall be restarted ahead of the previous deposit and then move back to fill the crater or such alternative technique shall be used as will ensure complete filling of the crater, or complete fusion between the new and old deposit and the base metal at the point of junction, and result in continuity of weld, Before welding operation is completed, all traces of slag shall be removed from the deposit, by chipping if necessary, and the deposit and the adjoining base metal shall be wire brushed and cleaned at all points. The requirements shall apply not only to successive layers, but also to successive beads, and to the over lapping area wherever a junction is made on starting a new electrode.

(5) The welds shall be free from cracks, discontinuity in welding and other defects such as (i) under-size (ii) over-size, (iii) under-cutting and (iv) over-cutting in the case of fillet welds and defects (ii), (iii) & (iv) in the case of butt welds.

All defective welds which shall be considered harmful to the structural strength shall be cut out and re-welded. In case of welded butt joints in steel of thickness up to 50mm the weld joint shall be subjected to radiographic examination as described in IS 1182.

All welds shall be cleaned of slag and other deposits after completion. Till the work is inspected and approved painting shall not be done. The surface to be painted shall be cleaned of spatter, rust, loose scale, oil and dirt.

## **15. PAINTING**

### **15.1 Materials**

Paints, oils, varnishes etc. of approved brand and manufacture shall be used. Only ready mixed Paint (Exterior grade) as received from the manufacturer without any admixture shall be used. If for any reason, thinning is necessary in case of ready mixed Paint, the brand of thinner recommended by the manufacturer or as instructed by the Engineer-in-Charge shall be used.

Approved Paints, oil or varnishes shall be brought to the site of work by the contractor in their original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

### **15.2 Commencing Work**

Painting shall not be started until the Engineer-in-Charge has inspected the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work. Painting of external surface should not be done in adverse weather condition like hail storm and dust storm. Painting, except the priming coat, shall generally be taken in hand after practically finishing all other building work.

The rooms should be thoroughly swept out and the entire building cleaned up, at least one day in advance of the Paint work being started.

### **15.3 Preparation of Surface**

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

### **15.4 Application**

**15.4.1** Before pouring into smaller containers for use, the Paint shall be stirred thoroughly in its containers, when applying also, the Paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform.

**15.4.2** The painting shall be laid on evenly and smoothly by means of crossing and laying off, the latter in the direction of the grains of wood. The crossing and laying off consists of covering the area over with Paint, brushing the surface hard for the first time over and then brushing alternately in opposite direction, two or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

**15.4.3** Where so stipulated, the painting shall be done by spraying. Spray machine used may be (a) high pressure (small air aperture) type, or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and



experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner.

**15.4.4** Spraying should be done only when dry condition prevails. Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next coat is applied. This should be facilitated by thorough ventilation. Each coat except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is laid.

**15.4.5** No left over Paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.

**15.4.6** No hair marks from the brush or clogging of Paint puddles in the corners of panels, angles of mouldings etc. shall be left on the work.

**15.4.7** In painting doors and windows, the putty round the glass panes must also be painted but care must be taken to see that no Paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting. However, bottom edge of the shutters where the painting is not practically possible, need not be done nor any deduction on this account will be done but two coats of primer of approved make shall be done on the bottom edge before fixing the shutters.

**15.4.8** On painting steel work, special care shall be taken while painting over bolts, nuts, rivets overlaps etc.

**15.4.9** The additional specifications for primer and other coats of Paints shall be as according to the detailed specifications under the respective headings.

#### **15.5 Brushes and Containers**

After work, the brushes shall be completely cleaned of Paint and linseed oil by rinsing with turpentine. A brush in which Paint has dried up is ruined and shall on no account be used for painting work. The containers when not in use, shall be kept closed and free from air so that Paint does not thicken and also shall be kept safe from dust. When the Paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean, and can be used again.

#### **15.6 Measurements**

Shall be as per IS 1200 only.

#### **15.7 PAINTING WITH SYNTHETIC ENAMEL PAINT**

**15.7.1** Synthetic Enamel Paint (conforming to IS 2933) of approved brand and manufacture and of the required colour shall be used for the top coat and an undercoat of ordinary Paint of shade to match the top coat as recommended by the same manufacturer as far the top coat shall be used.

#### **15.7.2 Painting on New Surface**

##### **15.7.2.1. Preparation of Surface**

**15.7.2.1.a Wooden Surface :** The wood work to be painted shall be dry and free from moisture. The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material conforming to IS 345 with same shade as Paint shall be used where specified. The surface treated for knotting shall be dry before Paint is applied. After obtaining approval of Engineer-in-Charge for wood work, the priming coat shall be applied before the wood work is fixed in position. After the priming coat is applied, the holes and indentation on the surface shall be stopped with glazier's putty or wood putty. Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in stopping and the latter is therefore liable to crack.

**15.7.2.1.b Iron & Steel Surface :** All rust and scales shall be removed by scrapping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling which becomes loose by rusting, shall be removed. All dust and dirt shall be thoroughly wiped away from the surface. If the surface is wet, it shall be dried before priming coat is undertaken.

**15.7.2.1.c Plastered Surface :** The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations, shall be filled up with plaster of paris and rubbed smooth.

**15.7.2.2 Application :** The number of coats including the undercoat shall be as stipulated in the item.

(a) *Under Coat* : One coat of the specified ordinary Paint of shade suited to the shade of the top coat, shall be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.

(b) *Top Coat* : Top coats of synthetic enamel Paint of desired shade shall be applied after the undercoat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure properly uniform glossy surface.

**15.7.2.3** Other details shall be as specified above as far as they are applicable.

### **15.7.3 Painting on Old Surface**

**15.7.3.1 Preparation of Surface :** Where the existing Paint is firm and sound it shall be cleaned of grease, smoke etc. and rubbed with sand paper to remove all loose particles dusted off. All patches and cracks shall then be treated with stopping and filler prepared with the specified Paint. The surface shall again be rubbed and made smooth and uniform. If the old paint is blistered and flaked it will be necessary to completely remove the same as described in para 13.41 of CPWD Specifications. Such removal shall be paid for separately and the painting shall be treated as on new surface.

**15.7.3.2 Painting :** The number of coats as stipulated in the item shall be applied with synthetic enamel Paint. Each coat shall be allowed to dry and rubbed down smooth with very fine wet abrasive paper, to get an even glossy surface. If however, the surface is not satisfactory additional coats as required shall be applied to get correct finish.

**15.7.3.3** Other details shall be specified above as far as they are applicable.

### **15.8 PAINTING WITH ALUMINIUM PAINT**

**15.8.1** Aluminium Paint shall be (conforming to IS 2339) of approved brand and manufacture. The Paint comes in compact dual container with the paste and the medium separately.

The two shall be mixed together to proper consistency before use.

#### **15.8.2 Preparation of Surface**

**15.8.2.1 Steel Work (New Surfaces) :** All rust and scales shall be removed by scraping or brushing with steel wire brushes and then smoothed with sand paper. The surface shall be thoroughly cleaned of dust.

#### **C.G.S. Sheets (New Surfaces) : Preparation of Surface**

**Painting New Surface :** The painting of new G.S. sheets shall not usually be done till the sheets have weathered for about a year. When new sheets are to be painted before they have weathered they shall be treated with a mordant solution prepared by mixing 38 gm of copper acetate in a litre of soft water or 13 gm hydrochloric acid in a solution of 13 gm each of copper chloride, copper nitrate and ammonium chloride dissolved in a litre of soft water. This quantity of solution is sufficient for about 235 sqm. to 280 sqm of area and is applied for ensuring proper adhesion of Paint. The painting with the mordant solution will be paid for separately. Before painting on new or weathered G.S. sheets, rust patches shall be completely cleaned with coarse emery paper and brush. All grease marks shall also be removed and the surface washed and dried and rusted surface shall be touched with synthetic enamel paint of approved brand, manufacturer and shade.

**Steel Work or C.G.S. sheets (Old Surfaces):** Painting Old Surface: If the old Paint is firm and sound, it shall be cleaned of grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with synthetic enamel paint. If the old Paint is blistered and flaked, it shall be completely removed as described in 13.41 of CPWD Specifications. Such removal shall be paid for separately and painting shall be treated as on new work..

#### **15.8.3 Application**

The number of coats to be applied shall be as given in the item. Each coat shall be allowed to dry for 24 hours and lightly rubbed down with fine grade sand paper and dusted off before the next coat is applied. The finished surface shall present an even and uniform appearance.

As aluminium paste is likely to settle in the container, care shall be taken to frequently stir the Paint during used. Also the Paint shall be applied and laid off quickly, as surface is otherwise not easily finished.

## **16. CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPES**

**16.1** CPVC pipes & fittings used in hot & cold potable water distribution system shall conform to requirement of IS 15778. The material from which the pipe is produced

shall consist of chlorinated polyvinyl chlorides. The polymer from which the pipe compounds are to be manufactured shall have chlorine content not less than 66.5%. The internal and external surfaces of the pipe shall be smooth, clean and free from grooving and other defects. The pipes shall not have any detrimental effect on the composition of the water flowing through it. Diameter and wall thickness of CPVC pipes are as per given in Table 18.16 below.

**TABLE 16.1a**

Sl.No.	Nominal Size	Nominal Outside Diameter	Mean Outside Diameter		Outside Diameter at any point		Wall thickness					
			Min	Max	Min	Max	Class 1, SDR 11			Class 3, SDR 17		
							Avg. Max	Min	Max	Avg. Max	Min	Max
1	2	3	4	5	6	7	8	9	10	11	12	13
i	15	15.9	15.8	16.0	15.8	16	2.2	1.7	2.2	-		
ii	20	22.2	22.1	22.3	22.0	22.4	2.5	2	2.5	-		
iii	25	28.6	28.5	28.7	28.4	28.8	3.1	2.6	3.1	-		
iv	32	34.9	34.8	35	34.7	35.1	3.7	3.2	3.7	-		
v	40	41.3	41.2	41.4	41.1	41.5	4.3	3.8	4.3	-		
vi	50	54.0	53.9	54.1	53.7	54.3	5.5	4.9	5.5	-		
vii	65	73.0	72.8	73.2	72.2	73.8	-	-	-	4.8	4.3	4.8
viii	80	88.9	88.7	89.1	88.1	89.7	-	-	-	5.9	5.2	5.9
ix	100	114.3	114.1	114.5	113.5	115.1	-	-	-	7.5	6.7	7.5
x	150	168.3	168.0	168.6	166.5	170.1	-	-	-	11.1	9.9	11.1

**Notes**

1. For CPVC pipes SDR is calculated by dividing the average outer diameter of the pipe in mm by the minimum wall thickness in mm. If the wall thickness calculated by this formula is less than 1.52 mm, it shall be increased to 1.52 mm. The SDR values shall be rounded to the nearest 0.5.

**16.2 Dimensions of Pipes**

The outside diameter, outside diameter at any point and wall thickness shall be as given in Table 18.16.

**16.2.1 Diameter :** The outside diameter and outside diameter at any point as given in Table 18.16 shall be measured according to the method given in IS 12235 (part 1).

**16.2.2 Diameter at any point :** The difference between the measured maximum outside diameter and measured minimum outside diameter in the same cross-section of pipe (also called tolerance on ovality) shall not exceed the greater of the following two values:

(a) 0.5 mm, and

**(b) 0.012 dn rounded off to the next higher 0.1 mm.**

**16.2.3 Wall Thickness :** The wall thickness of the pipes shall be as given in Table 18.16. Wall thickness shall be measured by any of the three methods given in IS 12235 (part 1). To check the conformity of the wall thickness of the pipe throughout its entire length, it is necessary to measure the wall thickness of the pipe at any point along its

length. This shall be done by cutting the pipe at any point along its length and measuring the wall thickness as above. Alternatively, to avoid destruction of the pipe, non destructive testing methods such as the use of ultrasonic wall thickness measurement gauges shall be used at any four points along the length of the pipe.

### **Tolerance on Wall Thickness**

(a) For pipes of minimum wall thickness 6 mm or less, the permissible variation between the minimum wall thickness (eMin) and the wall thickness at any point (e), (e - eMin) shall be positive in the form of +y, where  $y=0.1 eMin+0.2$  mm.

(b) For pipes of minimum wall thickness greater than 6mm, the permissible variation of wall thickness shall again be positive in the form of +y, where y would be applied in two parts.

(c) The average wall thickness shall be determined by taking at least six measurements of wall thickness round the pipe and including both the absolute minimum and absolute maximum measured values. The tolerance applied to this average wall thickness from these measurements shall be within the range  $0.1 eMin+0.2$  mm (see Table 18.16).

(d) The maximum wall thickness at any point shall be within the range  $0.15eMin$  (see Table 18.16).

(e) The results of these calculations for checking tolerance shall be rounded off to the next higher 0.1 mm.

**16.2.4 Effective Length (Le) :** If the length of a pipe is specified, the effective length shall not be less than that specified. The preferred effective length of pipes shall be 3, 5 or 6 m. The pipes may be supplied in other lengths where so agreed upon between the manufacturer and the purchaser.

### **16.3 Pipe Ends**

The ends of the pipes meant for solvent cementing shall be cleanly cut and shall be reasonably square to the axis of the pipe or may be chamfered at the plain end.

### **16.4 Physical and Chemical Characteristics**

**16.4.1 Visual Appearance :** The colour of the pipes shall be off-white. Slight variations in the appearance of the colour are permitted.

The internal and external surface of the pipe shall be smooth, clean and free from grooving and other defects.

**16.4.2 Opacity :** The wall of the plain pipe shall not transmit more than 0.1 per cent of the visible light falling on it when tested in accordance with IS 12235 (Part 3).

**16.4.3 Effect on Water :** The pipes shall not have any determinate effect on the composition of the water flowing through them, when tested as per 10.3 of IS 4985.

**16.4.4 Reversion Test :** When tested by the method prescribed in IS 12235 (Part 5/ Sec 1 and Sec 2), a length of pipe 200 ±20 mm long shall not alter in length by more than 5 per cent.

**16.4.5 Vicat Softening Temperature :** When tested by the method prescribed in IS 12235 (part 2), the Vicat softening temperature of the specimen shall not be less than 110°C.

**16.4.6 Density :** When tested in accordance with IS 12235 (Part 14), the density of the pipes shall be between 1450kg/m<sup>3</sup> and 1650kg/m<sup>3</sup>.

## 16.5 Mechanical Properties

**16.5.1 Hydrostatic Characteristics :** When subject to internal hydrostatic pressure test in accordance with the procedure given in IS 12235 (part 8/Sec 1), the pipe shall not fail during the prescribed test duration. The temperatures, duration and hydrostatic (hoop) stress for the test shall conform to the requirements given in Table 18.17. The test shall be carried out not earlier than 24 h after the pipes have been manufactured.

**TABLE 18.17**  
**Requirements of Pipes for Internal Hydrostatic Pressure Test**  
**(Clause 16.5.1)**

Sl.No	Test	Test Temperature Min.	Test Period	Hydrostatic (Hoop) Stress
		°C	h	Mpa
1	2	3	4	5
i	Acceptance	20	1	43.0
ii	Type	95	165	5.6
iii	Type	95	1000	4.6
iv	Type	95	8760	3.6(Test for thermal stability)

**16.5.2 Thermal Stability by Hydrostatic Pressure Testing :** When subject to internal hydrostatic pressure test in accordance with the procedure given in IS 12235 (Part 8/Sec 1) and as per requirement given in Table 18.17, Sl. No. (iv), the pipe shall not burst or leak during the prescribed test duration.

**16.5.3 Resistance to External Blow at 0°C :** When tested by the method prescribed in IS 4985, with classified striker mass and drop height as given in Table 18.18, the pipe shall have a true impact rate of not more than 10 per cent.

**TABLE 18.18**  
**Classified Striker Mass and Drop Height Conditions for the Falling Weight Impact Test**  
**(Clause 16.5.3)**

Sl.No	Nominal pipe size	Mass of falling weight	Falling height
	mm	Kg	mm
1	2	3	4
i	15	0.5±0.5%	300±10
ii	20	0.5±0.5%	400±10
iii	25	0.5±0.5%	500±10
Iv	32	0.5±0.5%	600±10
V	40	0.5±0.5%	800±10
Vi	50	0.5±0.5%	1000±10
Vii	65	0.8±0.5%	1000±10
Viii	80	0.8±0.5%	1200±10
Ix	100	1.0±0.5%	1600±10
X	150	1.0±0.5%	2000±10

**16.5.4 Flattening Test :** When tested by the method prescribed in IS 12235 (part 19), pipe shall show no signs of cracking, splitting and breaking.

**16.5.5 Tensile Strength :** When tested by the method prescribed in IS 12235 (Part 19), the tensile strength at yield shall not be less than 50 MPa at  $27 \pm 2^\circ\text{C}$ .

#### **16.6 Sampling and Criteria for Conformity**

**The sampling procedure and criteria for conformity shall be as given in Annexure F in Specifications CPWD.**

#### **16.7. Marking**

**16.7.1** Each pipe shall be clearly and indelibly marked in ink/paint or hot embossed on white base at intervals of not more than 3 m. The marking shall show the following:

- (a) Manufacturer's name or trade-mark
- (b) Outside diameter,
- (c) Class of pipe and pressure rating, and

**(d) Bath or lot number**

**16.7.2 BIS Certification Marking :** Each pipe may also be marked with the Standard Mark.

#### **16.8 Fittings**

The fittings shall be as follows:

- (a) Plain CPVC solvent cement fittings from size 15 mm to 160 mm.
- (b) Brass threaded fittings.
- (c) Valve from size 15 mm to 160 mm
- (d) *Brass Threaded Fittings:* All types of one end brass threaded male/female adaptors in various fittings like coupler, socket, elbow, tee are available for transition to other plastic/metal piping and for fixing of CP fittings. Ball, Gate valves in CPVC are available in all dimensions. All fittings shall carry the following information:

- (1) Manufacturer's name/trade mark.

(2) Size of fitting

## 16.9 Piping Installation Support and Spacing

**16.9.1 Concealed Piping:** Pipes can be concealed in chases. The pipes and fitting are to be pressure tested prior to concealing the chases. To maintain alignment of CP fittings while joining, all alignment of fittings and pipe shall be done correctly. DO NOT USE NAILS FOR HOLDING OF PIPES IN THE CHASES.

**16.9.2 External Installations:** For pipes fixed in the shafts, ducts etc. there should be sufficient space to work on the pipes. Pipes sleeves shall be fixed at a place the pipe is passing through a wall or floor so as to allow freedom for expansion and contraction. Clamping of the pipe is done to support it while allowing the freedom for movement. All pipes exposed to sunlight shall be painted with a water based acrylic paint emulsion to enhance UV protection. Pipes in trenching shall be laid in accordance to the Good Plumbing practices followed for Metal piping.

### Recommended Support Spacing (Distance between Pipe Clamps Horizontal Support)

Pipe size	Horizontal support (In Meter)			
	Temperature			
	23°C	38°C	60°C	82°C
16 mm (1/2")	1.22	1.22	1.07	0.92
20 mm (3/4")	1.53	1.37	1.22	0.92
25 mm (1/0")	1.68	1.3	1.37	0.92
32 mm (1 1/4")	1.83	1.68	1.53	1.22
40 mm (1 1/2")	1.98	1.83	1.68	1.22
50 mm (2")	2.29	2.14	1.98	1.22

**16.9.3 Expansion LOOP:** CPVC systems, like all piping materials, expand and contract with changes in temperatures. CPVC pipes shall expand 7.5 cm per 30 m length for a 40 °C temperature change.

Expansion does not vary with Pipe size. Thermal expansion can generally be accommodated at changes in direction. On a long straight run, an offset or loop based on the following chart is required.

Nominal Pipe	Length of Run (Meter), Loop length in cms. Size				
	6 metre	12 metre	18 metre	24 metre	30 metre
	15	43	56	69	79
20	48	66	81	91	104
25	53	74	91	104	117
32	58	81	102	117	130
40	63	89	109	127	142
50	71	102	124	145	63



**16.10 Testing**

All water supply systems shall be tested to hydrostatic pressure test. The pressure tests are similar to the test pressure used for other plastic/metal pipes. System may be tested in sections and such section shall be entirely checked on completion of connection to the overhead tank or pumping system or mains.

**16.11 Measurements**

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm for the finished work, which shall include CPVC pipe and fittings including plain and Brass threaded fittings and jointing solvent cement.

**17 Trenches**

**17.1** The trenches shall be so dug that the pipes may be laid to the required alignment and at required depth.

**17.2** Cover shall be measured from top of pipe to the surface of the ground.

**17.3** The bed of the trench, if in soft or made up earth, shall be well watered and rammed before laying the pipes and the depressions, if any, shall be properly filled with earth and consolidated in 20 cm layers.

**17.4** If the trench bottom is extremely hard or rocky or loose stony soil, the trench shall be excavated at least 150 mm below the trench grade. Rocks, stone or other hard substances from the bottom of the trench shall be removed and the trench brought back to the required grade by filling with selected fine earth or sand (or fine moorum if fine soil or sand is not available locally) and compacted so as to provide a smooth bedding for the pipe. Where excavation requires blasting operation, it shall be ensured that no pipes have been stacked in the vicinity and completed pipe line in the vicinity has already been covered before starting of blasting operations; this is necessary to prevent damage to the exposed pipes in the vicinity by falling stones as a result of blasting.

**17.5** After the excavation of the trench is completed, hollows shall be cut at the required position to receive the socket of the pipes and these hollows shall be of sufficient depth to ensure that the barrels of the pipes shall rest throughout their entire length on the solid ground and that sufficient spaces left for jointing the underside of the pipe joint. These socket holes shall be refilled with sand after jointing the pipe.

**17.6** Roots of trees within a distance of about 0.5 metre from the side of the pipe line shall be removed or killed.

**17.7** The excavated materials shall not be placed within 1 metre or half of the depth of the trench, whichever is greater, from the edge of the trench. The materials excavated shall be separated and stacked so that in refilling they may be re-laid and compacted in the same order to the satisfaction of the Engineer-in-Charge.

**17.8** The trench shall be kept free from water. Shoring and timbering shall be provided wherever required. Excavation below water table shall be done after dewatering the trenches.

**17.9** Where the pipe line or drain crosses an existing road, the road crossing shall be excavated half at a time, the 2nd half being commenced after the pipes have been laid in the first half and the trench refilled. Necessary safety measures for traffic as directed shall be adopted. All types, water mains cables, etc. met within the course of excavation shall be carefully protected and supported. Care shall be taken not to

disturb the electrical and communication cable met with during course of excavation, removal of which, if necessary, shall be arranged by the Engineer-in-Charge

## **18. LAYING AND JOINTING CEMENT CONCRETE PIPES AND SPECIALS**

(i) **Trenches:** Trenches shall be as described in 16. Where the pipes are to be bedded directly on soil, the bed shall be suitably rounded to fit the lower part of the pipe, the cost for this operation being included in the rate for laying the pipe itself.

(ii) Loading, transporting and unloading of concrete pipes shall be done with care. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain pulley block is recommended. All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used. Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used. Pipes shall be laid true to line and grade as specified. Laying of pipes shall proceed upgrade of a slope.

(iii) If the pipes have spigot and socket joints, the socket ends shall face upstream. In the case of pipes with joints to be made with loose collars, the collars shall be slipped on before the next pipe is laid. Adequate and proper expansion joints shall be provided where directed.

(iv) In case where foundation conditions are unusual such as in the proximity of trees or holes, under existing or proposed tracks manholes etc. the pipe shall be encased all-around in 15 cm thick cement concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) or compacted sand or gravel.

(v) In cases where the natural foundation is inadequate the pipes shall be laid either in concrete cradle supported on proper foundations or on any other suitably designed structure. If a concrete cradle bedding is used the depth of concrete below the bottom of the pipe shall be at least  $1/4^{\text{th}}$  of the internal dia of the pipe subject to the min. of 10 cm and a maximum of 30 cm. The concrete shall extend up the sides of the pipe at least to a distance of  $1/4^{\text{th}}$  of the outside diameter of pipes 300 mm and over in dia. The pipe shall be laid in this concrete bedding before the concrete has set. Pipes laid in trenches in earth shall be bedded evenly and firmly and as far up the haunches of the pipe as to safely transmit the load expected from the backfill through the pipe to the bed. This shall be done either by excavating the bottom of the trench to fit the curve of the pipe or by compacting the earth under around the curve of the pipe to form an even bed. Necessary provision shall be made for joints wherever required.

(vi) When the pipe is laid in a trench in rock hard clay, shale or other hard material the space below the pipe shall be excavated and replaced with an equalising bed of concrete, sand or compacted earth. In no place shall pipe be laid directly on such hard material.

(vii) The method of bedding and laying the pipes under different conditions are illustrated separately.

(viii) When the pipes are laid completely above the ground the foundations shall be made even and sufficiently compacted to support the pipe line without any material

settlement. Alternatively the pipe line shall be supported on rigid foundations at intervals. Suitable arrangements shall be made to retain the pipe line in the proper alignment, such as by shaping the top of the supports to fit the lower part of the pipe. The distance between the supports shall in no case exceed the length of the pipe. The pipe shall be supported as far as possible close to the joints. In no case shall the joints come in the centre of the span. Care shall be taken to see that super imposed loads greater than the total load equivalent to the weight of the pipe when running full shall not be permitted. Suitably designed anchor blocks at change of direction and grades for pressure lines shall be provided where required.

**19. LAYING AND JOINTING STONE WARE PIPES:**

For all sewers and drains, glazed stoneware pipes shall be used as far as possible in preference to other types of pipes. These are suitable, particularly where acid effluents or acid sub-soil conditions are likely to be encountered.

(i) *Trenches:* Specifications described in 17 shall apply, as far as possible. The trench shall be so dug that the pipe can be laid to the required alignment and at the required depth. When the pipe line is under a roadway, a minimum cover of 90 cm is recommended for adoption, but it may be modified to suit local conditions. The trench shall be excavated only so far in advance of pipe laying as specified by the Engineer-in-Charge. The trench shall be so shored and drained that the workmen may work therein safely and efficiently. The discharge of the trench dewatering pumps shall be conveyed either to drainage channels or to natural drains. The excavation shall be carried out with manual labour or with suitable mechanical equipment as approved by the Engineer-in-Charge. Unless otherwise specified by the Engineer-in-Charge, the width at bottom of trenches for different diameters of pipes laid at different depths shall be as given below:—

(a) For all diameters, up to an average depth of 120 cm, width of trench in cm = diameter of pipe + 30 cm.

(b) For all diameters for depths above 120 cm, width of trench in cm = diameter of pipe + 40 cm.

(c) Notwithstanding (a) and (b) the total width of trench shall not be less than 75 cm for depths exceeding 90 cm. The width of trench in the upper reaches shall be increased as described in sub-head 'Earthwork'.

(ii) *Laying* : Where the pipes are laid on soft soil with maximum water table lying at invert level of the pipe, the pipes shall be bedded in cement concrete with thickness and mix as specified, projecting on each side of the pipe to the specified width of the trench . The pipes with their crown level at 1.20 m depth and less from ground shall be covered with 15 cm thick. Concrete above the crown of the pipe and sloped off to meet the outer edges of the concrete, to give a minimum thickness of 15 cm all-around the pipe. Pipes laid at a depth greater than 1.20 m at crown and maximum water table level rising above the invert level of pipe, shall be concreted at the sides up to the level of the centre of the pipe and sloped off from the edges to meet the pipe tangentially .

The pipe shall be carefully laid to the alignments, levels and gradients shown on the plans and sections. Great care shall be taken to prevent sand etc. from entering the pipes. The pipes between two manholes shall be laid truly in a straight line without

vertical or horizontal undulation. The pipes shall be laid with socket ends facing upstream. The body of the pipe shall for its entire length rest on an even bed of concrete and places shall be excavated in the concrete to receive the socket of the pipe. Where pipes are not bedded on concrete, the trench floor shall be left slightly high and carefully bottomed up as pipe laying proceeds, so that the pipe barrels rest on firm and undisturbed ground. If the excavation has been carried too low, the desired levels shall be made up with concrete 1:5:10 (1cement : 5 fine sand: 10 graded stone aggregate 40 mm nominal size) for which no extra payment shall be made.

If the floor of the trench consists of rock or very hard ground that cannot easily be excavated to smooth surface the pipe shall be laid on a leveling course of concrete as desired.

When S.W. pipes are used for storm water drainage, no concreting will normally be necessary. The cement mortar for jointing will be 1:3 (1cement : 3 fine sand). Testing of joints will also not be done

(iii) *Jointing* : Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be slipped home well into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly home so as to fill not more than 1/4th of the total depth of the socket.

The remainder of the socket shall be filled with stiff mixture of cement mortar in the proportion of 1:1 (1 cement: 1 fine sand). When the socket is filled, a fillet shall be formed round the joint with a trowel forming an angle of 45 degree with the barrel of the pipe. After a day's work any extraneous material shall be removed from the inside of the pipe. The newly made joints shall be cured for at least seven days.

(iv) *Testing of Joints* : Stoneware pipes used for sewers shall be subjected to a test pressure of 2.5 m head of water at the highest point of the section under test. Before commencing test, the pipeline shall be filled with water and maintained full for 24 hours under head of 0.6 m of water. The test shall be carried out by suitably plugging the lower end of the drain and the ends of the connection if any and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head, or the top may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitable for observation. The tolerance of two liters per centimeter of diameter per kilometer may be allowed during a period of 10 minutes.

If any leakage is visible, the defective part of the work shall be cut out and made good. A slight amount of sweating which is uniform may be overlooked, but excessive sweating from a particular pipe or joint shall be watched for and taken as indicating a defect to be made good.

Any joint found leaking or sweating, shall be rectified or embedded into 15 cm layer of cement concrete (1:2:4) 30 cm in length and the section retested.

(v) *Refilling* : In cases where pipes are not bedded on concrete special care shall be taken in refilling trenches to prevent the displacement and subsequent settlement at the surface resulting in uneven street surfaces and dangers to foundations etc. The backfilling materials shall be packed by hand under and around the pipe, and rammed with a shovel and light tamper. This method of filling will be continued up to the top of pipe. The refilling shall rise evenly on both sides of the pipe continued up to 60 cm

above the top of pipe so as not to disturb the pipe. No tamping should be done within 15 cm of the top of pipe.

(vi) *Measurements* : The lengths of pipes shall be measured in running metres nearest to a cm as laid or fixed, from inside of one manhole to the inside of the other manhole. The length shall be taken along the centre line of the pipes over all fittings such as bends, junctions, etc. which shall not be measured separately.

Excavation, refilling, shoring and timbering in trenches, and cement concreting wherever required shall be measured separately under relevant items of work.

(vii) *Rate* : The rate shall include the cost of materials and labour involved in all the operations described above excluding the cost of concrete which shall be paid for separately.

## **20. MODE OF MEASUREMENTS:**

Where not otherwise specified, the value of work done under this contract shall be calculated as follows:-

- a. The net dimensions only filling in foundations plinth and other stone masonry or brick walls.
- b. Brick, concrete and arching will be measured in the center of the arching, the full breadth and the full thickness of the stone, concrete or bricks in the wall.
- c. In case of plain, curved, moulded or chamfered cut stone work the dimensions of the smallest stone out of which the work can be cut will be taken.
- d. In woodwork the cube measurements are to be taken only on the fullest visible dimensions of the pieces of the woodwork. The cover lap of scarfs, projections of tennons etc. will not be allowed, except in the case of girders and joists, which will be measured full.
- e. The superficial measurements of planking will be of the surface seen, and the dimensions of tongues or laps will not be allowed.
- f. Coursed khandkee facing will be paid extra on the walling and deduction will be made for all out-stone work in the facing paid for separately.
- g. For round columns, measurements of the square stone from which it can be cut will be taken.
- h. Where frames are included in the items, doors and windows will be measured outside to outside (clear) of the frames after the door or window is closed. Where frames are not included, shutters will be measured clear between the frames after they are closed and rebates will not be paid for separately. Curved heads, fanlights etc. will be similarly measured. Horns will not be paid for separately.
- i. For walling, the actual cubical content of the masonry will be taken after deducting all openings cut stone work and all other items of works paid for separately.
- j. For cut stone steps, the measurements of only the exposed rise, tread and length of the steps will be taken; overlaps and tails will not be allowed.
- k. Measurements of the plaster will be the whole plastered surface of the wall, after making deductions for openings and for dressings and other portions not plastered. All mouldings which will be required to be worked out true to a template and drawn near clean and level, and all exposed angles and junctions with door frames etc., to be included in the rate for plastering.

- l. Tiling roofs with Mangalore or other similar tiles, The measurements of this work will be taken on the slopes of the roof. Nothing extra will be allowed for ridges, hips, overlaps etc.
- m. Where lead sheet work in gutters, covering to roofs etc. is to be measured superficially, net measurements will be taken. Nothing extra will be allowed for overlaps.
- n. Measurements for lightening conductors will be taken from the highest point of the conductor to the bottom of the earth-plats.
- o. Asphalt flooring will be measured on the actual area covered by the asphalt.
- p. Minton-tiled flooring will be measured on the actual area covered by the tiles.
- q. Porbunder stone and other pavement will be measured on the actual area covered by the slabs.
- r. When rock excavation is measured in depots, 40 percent of the measured quantity will be deducted to allow for voids.
- s. While measuring quantities of surplus earth to be removed from site of work, 30 per cent of material loaded will be deducted from lorry measurements.

### **20.1 R.C.C. WORK:**

- a. All R.C.C. work will be measured and paid for at the overall design dimensions, increase in dimensions caused by the plaster finish will not be taken into account.
- b. In the case of junctions of two or more members of R.C.C. work, only one of the members will be measured full and no claim for overlap of other members will be allowed either in respect of cubic contents or extension of reinforcement necessary at the junctions.
- c. Junctions of the Tee and or rectangular beams with slab: - beams will be measured upto the top of the slab.
- d. Junction of beams and columns: - columns will be measured full.
- e. Junction of columns and footing: - footings will be measured full.
- f. Junction of columns and pile caps: - pile caps will be measured full.
- g. Junction of pile caps and plinth beams: - pile caps will be measured full.
- h. Junction of gallery slabs with parapet and drop (apron walls) slabs will be measured full. Chajjas will be measured in sq. mts. arrived at by multiplying length and projection as measured on the top surface exclusive of the vertical edge. Drip moulding watas or any other mouldings will not be separately measured.
- i. Junction of columns and lintels: - columns will be measured full.

### **20.2 MODE OF MEASUREMENT AND RATES FOR M.S. REINFORCEMENT:**

The rate shall be on weight basis for 1 Tonne of Mild Steel reinforcement. The weight of steel reinforcement incorporated in the concrete will be measured in Tonnes based on the total computed weights for the sizes and lengths of bars as shown on the plans or as ordered by the Engineer. No allowance will be made for wastage while computing the weight, hooks and bands will be taken into account but not the laps. The lengths of the bars shall be measured correct to two places of decimals in meters and the weight payable would be worked out on the following basis correct to 0.10 of a kg.

<b>Diameter of bars in millimeters</b>	<b>Weight in Kg. per metre.</b>
8	0.395
10	0.62
12	0.89
16	1.58
20	2.46
22	2.99
25	3.86
28	4.84
32	6.32
36	8.00
40	9.88

The wire for tying and devices for supporting bars and maintaining various clearances will not be measured or paid.

No payment will be made for pins, clips, binding wires, tack welding done in lieu of tying, separators, wire chassis and other materials used for fastening and supporting reinforcement in place. If the bars are substituted at the contractor's request and as a result more steel is used than specified only the quantity specified shall be paid. The F.M.B. rate shall include the cost of steel and of cutting, bending and binding, placing, cleaning, supporting etc., the M.S. bars including laps and wastage.

## **21. TESTING SAMPLES OF CEMENT CONCRETE.**

### **21.1 PRELIMINARY TESTS FOR CONTROLLED CONCRETE**

For controlled concrete preliminary tests referred to m Para 2.1 & 3.0 shall consist of three sets of separate tests, and in each set, tests shall be conducted on six specimens. Not more than one set of six specimens shall be made on any particular day. Of the six specimens in each set, three shall be tested at seven days and the remaining three at 28 days. The preliminary tests of 7 days are intended only to indicate the strength likely to be attained at 28 days.

### **21.2 WORK STRENGTH TESTS FOR CONTROLLED AND NORMAL CONCRETE :**

Similar works tests shall be carried out whenever the quality and grading of materials is changed irrespective of the quantity of concrete poured. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge, when procedure of tests given above reveals a poor quality of concrete and in other special cases.

All work shall be carried out under the supervision of a qualified and a competent Engineer who will supervise proportioning, placing and compacting of concrete at all stages.

All necessary labour, materials, equipment, etc. for sampling, preparing test cubes, curing, etc., shall be provided by the Contractor. Testing of the materials

and concrete may be arranged by the Engineer-in-charge in an approved laboratory at the cost of the contractor.

### **21.3 STANDARD OF ACCEPTANCE**

The average strength of the group of cubes cast for each day shall not be less than the specified works cube strength. 20 percent of the cubes cast for each day may have values less than the specified strength, provided the lowest value is not less than 85 per cent of specified strength.

### **21.4 MANUFACTURER'S CERTIFICATION: TESTING RESULTS ETC.**

For all materials required for concrete construction including cement, aggregate, water, reinforcing and pre-stressing steel the original copies of test certificates, test results etc. either carried out by the manufacturer or any other agency, the mix design recommendations etc. shall be submitted to the Engineer-in-charge for his approval and record. It shall remain the property of the Engineer-in-charge.

### **21.5 CHLORIDE / SULPHATE CONTENTS**

Since the chloride contents of the constituent materials of the concrete would be additive, it is desirable to keep a check on the overall chloride / sulphate contents of the concrete to keep it minimal. Specially, for pre-stressed concrete, the total chloride / sulphate contents of the concrete when manufactured according to the requirements of workability and strength shall be as given below. The cost of testing for the chloride / sulphate contents of the ingredients of concrete and of undertaking remedial measures if the chloride / sulphate contents is more than the permissible limit shall be borne by the contractor.

- a) Total water soluble sulphate (SO<sub>2</sub>) content of the concrete mix expressed as (SO<sub>2</sub>) shall  
not exceed 4 per cent by mass of cement used in the mix.
- b) Total chloride content in concrete expressed as chloride-ion shall not exceed the  
following values by mass of content used :

<u>Type</u>	<u>Per Cent</u>
PSC	0.10
R.C.C. (in severe condition of exposure)	0.20
R.C.C. (in moderate condition of exposure and PCC	0.30

## **22. ADDITIONAL CONDITIONS/ DIRECTIONS TO THE TENDERERS USING READY MIXED CONCRETE.**

1. All special conditions/ directions for cement concrete work shall also be applicable.
2. The contractor shall procure RMC from the RMC plant approved by MDL only if the contractor does not possess his own RMC plant, approved by MDL.



3. Ready mix concrete prepared and transported will be as per IS 4926 of latest revision I.S. CODE.
4. Portland slag cement to be used shall conform to IS 455 & IS 8112 or OPC 53 grade at the specific instructions of Engineer-in-charge.
5. No dry mix shall be brought on site and water added there at.
6. Ready mix concrete will be brought to the site from RMC plant only by transit mixers (agitators)
7. Every transit mixer will carry delivery challan, mentioning the minimum following details.  
Name of Manufacturer and Depot.  
Serial No. of challan.  
Date  
Truck No.  
Name of contractor to whom the RMC is being supplied.  
Location of contract work.  
Grade of concrete.  
Specified workability.  
Cement content and Grade of cement. (minimum cement required shall be distinctly marked.)  
Time of loading.  
Quantity of concrete.  
Type of admixture.
8. When the truck arrives on site, the drum should always be speeded to about 10 to 15 rev/min, for at least 3 minutes, to make sure that the concrete is thoroughly mixed and uniform, before discharge.
9. Testing of Ready Mixed Concrete: - The sampling and testing requirements for ready mixed concrete are the same as those for site mixed concrete. As regards testing of workability following procedure to be followed.  
After making sure that the concrete has been uniformly mixed, take a sample from the first 0.5 cu. m. of concrete discharge, and do a slump (or compacting factor) test on the sample. If the result complies with the specified requirements, then the load should be accepted, If the results are beyond limits, a further sample should be taken from the second 0.5 cu. m. of the discharge, and if this is satisfactory, the load should be accepted, if not, the concrete load shall be rejected, as the same is not as per the specification range. The specified slump is 75 to 100 mm while carrying out above tests; it may vary by 10 mm. as per IS 4926-latest revision.
10. Twelve cubes shall be cast at the plant as well as at the site for every day's work where the concrete is placed.
11. The admixtures used shall conform to IS-9103-latest rev or ASTM C-494 of latest rev and shall be compatible with the cement used for manufacturing concrete.

12. All taxed/duties etc. will be borne by the contractors and not by the MDL.
13. No extra payment will be made for the use of admixtures.
15. The contractors will make all arrangements & provide an uninterrupted access to R.M.C. plant for engineers to check the ready mixed concrete.
16. It will be sole right of the Engineer to allow or disallow the use of ready mixed concrete if all the conditions 1 to 15 are not complied with.

## **23 RAIN WATER SPOUTS**

**23.0** The sectional area of rain water spouts provided shall be generally at the rate of 1 square cm per 70 to 80 square decimetre of roof area drained. However in locations subject to excessive and high intensities of rainfalls, the area of spouts provided may be suitably increased to suit local conditions. No spout shall be less than 80 mm in diameter. The spacing of spouts shall be arranged to suit the position of openings in the wall.

The spouts shall be 100 mm in diameters and 60 cm long.

**23.1.1** The stone ware pipe shall be perfectly sound, free from fine cracks, imperfections of glazing etc. They must be straight cylindrical and of standard nominal diameter and length and depth of socket as given in IS 651. Full length of pipes shall be used on the work. They must be thoroughly salt glazed inside and outside shall generally conform to IS 651.

**23.1.2 Fixing :** These shall be provided at the mouths of khurras and shall be fixed in cement mortar 1:3 (1 cement : 3 coarse sand) with the socket embedded in the masonry and the spigot end projecting outside. The masonry around the pipe and socket shall be thoroughly wetted and the holes shall be given a coat of cement mortar around. The S.W. pipe shall then be inserted and fixed with a surround of mortar. In case the hole has become much larger than the size of the pipe, cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 12.5 mm nominal size) shall be used to fill in the annular space. The spouts shall slope downward at the rate of 1 in 6. The projection outside the wall shall be uniform and not less than 40 cm. The entrance into the pipe shall be smoothly rounded to meet the internal bore of the pipe to facilitate easy flow. Care shall be taken to ensure that the vertical plane through the centre line of the spouts is at right angles to the plane of the wall. Spouts in a row shall be true to line.

**23.1.3 Measurements :** Spouts shall be measured in numbers.

**23.1.4 Rate :** The rate shall include the cost of all materials and labour involved in all the operations described above including scaffolding.

## **24. TACK COAT**

### **24.1 HOT STRAIGHT RUN BITUMEN**

**24.1.0** The rate of application of binder which shall be as specified and which shall conform to 16.1.5 shall depend on the surface on which the premix carpet is to be laid.

- (a) 0.75 kg/sqm on W.B.M. surface.
- (b) 0.50 kg/sqm on existing black topped surface.

#### **24.1.1 Materials**

**Bitumen** : This shall be straight-run bitumen of penetration value 80/100 (VG 30) conforming to IS 73 specifications.

#### **24.1.2 Preparation of Surface**

#### **24.1.3 Cleaning**

Prior to the application of bitumen, all vegetation, loose sealing compound, caked mud, animal dung, dust, dirt and foreign material shall be removed from the entire surface of the pavement and from existing dummy, construction and expansion joints (wherever existing) by means of mechanical sweepers and blowers, otherwise with steel wire brushes, small picks, brooms or other implements as approved by the Engineer-in-Charge. The material so removed shall be disposed off as directed by the Engineer-in-Charge.

#### **24.1.4 Weather and Seasonal Limitations**

The tack coat shall not be applied nor any bitumen work done during rainy weather or when the surface is damp or wet or when the atmospheric temperature in the shade is not more than 16° C.

#### **24.1.5 Application of Tack Coat**

**24.1.5.1 Heating** : Bitumen shall be heated in a boiler to a temperature of 165 deg. C to 175 deg. C and maintained at that temperature. Temperature shall be checked at regular intervals with the help of a thermometer.

**24.1.5.2 Application of Bitumen** : Hot bitumen shall be applied evenly to the clean, dry surface by means of a pressure sprayer at specified rate. Even and uniform distribution of bitumen shall be ensured. Bitumen shall be applied longitudinally along the length of the pavement and never across it. Excessive deposits of bitumen caused by stopping or starting of the sprayer or through leakage or any other reason shall be suitably rectified.

#### **24.1.6 Measurements**

Length and breadth shall be measured correct to a cm, along the surface of pavement. Area shall be worked out in sqm correct to two places of decimal.

#### **24.1.7 Rate**

Rate shall include the cost of all materials and labour involved in all the operations described above.

### **24.2 TACK COAT WITH BITUMEN—EMULSION**

**24.2.1** Specification of item 24.1 to be followed except Bitumen emulsion (Rapid Setting) of specified grade and consistency to be used at room temperature instead of hot straight run bitumen at following rate.

1. on w.b.m @ 0.4kg/sqm.

2. on bituminous surface @ 0.25 kg/sqm.

## 25. ASPHALT ROAD

**Please refer MORTH specification as mentioned below:**

GSB – MORTH specification (401)

WMM - MORTH specification (406)

DBM - MORTH specification (507)

BC - MORTH specification (512)

## 26. POLYMER MORTAR :

The surface shall be cleaned of all dust and loose material with the help of vacuum cleaner and made wet to receive the bond coat .The bonding coat shall be in the proportion of 1:1 or 1:1.5 of cement and polymer.

The quantity by weight of polymer, cement and sand for preparation of polymer mortar shall be checked

Acrylic Polymer	:	1Kg
Cement	:	5Kg
Quartz	:	15Kg
Water	:	1 to 1.5 litres depending on the consistency

(Design mixed quartz sand shall be used).Polymer to be used shall be tested for physical and chemical properties)

The mortar shall be mixed in a mixer and the bonding coat shall be applied only when the mix is ready. The mortar shall be applied by pressing hard and each layer of 10mm shall be compacted with hand vibrator. The mortar shall be applied to match the existing surface and refuse material should not be used again unless mixed with additional quantity of polymer.

No bonding coat is needed if the 2<sup>nd</sup> layer of mortar is applied within 4 hours. Curing shall be done by sprinkling after 48 hours. No direct splashing of water shall be permitted.

<b>27. APPROVED MAKE LIST</b>		
<b>Sr. No.</b>	<b>DESCRIPTION</b>	<b>APPROVED MAKES</b>
1	Cement	BIRLA, AMBUJA , ULTRATECH. L & T,ACC
2	Reinforcement Steel (Fe 500 grade)	TATA, SAIL,VIZAG, RINL
3	Structural Steel	TATA ,SAIL, JINDAL
4	Ready Mix Concrete Suppliers	ACC, ULTRATECH,LAFARGE, GODREJ
5	For Repair works	Fosroc,Sunanda, BSF, Krishna conchem or Equivalent as approved by Engg. - In- charge.
6	Paint (All type)	Asian/Nerolac/Berger

7	FRP Manhole cover with frame	Everlast/Fibrocast
8	NP 2 Class Hume Pipe	Locally available (Vishwa/Bharat/Indian pipes/Arihant)
9	CPVC pipes	Astral/Crilce/Supreme
10	Anchor fastener	Hilti/Fisher
11	Ladder type cable tray	Sudhir switchgears/Profab/Indiana
<b>Note :</b>	<b>Brand deviation if any, needs to be tested for cement, steel and structural steel prior to using it for construction</b>	

**SECTION- III**

**MECHANICAL WORKS**

**Definitions and Interpretation.**

. **“Definitions”** In the contract (as herein after defined) the following words and expressions shall have the meaning hereby assigned to them except where the context otherwise Requires:-

- (a) **"Employer/Client"** means Mazagon Dock Shipbuilders Limited (MDL) of Dockyard road, Mazagon, Mumbai-400 010
- (b) **"Engineer"** means HOD or any other person appointed from time to time by the Employer notified in writing to the Contractor to act as an Engineer for the purpose of the contract.
- (c) **“Bidder”** means the person or person’s firm or company whose Tender-bid has been received by the employer and includes the bidder’s personal representatives, successors and permitted assignees.
- (d) **“Contractor / Supplier”** means the person or persons firm or company who’s Tender-bid has been accepted by the employer and includes the contractor's personal representatives, Successors and permitted assignees.
- (e) **“Works”** means the works to be executed in accordance with the contract and includes materials, apparatus, equipment, plant, fittings, and things of all kinds (other than Construction plant) to be provided and work to be done by the contractor under this contract and all temporary works of every kind required for the execution completion or maintenance of the works.
- (f) “Supplier Furnished Materials (SFM) / Items”: **“Items”** means the materials, apparatus, Equipment, fittings and other things for incorporation of the works.
- (g) **“Contract / Order”** means the contract effected by the contractor's Tender - bid and the Employer's acceptance thereof comprising (in addition to the Tender and the acceptance) the Priced bill of quantities and schedules, schedules of particulars (if any) Specification and Drawings, these general conditions of contract and any special or particular conditions of Contract or attached to any of the foregoing documents, all of which shall be deemed to embody any alteration agreed in writing between the parties before the formal acceptance of The Tender.
- (h) **“Contract Price”** means the sum named in the Tender subject to such additions thereto or Deductions therefrom as may be made under the provisions herewith after contained.
- (i) **“Constructional Plant”** means all appliances or things of whatsoever nature required for the execution, completion or maintenance of the works or Temporary Works (as hereafter defined) but does not include materials or other things intended to form or forming part of the Permanent work.

## **1) SPECIFICATION & CONDITION FOR PIPING WORKS**

### **A. General**

The contractor is expected to visit the site to get himself acquainted with prevailing site conditions i.e. availability of water, power, approach road etc before quoting the Tender. The contractor shall be entirely responsible for provision of all such utilities. No delay shall be entertained on this account.

Measurement of pipeline shall be taken in running meter up to second decimal place for actual pipeline laid at site. Gate valves, strainers, filters etc. would not be included for measurement of pipeline.

No extra charges for pipeline fabrication wastage will be entertained apart from the basic pipeline fabrication charges. If any wastage occurs expenses shall be completely borne by the contractor.

Metal Scrape of the contractor shall be checked and verified by Engineer –In – Charge, then alone can be dispatched outside the MDL premises.

The above ground pipeline will pass through Steel Structure / Brick Wall / Civil Pedestal / Ground mounted steel supports etc at places. The contractor will dismantle the required portion of the brick wall / structure for passing the line and also will make good the damaged surface of the brick wall / structure to its original conditions. Necessary pipe sleeve, if required shall also be provided by the contractor without any extra cost.

Contractor shall send one spool piece in each pipe lot to NABL/ Approved Lab for Chemical & Mechanical Testing. Cost of this Testing shall be borne by contractor only. Testing Report copy shall be submitted to the Client/Consultant for their reference & record purpose.

### **B. Inspection**

Engineer-in-Charge or his authorized representative shall have free access at all reasonable times to inspect those parts at the manufacturer's works which are connected to the fabrication of the steel work and shall be provided with all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with the provision of this contract.

Inspection shall be made at the place of manufacture prior to dispatch of the fittings. The inspection shall be conducted so as not to interfere unnecessarily with the operation of work.

Defects of any kind in supplied material, its fabrication, erection, testing & commissioning, shall be made good by the contractor, within reasonable time.

The suitability and capacity of all plants & equipments used for erection shall be to the satisfaction of the engineer.

### **C. Piping Works:**

#### **1. Working Drawings:**

- a. Drawings accompanying the Tender document are indicative for scope of work and



issued for Tendering purpose only.

- b. However the contractor is required to prepare the drawings for the complete piping work with its isometric view etc. To calculate the actual requirement of various items / fittings like bends flanges etc. The complete set of drawings shall be submitted by Contractor for approval, before commencement of the work. No fabrication will start without the approval of CONSULTANT / CLIENT. The construction drawings shall include the following:
1. General arrangement drawings.
  2. Location of all weld seams, weld sizes and details of weld with joint number.
  3. Material to be used.
  4. Welding procedures.
  5. Edge preparation and method employed.
  6. Tolerances as per IS Standards.
  7. Quality, brand and gauge of electrodes to be used.
  8. Details of welding reinforcement
  9. Details of brackets for supporting pipes, platforms, etc.
  10. Any correction or modifications suggested by CONSULTANT / CLIENT while approving the drawings.
- c. The drawings shall be prepared on the computer and hard copy of 3 sets of A2 size as well as one CD of such in-built drawings shall be submitted after completion of work. All drawings are to be prepared on the AutoCAD (on PC).

## 2. Fabrications:

Bends, reducers, expanders, tees and end blinds etc. provided should be factory made & forged irrespective of diameter of pipeline. Such fittings shall have same material composition as that of pipeline under fabrication.

## 3. Erection:

- a. **Cleaning:** Before erection, all pre-fabricated spool pieces, pipe-fittings etc. shall be cleaned inside and outside by suitable means. The cleaning process shall include removal of 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 before use.
- b. **Flange Connections:** While fitting up matching flanges, care shall be exercised to properly align the pipes and to check the flanges for genuineness, so that faces of the flanges can be pulled together without inducing any stresses in the pipes and equipments nozzles.
- c. **Valves:** Valves shall be installed with spindle, Wheel, actuators orientation / position or shown in the layout drawings.
- d. **Saddle plate on pipes near pedestals:** The saddle plate shall be provided on the pipe near pedestal location. The drawing shall be released at the time of construction.
- e. **Laying:** The laying of the Pipeline should be such that longitudinal seal weld of pipeline should be kept at top position i.e. alternate pipes shall be welded by keeping weld seam at 10 O Clock & 2 O" clock position.

## 4. Pipe supports:

Pipe supports are designed to effectively sustain the weight and thermal effects of the

pipng system and also to prevent its vibrations. Location and design of pipe supports shall be as per the following table.

Nominal pipe size in mm.	Maximum span in M.
080 mm	3.60 m
100 mm	4.25 m
150 mm	5.15 m
200 mm	5.75 m
250 mm	6.70 m
300 mm	7.00 m
350 mm	7.50 m

The above spacing is only indicative and shall be kept as per site requirements (min. of above). The minimum clearance of 300 mm has to be maintained between the ground and the bottom surface of pipeline. All pipeline supports will be numbered serially for identification.

#### **D. Welding Requirements in Pipeline Fabrication**

##### **i. Welding Responsibility:**

The contractor is responsible for the welding done by the welders employed by him. Engineer-In-Charge shall witness the tests required to qualify welding procedures and to qualify the welders and if, necessary re-qualify welders and welding operators. Testing is to be offered by the contractor at his own cost. Such test weld pieces tested at NABL approved labs are sent further for Mechanical & Chemical Testing.

##### **ii. Welding of Pipelines:**

The welding of pipelines shall be as per API -1104.

##### **iii. Welding Qualification:**

**Qualification requirement:** Qualification of the welding procedures to be used and the performance of welders and welding operators shall conform to the requirements of the ASME Section IX.

##### **iv. Procedure qualification:**

- a. Consultant / Client are responsible for qualifying any welding procedure that will be used. Welding procedures qualified by others may be used, subject to the specific approval of the Engineer-in-Charge / Inspector provided that the following conditions are met.
  - i) The proposed Welding Procedure Specification (WPS) has to be prepared, qualified and executed by responsible, recognized organization with expertise in the field of welding.
  - ii) The Contractor is expected not to make any change in the welding procedure.
- b. The contractor should accept written responsibility for both i.e. the Welding Procedure Specifications (WPS) and the Procedure Qualification Record (PQR).
- c. The contractor is required to have least currently employed welder or welding operator, who have met with the following requirements

- i. While in employment, the welder has satisfactorily passed a performance qualification test using the procedure and the P-Number material specified in the WPS.
- ii. The performance bend test required by ASME Section IX QW-302 shall be used for this purpose

**v. Performance qualification:**

- a. Consultant / Client may accept a performance qualification made by government certified agencies.
- b. The Contractor shall obtain a copy from the government certified agencies of the performance qualification test record & submit the same to Engineer-In-Charge with specific recommendation & approval of Inspector with the following details.
  1. The name of the agency.
  2. The name of the welder or welding operator.
  3. The procedure identification.
  4. The date of successful qualification.

**vi. Qualification record:**

The Contractor shall maintain a self-certified record, available to the Engineer-In-Charge. The records will have the following details: a) the procedure used. b) The welders and welding operators employed showing the date and results of procedure and performance qualifications c) the identification symbol assigned to each welder and welding operator.

**vii. Welding materials**

**Filler metal:** Filler metal shall conform to the requirements of ASME Section IX, filler metal, not yet incorporated in ASME Section IX may be used with CONSULTANT/CLIENT approval, if a procedure qualification test is first successfully made. Test Certificate of all electrodes /filler metals is to be submitted by contractor before taking up job.

**viii. Cleaning**

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

**ix. End preparation:**

- a. End preparation is acceptable only if the surface is reasonably smooth and true, and slack from oxygen or arc cutting is cleaned from thermally cut surfaces.
- b. Discoloration that is left over on a thermally cut surface is not considered detrimental to oxidation.
- c. End preparation, for groove welds specified in ASME or as specified, which meets the WPS is acceptable.
- d. Edge preparation - The pipes supplied are generally with bevelled ends. However, in case any ends are damaged the cutting/ bevelling shall be carried out.

**x. Welders identification symbol:**

Each qualified welder and welding operator shall be assigned as an identification

symbol. Unless otherwise specified in the engineering design, each weld or adjacent area shall be marked with the identification symbol of the welder or welding operator. In addition to marking the weld, appropriate records shall be maintained such as joint number etc.

**xi. Tack welds:**

- a. Tack welds at the root of the joint shall be made with filler equivalent to that are to be used in the root pass.
- b. Tack welds shall be made by a qualified welder or welding operator.
- c. Tack welds shall be used with the root pass weld, except for those, which have cracked, shall be removed. Bridge tacks (above the weld) shall be removed.
- d. Tack welds used in assembling shall be removed and surface is to be grinded properly and gaps filled with weld metal.

**xii. Peening:**

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

**xiii. Climatic conditions:**

- a. No welding shall be done if there is impingement on the weld area, of rain, snow, sleet or excessive wind or if the weld area is frosted or wet.
- b. Electrodes for welding shall be stored in a dry place (HOT CASE) in their original packets or cartons.

**Xiii. Fillet & socket welds:**

Fillet welds, including socket welds, may vary from convex to concave. The size of fillet weld shall be as per engineering design.

**E. Testing Of Piping System:**

1. Testing of piping after erection shall be done as per API-1104 and as specified in the price bid.
2. With the exclusion of instrumentation, piping systems fabricated or assembled in the shop/factories shall be tested at the site, irrespective of whether or not they have been pressure tested prior to site welding or fabrication.
3. A Pneumatic test is at 1.1 times of Design Pressure and shall be maintained for a period of minimum 30 mins or time required for checking complete loop through specified procedure, whichever is more. A Hydro test at 1.5 times of Design Pressure shall be maintained for a period of minimum 30 mins or time required for checking complete loop through specified procedure whichever is more.

4. All tests shall be completed to the satisfaction of consultant/client engineer including retesting if any leakage is noticed during testing and same shall be recorded accordingly.
5. The consultant engineer shall be notified in advance by the contractor of testing sequence/ program, to enable him to be present for witnessing the test.
6. All equipments, materials, consumables, calibrated instruments testing media and services required for carrying out the pressure testing of piping system shall be provided by the contractor at his own cost.
7. Test records in triplicate shall be prepared and submitted by the contractor for each piping system line wise for the pressure test done in the proforma as approved by site engineer.
8. Contractor shall offer the testing to client/consultant only after successful testing is confirmed at their end.

#### **F. Dismantling of Existing Pipeline:**

**The scope of work for contractor** shall be to Remove/Dismantle existing Pipeline including hydrant/ valves, other fittings etc. Contractor shall dismantle existing compressed Air & Fire-fighting pipeline in MDL yards as per Technical specs/ Tender drawings, Work Instruction, under the supervision of concerned engineer. After dismantling, contractor shall carry out the **following steps for segregation/storage**.

- 1) Remove/ dismantle existing pipeline of Compressed Air & Fire-fighting along with Hydrant/valves, other fittings etc.
- 2) Measure the diameter & length of pipes and mark details on pipe with date of dismantled.
- 3) Check the pipe for reusability, if it is reusable then mark the pipe with white paint strip ring. If it is not reusable then mark the pipe with black paint strip ring.
- 4) After bifurcation of pipes, contractor shall transport the pipe up to the bins, Bins marked as USEFUL bin & NOT USEFUL bin. Contractor shall check the condition of Bins & once they are filled then inform to concerned MDL executive. **For more reference see attached Algorithm chart.**

#### **Dismantling of Existing Piping :-**

Dismantling of existing piping ,valves ,flanges ,Instruments ,Gauges etc.(all sizes, all materials & thickness) and providing all necessary consumables, manpower tools &tackles, lifting equipments, scaffolding at all elevations, salvaging of usable piping items for reuse or to return to owner's storage point, returning of the waste material to owner's storage point, cleaning the work site from all unserviceable materials for disposal to spoil heaps anywhere inside plant boundary as specified/instructed by owner's/engineer-in-charge.

#### **G. DOCUMENTS TO BE SUBMITTED BY CONTRACTOR: (Four copies each)**

1. Welder's qualification test report as per IS-817.
2. Manufacturer's Test certificate for Electrodes and all material such as pipes, fittings, valves, flanges, gaskets, hardware etc all complete as required for completion of the system as per scope of work.
3. Flushing reports.
4. Pipeline quantity certificates for product piping system as per the pipelines laid.
5. Contractor shall be submitted Shop drawing of pipe routing with sizing & length, area & shop-wise for Approval.
6. On completion of work, as built drawings of complete piping system are to be prepared

and furnished by the contractor as required by CONSULTANT / CLIENT all drawings are to be prepared on Auto-Cad (on PC). The contractor shall submit two CDs containing all drawings, one set of tracing and 3 sets of drawings/ printouts in A2 size duly laminated.

7. Pipeline elevation profile for the entire route of pipeline & any other records as required by the site engineer.

## **2) SPECIFICATION & CONDITION FOR FIRE FIGHTING PIPING WORKS**

### **General:**

Fire safety in building has become a very important consideration in construction and maintenance. A normal office building has fire load in the form of large quantities of papers and furnishing. Buildings like Hospitals, Laboratories, Auditorium, Libraries, and Museum etc. require fire safety provisions by virtue of their type of occupancy and importance, irrespective of their height. The design and installation of a fire-fighting system is of utmost importance. The fire fighting installation on completion will have to be got cleared from the local fire fighting authorities (Fire Service) for its efficacy, suitability and usability by the Fire Service in the event of a fire.

Following types of water base, fixed fire fighting installations are normally provided in buildings:

Wet Riser  
Down Comer  
Automatic Sprinkler

The design of fire fighting system for a building shall be based as per the provisions in National Building Code of India (Part IV) (Amended up to date) and also considering the provisions in the Development Control Rules of local body/authority.

The operating pressure of individual hydrant shall be between 7 kg/cm<sup>2</sup> to 3.5.kg/cm<sup>2</sup> and the operating pressure of the farthest level hydrant from main pump shall be minimum 3.5 kg/cm<sup>2</sup>

The pipeline will be designed in such a way that it should be possible to get discharge of specified pressure at any location.

### **Special Instruction for Fire fighting contractor:**

The Fire fighting contractor should have valid license from **Directorate of Maharashtra Fire Services** as per Maharashtra Fire Prevention and Life Safety Act 2006 in relation to:

a) Fire fighting system installation such as Hydrant, Sprinkler, Pumping etc.

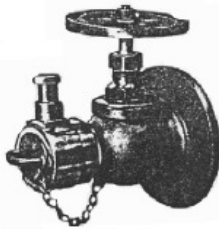
The category of license should be A / B or C class.

On completion of the fire fighting installation, the contractor should issue "Form B".

**Special Instruction for Fire fighting Pipeline replacement inside the Pump House near By Kasara Wet Basin:**

- 1) Inside the pump house there is Total 6 FF pumps, of them only 4 pumps are in working condition. 3 have electrical pumps & 1 Diesel pump.
- 2) Contractor's scope of work for that, to replace & install new suction & discharge line of all 4 pumps including all accessories i.e. Reducer, strainer, Tee, Bends, Motor & Manual operated Valves, flanges, gaskets, Bolts/Nuts/Washer etc. Some of location pressure gauges are also required or any other pressure switches are required for the same as per Tender BOQ/ Tender drawings/Concerned Engineer-In-charge.

**Hydrant Valves (Landing Valves)**



Wheel Valve Pattern

**Note: Attached Hydrant valve sketch only for reference purpose.**

**Specification No. (FF-VL/HV)**

**Scope:**

Supplying and installing gun metal single outlet, hydrant valve, **Wheel Valve pattern (Straight flow)**, conforming to IS: 5290, ISI mark, with PVC blank cap and S.S chain with electroplate in an approved manner.

**Material:**

**Valve Body, bonnet, stop valve, Check nut, female outlet:** Bronze alloy

**Lug:** Pull out type, horizontal mounted (2 No's lugs)

**Hand Wheel:** M.S. or C.I. (Black painted)

**Spring:** Made of phosphor wire

**Washer, Gasket:** Rubber

**Blank Cap:** PVC

**Method of Construction:**

The hydrant valve shall be connected with provided flange, gaskets, Nut bolts etc. with use of required tools and tackles and as per Tender drawings.

The water discharge shall be not less than 900 lpm for single head and 1800 lpm for double head valves at 7kg/cm<sup>2</sup>

**Mode of Measurement:**

Executed quantity shall be measured on number basis.

**Air Release Valve/Drain Valve**

**Specification No.** (FF-FFA/ARV/DV)

**Scope:**

Supplying and erecting Air release/Drain valve of 20/25mm  $\phi$  made from G.M. with necessary G.I. coupling for fixing on top of piping system or on specific area as shown in drawings.

**Material:**

**Air release/Drain Valve:** Gun metal

**Coupling:** G.I.

**Method of Construction:**

Air release/Drain Valve with necessary GI coupling shall be fixed on top of piping system or on specific area as shown in drawings.

**Mode of Measurement:**

Executed quantity shall be measured on number basis.



**SECTION- IV**

**SPECIFICATION**  
**FOR**  
**INTERNAL COATING OF PIPES CARRYING**  
**RAW / SEA / BRACKISH WATER**

### 1.0 Bidder Qualification:

Bidder should give a notarized declaration regarding the name of coating manufacturer & coating applicator (to be engaged by them for internal coating as per Table 1.1: SPECIFICATION FOR INTERNAL COATING OF PIPES CARRYING RAW / SEA / BRACKISH WATER of this Tender doc.) along with documents pertaining to coating manufacturer & applicator in compliance to their credential to meet the below mentioned Tender requirement:

- a. Coating manufacturer should have their own glass flake coating manufacturing facility in India. Factory license and / any other relevant documents to substantiate as a proof of manufacturing facility of glass flake coating in India, to be enclosed with the unpriced bid.
- b. Coating manufacturer should have minimum 10 years of experience in glass flake coating manufacturing & application work.
- c. Coating manufacturer & applicator should submit at least one performance certificate for satisfactory working of pipeline internal coating for minimum 15 years in India.
- d. Coating manufacturer should submit notarized document regarding the availability of machinery and other facilities, mainly Rotoblast and Boroscope etc. as per Table 1.1: SPECIFICATION FOR INTERNAL COATING OF PIPES CARRYING RAW / SEA / BRACKISH WATER of this Tender document.
- e. Coating manufacturer to submit test certificates from independent reputed laboratory towards the Tender test values as mentioned in this specification.

### 2.0 Coating Material

Coating materials complying with following specifications shall be used

**Table 1.1**

Sr. No.	Equip ment to be coated	MOC	Coating Specification		Coating Properties			Coating Thickne ss
			Surface Prep.	Coating Descripti on	Test	Test Method	Value	
1	Interna l surface of pipes handli ng raw/se a/ brackis h water	Mild Steel	Abrasiv e Blast cleanin g to SSPC SP 10 / SA 2.5 Standar d	2 - Pack Cold Cured Isophthali c Polyester Acrylic Co Polymer Glass Flake Filled Coating <b>(Kirloskar Corrocoat make or equivalen t)</b>	Water Vapour Permeabil ity	ASTM-D-1653-72	Less than 0.2 gm/m <sup>2</sup> /day /mm	1000 microns +/-200 microns
				Adhesive Strength	ASTM-D-4541	More than 80 Kg/cm <sup>2</sup> Cohesive Failure		
				Tensile Strength	ASTM-D-638-90	More than 20 N/mm <sup>2</sup>		
				Abrasion Resistanc e	ASTM-D-4060-90	Less than 350 mg loss, 1000 gm / 1000 cycles / H		

						18 wheel	
					Cathodic Disbondment	G 8	Less than 0.1 mmr
					Holiday Test		8kv DC current 1000 microns

### **3.0 Atmospheric Condition Requirements**

This section deals with the atmospheric condition requirements to be checked while doing the job.

1. Blasting or Coating shall not be carried out if the following conditions prevail.
  - A. When temperature of the surface to be coated is less than 3°C above the dew point, or the relative humidity is higher than 85%.
  - B. When the base metal temperature is greater than 60°C.
  - C. When the atmospheric temperature is below 4°C
  - D. When there is likelihood of an unfavourable change in the weather condition within 2 hours after coating.
  - E. When there is deposition of moisture in the form of rain or condensation.
2. Humidity shall be calculated using whirling hygrometer whose thermometers should have valid calibration certificate.
3. Surface temperature shall be measured using steel temperature gauge.
4. Record shall be maintained throughout the execution period. Readings shall be taken at the final stages of blasting & during coating application process. The frequency of reading should be increased during adverse weather conditions by 10 %.

#### **3.1.0 Preliminary Check Requirements**

This section deals with the preliminary check requirements to be done while doing the job.

##### **3.1.1 Chloride Contamination Test**

The 2% Ferricyanide paper method shall be used to determine the chloride contamination.

##### **3.1.2 Abrasive Dryness Check**

The abrasive to be used shall be checked for dryness by taking a small quantity of abrasive on a filter/tissue paper and checking for traces of moisture absorbed in the filter/tissue paper. The test shall be conducted before starting of blasting once in a day.

##### **3.1.3 Compressed Air Dryness Check**

Compressed air to be used for blasting shall be free from oil & moisture and it shall be tested adopting "Blotter Test". A piece of blasting paper shall be held in front of the blast hose nozzle to check for traces of oil / moisture captured by the blotting paper.

#### **4.0 Surface Preparation**

This section deals with the methods & requirements of surface preparation before coating application.

##### **4.1.0 Masking**

1. Ensure that areas not being coated are fully and adequately masked.
2. Ensure that stud holes dowel holes oil ways etc. are suitably masked or plugged to prevent ingress of blasting abrasives.

##### **4.2.0 Surface Preparation Methods for Metallic Surfaces**

The various methods of surface preparation and location application are tabulated below for internal coating:

<b>Internal Coating</b>	
For pipes up to 8" dia	Manual blasting
For pipes 10" to 24" dia	Rotoblast
For pipes 24" dia and above	Manual blasting.
For spot repairs	Preferred is vacuum blast; If it is not available, protect surrounding area suitably before blasting
Elbows	Angular nozzle

##### **4.3.0 Blasting**

Blasting should be done as per methods stated in the above table.

Copper slag blasting shall be carried out. Before this operation, removal of existing coating, if any shall be done by chipping, grinding and by other suitable means.

Clean & dry Copper Slag for ferrous base substrate.

While using a rotoblast as guideline, on time passes for effective blasting can be as given below. However this may change depending upon substrate conditions. The blast profile after one & two passes to be checked at site to standardize the speed of blast by inspector. As a thumb rule guideline for each pipe to be blasted shall undergo 3 passes with rotoblast. Each pass shall proceed at a speed of minimum 2.5 minutes per meter of pipe.

The minimum recommended compressed air required for blasting is about 250 cfm minimum and 6 kg/cm<sup>2</sup> pressure or more. The blast pot shall be fitted with a pressure guage to indicate the pressure.

On completion of blasting inside small bore pipes, blasting quality shall be inspected using a boroscope as stated in section 6.2.0

Clean the blasted surface with dry compressed air/vacuum cleaner or with clean brush so that there is no presence of dust, grit and other foreign material.

When cleanliness and blast profile are acceptable, record in the In-process inspection register and release component for coating.

After blasting mask the area adjacent to the area is to be coated.

If the blasted surface has not been primed within the specified time (if required) or if there is any previous visible sign of blast condition change, then the surface shall be checked for metallic salt contamination and re-blast of the surface.

Where large areas are required to be blasted in a day, blasting shall be carried out from morning to evening ensuring weather condition. This shall be followed by a light sweep blast of the entire area, before priming.

The blast cleaned surface shall be blown-off with dry oil-free compressed air or vacuum cleaned.

A cello tape shall be thoroughly pasted to the cleaned surface. The tape shall be removed after a minute to check presence of dust if any.

The blast profile shall be checked by Keane Tator comparator.

The following time intervals are permitted before priming:

Humidity	Time lapse between blasting & coating(maximum)
Less than 60%	4 hours
60% to 75%	3 hours
75% to 85%	2 hours

If in a certain condition time lapse is not been maintained the blasted surface shall be sweep blasted before application of first coat.

#### **4.4.0 Surface Preparation for Field Joints/Welded joints**

**Surface preparation and Painting of Joints from inside the pipes on site after welding of pipes shall be as follows:**

1. Any old coating if present in the joint area shall be removed by grinding /mechanical means. This shall be followed by abrasive blasting of the exposed steel surface to Sa 2.5 & surface roughness profile of 50-75 microns.

<b>Pipe Diameter</b>	<b>Max. Pipe Length</b>	<b>Welded / Flanged</b>	<b>Joints between two pipes / spools</b>	<b>Surface Cleaning</b>	<b>Coating method</b>
3 to 4 inches	> 1 m	Flanged	NA	NA	NA
3 to 4 inches	6 m	Flanged	NA	NA	NA
3 to 4 inches	12 m	Flanged	NA	NA	NA
6 to 8 inches	12 m	Flanged	NA	NA	NA
10 to 16 inches	12 m	Welded	1	Rotoblast	Pipe Sprayer
10 to 16 inches	24 m	Flanged	NA	NA	NA
10 to 16 inches	48 m	Flanged	NA	NA	NA
18 to 20 inches	12 m	Welded	1	Manual Blasting	Brush Application
18 to 20 inches	24 m	Welded	2	Manual Blasting	Brush Application
18 to 20 inches	48 m	Flanged	NA	NA	NA
24 to 32 inches	12 m	Welded	1	Manual Blasting	Brush Application
36 inches and above	12 m	Welded	1	Manual Blasting	Airless Spray / Brush Application

2. Sweep Blasting shall be done on the old good coating adjacent to the exposed steel surface near the joint area. Such sweep blasting shall be done to a width of 1” over the old good coating.

3. Above surface preparation shall also be checked using a Boroscope

4. Overlap area: The overlap area of the repaired coating shall extend minimum 1” wide over the old good coated surface on both sides of the joint.

5. The old lining near joint areas shall be checked thoroughly for possible delamination. The blast surface shall be thoroughly cleaned using dry compressor air before proceeding with further work.

6. Coating shall be carried out as per section 5.0.0 of this technical specification.

7. Method for surface cleaning and coating for internal pipe joint is to be followed as mentioned below:

### **5.0 Coating Application**

This section deals with the methods & requirements of coating application.

The batch no. of each and every Painting material supplied shall be recorded on Daily Progress report of

Painting, which is to be duly verified by TPI.

### 5.1.0 Application Methods

The various application methods used for internal coating work shall be as follows:

<b>Internal Coating</b>	
For pipes of 3" to 4 " & above 1m length	Pipe spinning
For pipes of 3" to 4 " dia and less than 1m length and all small length spools	Brush application
For pipes from 6" to 32" dia	Pipe sprayer
For pipes above 36" dia	Airless spray

### 5.2.0 Mixing

1. All coating material tins shall be individually stirred thoroughly to obtain a homogenous consistency.
2. While doing spray application, the paint tins –which come in pre-measured kits, shall be fully mixed individually using a pneumatic stirrer. While doing Brush application only small batches of 1 KG capacity shall be taken. Here the mixing shall be done by using a metal spatula.
3. The mixing ratios as specified in the respective data sheet shall be strictly adhered to. The base shall be weighed out in Kilogram using a mechanical weighing machine calibrated at site using any standard factory packed commercial product available freely in the market. The catalyst shall be measured out in ML using marked syringes or measuring cylinders.

### 5.3.0 Application Process

1. The preparation and application of coating shall be done as per relevant product data sheet. Reference shall be made to product data sheet or where appropriate with the contract specifications for carrying out coating.
2. Coating in confined spaces should be done when the ambient temperature is low to avoid excess build-up of styrene fumes.
3. The entire thickness shall be built in multiple coats.
4. Each coat shall consist of minimum two passes wet on wet in perpendicular directions.
5. The spray applicator shall be provided with a disposable overall respiratory mask. All other people working with the paint shall be provided with eye splash goggles and masks.
6. The spray equipment shall be earthed properly to enable discharge of static build-up.
7. Minimum & maximum inter-coat intervals as given in the data sheet shall be strictly followed.

8. All weld joints wherever possible and phase transition joints shall receive a striped coat by brush using the coating material

**Airless spray pump should be of following specifications;**

**Air input – Max 6 Bar, 150 – 175 CFM**

**Output – Max. 450 Bar**

#### **5.4.0 Curing & Finish**

1. **Curing:** The initial cure and final cure shall be as given in respective product data sheets. The initial cure time shall come down with increase in ambient temperature. The initial cure time is judged by touching the coated surface with a gloved hand. Total tack freeness shall indicate initial cure releasing the coated component for further processing activities like, final coats, grinding, buffing cleaning, DFT & holiday testing etc.
2. The final cure has relevance to taking the coated component into service. Hence, irrespective of ambient temperatures the final cure period in terms of days as given in product data sheet shall be adhered to.

#### **5.5.0 Coating Application – Repairs**

Repair of coating defects found during application or during inspection after application.

##### **5.5.1 Testing and inspection - In process**

1. Testing of coatings is normally carried out as soon as they are sufficiently cured to give true thickness & to withstand damage by the test equipment. If defects are found repair shall be carried out.
2. In all instances the first step is to identify the extent of the defect. Local repairs to minor defects are permissible. The need for large-scale repairs indicates either an error in method of application which must be first identified and dealt with by supervision or product/application problems which must be investigated by a site supervisor / applicator.

##### **5.5.2 Repairs to coating**

1. Repairs should be done within 3 days of previous coat at normal temperatures. If outside this time-scale local blasting is required to ensure a good repair.
2. Dress out defects by mechanical means to have a clean surface.
3. If over coating is to be done within 7 days (but outside over coating time) then the surface must be prepared by sweep blasting.
4. If the exposed / damaged surface is less than 10 cm<sup>2</sup> then such repair can be carried out without blasting.
5. Any area in excess of this amount should be grit blasted using a vacuum blaster where possible. In case of damage area less than 10 cm<sup>2</sup> then it can be repaired thus.
6. De-contaminate surrounding area by using a suitable solvent such as Methylated spirit, Acetone, Xylene etc. after washing clean & allow solvent to evaporate.
7. Roughen up exposed metal & clean using rotary wire brush or a coarse emery paper with at least a 60 grade grit. Brush away residues then further roughen surface of the



existing coating up to 100 mm out from the damaged area. Brush away residues & ensure the whole area is clean.

8. Apply a thin coat of coating material to the surface of the exposed metal only taking care not to cover more than a few millimetres of the existing coating. Allow this freshly applied material to become tack-free.
9. Brush styrene monomer over the whole surface to be repaired (i.e. the whole area roughened by emery) & allow to evaporate from the surface.
10. Apply at least 2 main coats of coating material over the treated area taking care not to brush on to any roughened or contaminated areas. The coating should be allowed to harden sufficiently to bear the weight of next coat before application of further coats. However it does not need to be tack-free between coats. The thickness of the coating repairs should be in accordance with the same thickness as the original coating & it should be borne in mind that a cure period shall be required before putting the product into service, usually a minimum of 4 hours.

## **6.0      Inspection And Testing**

### **6.1.0      Chloride Salt Contamination Test**

Blasted surfaces shall be tested for chloride contamination by the 2% ferricyanide paper method. Testing frequency shall be one pipe per day.

### **6.2.0      Surface Profile Inspection**

- 6.2.1      Surface preparation shall be checked by a digital profile gauge, where possible.
- 6.2.2      Acceptable blasting finish is Swedish standard Sa2.5 with roughness profile of 50-75 microns.
- 6.2.3      In areas where dft measurement is not possible a boroscope shall be used to record an image of the blasted pipe.
- 6.2.4      The image shall be compared against a standard reference image created at site on a steel plate placed inside the pipe and abrasive blasted.
- 6.2.5      The blast profile in the test plate shall be checked in accordance with the required norms.

### **6.3.0      Dry Film Thickness Inspection**

- 6.3.1      The dry film thickness of the coated surface shall be checked using a digital film thickness gauge.
- 6.3.2      The DFT Meter shall be calibrated against a calibrated foil of known thickness.
- 6.3.4      The number of readings shall be in accordance with SSPC Pa 2

### **6.4.0      Holiday Test**

- 6.4.1      The coated surface shall be tested for holidays using a suitable DC holiday

testers

6.4.2 Holiday test voltages shall be as follows :  
For pipe internal coating: 8 KV DC current for 1mm DFT;

6.4.3 100% of coated surface shall be holiday tested.

### **6.5.0 Visual Inspection**

The internal coated surface shall be inspected visually using a boroscope for any gross imperfections if any.

## **3) SPECIFICATION & CONDITION FOR MECHANICAL WORKS**

### **1. Introduction**

This specification is intended to cover the technical requirements for the execution of Equipments & allied piping pre-fabrication; assembly, erection, alignment, testing, inspection and commissioning of the entire piping system.

All codes referred shall be the latest editions. The contractor shall bear the cost of repair, changes replacement etc due to non-compliance with the standards, codes and this Tender or due to disregard of the instructions given by the consultant/clients.

### **2. Scope**

The work contemplated under this contract includes piping work for the aforesaid Project, all as detailed in the Bill of Quantities, Specifications / Data Sheets and Drawings.

Notwithstanding the above, the CLIENTs reserve the right to order additional works under the same contract. The CLIENTs also reserves the right to omit or reduce any item of work included in the aforesaid Bill of Quantities and award the same to any other contractor or not perform it at all, at their discretion and the contractor shall not have any claim on the same.

The contractor for this work shall be required to work in co-operation and co-ordination with other contractors may be working at site and give them all reasonable assistance and help for the execution of the subject work in an efficient manner as directed. The words "Approved" or "As Directed" shall be deemed to convey approval or the directions of CLIENT. However, approval of any kind doesn't absolve the contractor from his obligation to pertain the work as per contractual requirement & responsibility of executing the work as per contract shall remain with contractor.

### **The scope of work of the contractor is described below:**

- Storage, Fabrication and Installation of all piping systems in accordance with material specification and applicable drawings & standards.
- Applying one coat of yellow zinc chromate, else otherwise defined primer on all installed piping & steel structures.
- Fabrication and erection of supporting fixtures & structures & pipe supports.
- Fabrication and erection of all drain piping and vent piping assembly, instrument tapping piping up to isolation valve, still if not mentioned in drawings.

- Testing, Flushing, Drying & Cleaning of Installed system& commissioning as instructed by Engineer-In-Charge.
- The Piping shall include all Fittings, Flanges, Gaskets, and bolting, valves etc, as per required in-site / drawing / specification or instructed by engineer.

- **Details of Painting:**

- a) **For GI Pipe** - One Coat of ETCH Primer (DFT -6 micron) + One Coat of Zinc Phosphate Epoxy Primer or Equivalent (DFT 40-50 micron). Zinc Rich Primer on Weld Joint Surface in place of ETCH Primer (DFT -75-120 micron) + Top coat of PU (DFT -100-150 micron).on full piping.

Colour coding of Compressed Air Pipeline as per **IS2379:1990 clause no 7.5 and 9.1**.  
Colour of Compressed Air Pipeline should be **Sky Blue**.

- b) **For FF Pipes-Outside Piping Painting shall be done as per following procedure:**

- a) Surface preparation and sand blasting (40 - 60 micron) +
- b) Apply one Primer Coat of Inorganic zinc silicate coating (DFT 50 - 70 micron) +
- c) Two Intermediate coats of High Build Epoxy (DFT 100-150 micron per coat) +
- d) Final coat of aliphatic acrylic PU paint (DFT 60 - 80 micron).

Colour coding of Fire fighting Pipeline as per **IS2379:1990 clause no 7.5 and 9.1**.  
Colour of Fire fighting Pipeline should be **Fire Red**.

- c) **For Air-Receiver** – Zinc Rich Primer (DFT 50-75 micron) + One Coat of Zinc Phosphate Epoxy Primer or equivalent (DFT 40-50 micron) + Top coat of PU (DFT 100-125 microns).

Contractor shall be arranging the necessary tools for checking DFT of equipment at site without charge/ any extra cost. (Paint DFT meter / Elecometer etc.)

- d) Applying one coat of '**yellow zinc chromate**' primer on all steel structures and final one coat epoxy painted.

All piping systems shall be fabricated, installed, flushed, and tested in accordance with specification and applicable codes/drawings. Any deviation from the specification and drawing shall be permitted only after obtaining the written approval of the Engineer-in-charge. Any discrepancy found between documents, shall be cleared before any application.

### **3. General Notes on Works**

The complete installation of piping works consists of accomplishing of all jobs here in enumerated including provision of all labour, tools and tackles, equipments, all materials and consumable such as welding electrodes, bolts and nuts, argon, oxygen and acetylene gases, oils for cleaning, lubricant for bolting etc. of approved quality as per relevant code. The work shall be executed according to the drawings, specifications & relevant codes etc. in an expeditious and workman like manner, as detailed in the standard practices and to the complete satisfaction of Engineer-In-Charge.

#### **3.1 Mobilization & set up**

Contractor shall mobilize all his set-up within pre-defined time. Site Office shall be established as per instructions given by Engineer-In-Charge. Erection of site office along with all required material, equipments, ancillary, consumables such as printer cartridge, papers etc. To be arranged by contractor & cost towards the same shall be borne by contractor.

### **3.2 Store**

Receipt and storing of materials, when supplied by the contractor shall satisfy the following requirements.

- Upon receipt of material at site, as & when it happens, contractor has to inspect it for suitability as per requirement and also the same should be immediately offered for inspection to client/ consultant via official communication. No material can be used without inspection by Client/ consultant.
- All materials must be marked for identification and should be accompanied by Manufacturer's test certificates conforming to all requirements.
- Materials with defects of any kind exceeding the allowable tolerances specified in relevant standards shall be rejected at no cost of the Owner.
- All materials shall be checked, sorted out, straightened and arranged by grades and qualities in their temporary store at site.
- Notwithstanding the test certificates, Site Engineer may ask for the materials to be tested as per relevant codes for satisfaction of quality of supplied materials. The Site Engineer will reject the materials if found unsatisfactory and the cost of such tests shall be borne by the contractor.
- All the fabricated and delivered items shall be suitably packed to be protected from any damages during transportation and handling. Any damage caused at any time shall be made good by the contractor at his cost.
- Any defective material used shall be replaced by the contractor at his own expense, care being taken to prevent any damage to any piping materials.
- Till handover, the custody of the materials belongs to the vendors.

### **3.3 Fabrication of Piping**

#### **a. Pre-fabrication**

The intent of pre-fabrication at the shop is to accelerate progress of pipe work and to minimize work in the field.

The contractor shall fabricate all piping work in conformity with the requirements of applicable general arrangement drawings and specifications. Where specific details of fabrication are not indicated in the drawings or not specified, herein fabrication and erection shall be done in accordance with the code for Process Piping ASME B 31.3 latest edition.

The contractor shall be held responsible for working to the exact dimensions as shown on the approved execution drawings (submitted by contractor) irrespective of individual permissible tolerance limits. In case of any errors found, it is contractor's responsibility to notify the Engineer-in-charge prior to fabrication or erection.

#### **b. Joints-Fit Up & Welding**

All pipes shall have ends bevelled for 2" & above and plain end 1.5" & below for welding. The fit-up of joints for welding shall be made properly and carefully using line-up clamps, with a uniform root spacing to facilitate the production of sound welds and to avoid misalignment. Tack welds may be used to hold the edge to weld in line.

Welded branch connections shall be used as indicated on the drawings. The centreline of the branch shall intersect the centreline of the header. All cuts shall be carefully bevelled and accurately matched to form a good V to permit full penetration of weld at all points. All welding shall be done in accordance with the welding specifications. For bevel end fit ups ASME B16.25 shall be followed.

**c. Joint Alignment**

The pipes, to be joined by welding shall be aligned correcting the existing tolerance on diameters, wall thickness and out of roundness. The same alignment shall be preserved during welding. For the internal misalignment due to difference in wall thickness, the component with higher wall thickness shall be internally machined/grind as per standards so that adjoining surfaces are approximately flushed. Until mentioned as otherwise in the drawings, valve stems shall be installed in vertical directions and shall not be installed with stems below the horizontal.

**d. Layout and Cutting of Pipes**

- a) For laying out headers, tees, laterals and other irregular details, cutting templates shall be used to ensure accurate cutting and proper fit up.
- b) All cutting shall follow the outline of the templates.
- c) Machine-cut levels to form the welding groove are preferred in carbon steel pipe. However, smooth, clean, slag-free, flame cut bevels are acceptable.
- d) Tack welds with full penetration shall be used and shall become the part of the finished weld. Defective welds with lack of penetration are not acceptable and shall be chipped/grounded out.
- e) No temporary weld attachment shall be with the extended clamps/attachment.
- f) All flanges facing shall be true and perpendicular to the axis of the pipe to which they are attached. Flanges bolt holes shall straddle the normal centrelines unless different orientation is shown in drawings to match the equipment connections etc.

**f. Cleaning of Piping**

- a) On completion of fabrication, all pipes and fittings shall be cleaned inside by suitable means (mechanical cleaning tool, wire brush, etc.) before erection to ensure that assembly is free from all loose foreign materials such as scale, stand, weld, spatter, particles, cutting chips etc.
- b) All field fabricated piping shall also be cleaned at the conclusion of the fabrication. All bars, welding circles and weld spatter shall be removed by any suitable means (mechanical tools, wire brush etc.).
- c) Both shop and field shall be blown out with compressed air at the termination of cleaning and capped.
- d) Cleaning requirements for special services, if any, shall be as specified in the piping, material specifications.

**g. Spool storage**

All fabricated spools shall be stored in the spool yard; all spools shall be handled & placed in such way that no metal to metal destructive / denting rubbing shall be there. Flange Part & Bevel End Part of spool shall be placed with care. They may be positioned with / on wood sleeves.

**3.4 Welding Works**

This specification covers field and shop welding for carbon steel piping system in particular, following types of joints bends branch connection, valves etc.

- a) Butt welds, between pipes, flanges, bends branch connection, valves etc.
- b) Fillet welds for junction of slip on flanges and socket weld fittings, reinforcing pads etc.

The following standard and procedure shall be applicable:

- a) Standard for welding pipes and related facilities - ANSI B 31.3 latest edition.

b) Code of procedure for manual metal arc welding of mild steel - IS: 823 latest edition (for structural work only) In case of any variation between the provision of the codes and the specification given below, the later will prevail.

### **Welding Requirements:**

All welds joining two sections of pipe, a section of pipes to a fitting or fittings shall be performed employing qualified welding procedure and welders in accordance to the given specification.

a) Before welding, the ends shall be cleaned by wire brushing, filing or grinding. Each weld-run shall be cleaned of slag before the next run is deposited.

b) Welding shall be done by certified welders only.

c) Welding at any joint shall be completed uninterrupted.

d) Welding shall done by manual shielded metal arc process. Automatic or semi-automatic welding processes may be done only with the specific approval of Engineer-in-charge.

e) Socket weld joint shall be done with low hydrogen type covered electrodes with manual shielded metal arc process.

f) As far as possible welding shall be carried out in flat position. If not possible, welding shall be done in position as close to flat position as possible.

g) Downward technique is not allowed.

h) A wire spacer of proper diameter may be used for the weld root opening but must be removed after tack welding and before applying root pass.

i) As a rule backing ring shall be used for circumferential butt welds.

j) Tack welding for the alignment of pipe joints shall be done only by qualified welders. Since tack welds form part of final welding, they shall be executed carefully and shall be free from defects. Defective welds shall be removed prior to the welding of joints. Electrodes size for tack welding shall be selected depending upon the root opening.

Tack should be equally spaced as follows:

- For 65 mm NB and smaller pipes: 2 tacks

- For 80 mm NB to 300 mm NB pipes: 4 tacks

k) Root run shall be made with respective electrodes/filler wires. The size of the electrodes shall not be greater (12 SWG) and should preferably be 2.64 mm (12 SWG). Welding shall be done with direct current values recommended by the electrodes manufacturers.

l) Upward technique shall be adopted for welding pipes to horizontally fixed position. For pipes with wall thickness less than 3 mm oxyacetylene welding is recommended.

m) On completion of each run craters, weld irregularities, slag etc. shall be removed by grinding or chipping.

n) During the process of welding, all movements, shocks, vibration or stresses shall be carefully avoided in order to prevent weld cracks.

o) Fillet weld shall be made by shielded metal arc process regardless of thickness and class of piping. Electrodes size shall not exceed 10 SWG (3.25mm). At least two runs shall be made on socket weld joints.

p) **Compressed Air pipeline welding:** Before welding surface is to be prepared by Buffing wheel to remove galvanized coating, for root run, vendor may use E 6010 or "TIG" welding. For final root and fill up contractor may choose TIG or E7018 as per approved WPS. After the welding Epoxy colter primer is to be applied on the joint.

q) **Fire fighting Pipeline welding** electrode shall be used **E 6010/E 6013** or approved By Client/Consultant.

### **Welding Procedure Qualification:**

Welding procedure qualification for all piping shall be as per the latest edition of Standard for welding pipelines and related facilities, ASME-Section - IX. It shall be the responsibility of contractor to arrange and carry out such tests at his own cost.

### **Welder's Qualification:**

Welder qualification for all piping shall be in accordance with ASME Sec.IX. Owner's inspector shall witness the test and certify the qualification of each welder. Welders approved by the Owner's Inspector only shall be employed. It shall be the responsibility of the contractor to carry out the qualification test of the welders at his own cost at the job site. All the tools, tackles and auxiliaries required for carrying out welder's test shall be supplied by the contractor at his own cost.

### **Preparation of Work Pieces:**

#### End Preparation

Preparation of ends to be welded will be made properly.

#### Cleaning

The ends to be welded shall be properly cleaned. All paint, oil, grease rust and oxide in general shall be removed, as well as all earth, sand or any other material which could be harmful to the welding. Ends shall be totally dry when welded. No dirt or debris will be permitted in the pipelines.

#### Alignment and Spacing

Piece to be welded shall be aligned and spaced in a suitable manner, so as to hold the ends during welding at distance to ensure full penetration. For pipe with thickness 4 mm or larger, the pieces to be butt welded shall be coupled by means of pipe couplers or by yokes or Bridge 'C' clamps.

### **Welding Technique for Root Pass:**

#### For Butt Joints

The root pass of butt joints, regardless of the technique used shall be such as to achieve full penetration. After the welding is started and until the joint has been completed, misplacements, shocks vibration or stresses shall be avoided in order to prevent cracks or breaks in the welds. On completion of the root pass, any visual defect or irregularities shall be grounded off to avoid defects or irregularities in the next pass.

### **Joint Completion:**

- a) Upward technique shall generally be used for pipe in horizontal and vertical position.
- b) When the welding is complete, butt joints shall have a cover pass. Welds shall have a regular appearance and shall be free from defects.

**DP Test:** 10% of weld joints to be DP tested size-wise.

### **Radiography:**

10% of the shop joints and 10% of the field joints are to be radio-graphically tested size-wise. However all joints in the buried/Underground pipeline shall be 100% radiographic.

### **Welding Inspection & Acceptance Standards:**

1. Use of electrodes: Only reputed electrodes like Adani / ESSAB should be used for carrying out welding.
2. Root and final run for Butt-welds, Nozzle welds, Structural attachment weld, Hanger, Support welds, socket welds etc. shall be checked with -100 % Visual

examination.

3. Visual check-up includes - Base metal identification, Base metal defects rectification, Edge preparation, Joint -Fit-up checking for both longitudinal and circumferential welding, Check of pipe -dia., Cleanliness, Tacking, Root pass & subsequent pass appearance, Cleaning between the passes, Completed weld appearance, Condition of the base metal in the area adjoining the welds, Excessive distortion if any, due to welding.

4. DP examination Procedure shall be as per Pr. Vessel code. However it includes Check for any crack or linear indication, porosity, or slag inclusion.

5. Radiography for pipe 25 mm and above, selection of the location and dia. of the pipe and sample size shall be at the discretion of quality supervisor from Purchaser. If a joint or weld length is acceptable, the remaining length by the same welder or group length shall be acceptable. In case of rejection two more lengths from the same lot / group shall be examined at the discretion of quality supervisor from the Purchaser. If weld joints are found defective after second radiography examination, all the remaining group joints shall be rejected. Welds with the crack, slag inclusions, cavity and incomplete fusion shall be rejected.

10% of butt welded joints of above ground Pipeline.

100% of butt welded of underground pipeline before buried.

7. Repair of Welds: Welds shall be repaired by additional welding in case of dimensional problem, but new weld joints are to be done for deficient quality. Cracks can be removed by grinding, chipping, arc or flame gouging with DP test.

The contractor shall also demonstrate the proper operation of all controls, instruments, and other equipment.

### **3.5 Installation of Above Ground Piping**

All piping shall be grounded and located as shown in piping drawings keeping in view piping specifications. No deviations from the arrangement shown shall be permitted without the written consent of the Engineer-in-charge.

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 equipment nozzles. The bolt holes of flanges in the vertical plane shall straddle the vertical centreline of the pipe in the erected position and for flanges in the horizontal plane, the bolt holes shall straddle plant north-south axis unless otherwise indicated in the drawings.

a) Flanged connections at the compressors shall be made in such a way as not to induce any stressed due to misalignment, making gap etc. The final tightening shall be done when the machines/equipments are aligned completely and specifically authorized by the Engineer-in-charge.

b) Temporary protective covers shall be provided at all flanges connections of compressors and other

Similar equipment until the piping is finally connected.

c) After the piping is erected in final position, it shall be cleaned, tested for tightness and kept dry, as described in the specifications.

d) The valve spindle positions shall be at accessible location. The Contractor shall however bring it to the notice of the Engineer-in-charge, in case he encounters any difficulties by them.

e) All valve stems shall be installed in a vertical direction.

### **3.6 Installation of Under Ground Piping**



The ends of the pipes shall be kept securely closed to prevent entry of any foreign Material / moisture after lowering into the trench.  
 Before making joints the pipe shall be carefully laid, so as to be perfectly aligned in both plan and profile and the end closures provided shall be removed.  
 Free access shall be provided for the welding of the circumferential joints.  
 There should be no obstruction to the welder from any side so that good welded joint is obtained.

Manually with stiff wire bruised and scrapped where necessary Pipe coat primer should be applied immediately after the cleaning of pipes. The entire pipe length shall be cleaned & coated but the ends of the pipe shall be left without coating and wrapping for a distance of 230 mm for joints which shall be coated and wrapped manually at site after laying, welding and testing of pipes.  
 The corrosion protection coating for buried pipes shall consist of coating and wrapping with anti-corrosive pipe coat made of Polymer bitumen/Polyethylene layer/Polyester layer.

#### Primer Coating

Pipe coat primer shall be solvent based rubber modified bituminous primer of density 0.92 gm/cu cm and viscosity of 500 to 1000 cps applied at 150 gms per Sq.M. Pipe coat shall be applied by brushing so as to produce effecting bond between metal and subsequently coating of pipe coat membrane. The drying time shall be not less than 24 hours.

#### Wrapping

Pipe coat membrane (wrapping) material shall consist of three layers of high molecular high density polyethylene, three layers of polymerized bitumen and one layer of polyesters (total seven layers). The same shall be applied under tension by heating the inner surface of the Membrane by means of a blow torch, melting the lower most polyethylene layer and softening the bitumen taking care that the centre course is not overheated and pressing the molten bituminous surface onto pipe, so that no air is entrapped or voids found. The resultant coating shall be free of air & voids. The resultant coating shall be free from all bubbles, wrinkles, irregularities, and discontinuities.

#### **Backing Material:**

- (a) Non-woven synthetic/FRP Tissue paper
- (b) Coating: Bituminous Rubber
- (c) Total tape thickness: Min 4 mm
- (d) Holiday Test: 10 KV
- (e) Resistance to lateral growth: No growth
- (f) Cathodic disbandment: No disbandment
- (g) Standard specification: IS: 10221

### **3.7 Installation of Equipments**

#### **TYPE OF EQUIPMENTS**

The type of equipment covered in this specification includes but is not limited to the following:

**Air Receivers/Unfired Pressure vessel.**

#### **Pre-erection activities**

The contractor shall be responsible for checking levels and orientation plan of all foundations, diameter, length and disposition of anchor bolts in accordance with the supplier's booklet and literature for installation, well in advance of taking up the actual erection of machinery. Contractor shall carry out minor rectification such as chipping of surface of foundation etc., where necessary. After completion of the pre-erection work to the satisfaction of the Engineer-in-charge, the contractor shall start erection of Machinery on foundation.

Final alignment, as specified by the manufacturers, shall be carried out after all piping connections are made. Tolerances specified by the manufacturers shall be adhered to.

### **3.8 Testing & Inspection**

#### **General**

The intent of this specification is to provide a basis and guide for carrying out field & other testing of piping to assure best quality & acceptable criteria of installed piping. Chemical composition and mechanical properties shall be checked as per relevant material specification, for each lot. QAP (Quality Assurance Plan) shall be provided & could be approved by consultants prior to start of the work. Manufacturer / Supplier shall give reasonable notice and provide without charges reasonable access and facilities required for inspection, to Consultant's Representatives. Inspection and tests performed / witnessed by Consultants Representatives shall in no way relieve the manufacturer's obligation to perform the required inspection and tests. Inspection by consultants shall in no way absolve the supplier of his responsibility of including technical requirements and specifications.

All pipes and their dimensions, tolerance, chemical composition, physical properties, heat treatment, hydro test and other testing and marking shall conform to the codes and standards specified in the requisition. Deviations, if any, shall be clearly highlighted in the offer.

Owner's inspector shall have free access in all places, where the work is being done or any other thing and place concerned with the work.

Owner is entitled to send his own inspector to field or shops where pre-fabricated erection of pipe lines is being done, with the following functions but is not limited to:

- i) Check that the welding performance and welding equipment used on the job are suitable and conform to relevant standards.
- ii) Supervise welding procedure qualification.
- iii) Supervise welder performance qualification.
- iv) Check whether welding is conforming to relevant specification and the practice followed is in accordance with good pipeline construction practice.
- v) Check any other performance to ensure quality of work.

Contractor shall notify sufficiently in advance the commencement of qualification tests, welding work and acceptance tests, to enable the Owner's inspector to supervise the same.

Contractor shall provide the Owner's Inspector with all facilities necessary for carrying out his work at no extra cost to the owner. Approval from the Owner's Inspector shall not relieve the contractor partially or fully of his responsibilities and guarantees under this contract.

All equipments, materials, consumable and services mentioned below but are not limited in requirement to carry out pressure testing of piping to be provided by the contractor at his cost, Pump sets for pressurization, air compressor, Hoses, Solvents for DPT etc.

Defects, if any, noticed during testing shall be rectified immediately by the contractor at his own cost.

**Special Note: Contractor shall arrange Third party/ competent Authority (Competent Authority approved from MDL only) for Inspection of Equipment (i.e. Air receiver/Pressure Vessel) after installation in MDL premises. Cost of Inspection and other cost if any, shall be borne by the contractor only. Contractor is full responsible for applying and obtaining the necessary approval/certificate from statutory body/TPI.**

### **Mechanical Clearance**

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

- i) Installation of Correct materials as per specification.
- ii) Correct installation of line (in accordance with the approved drawings).
- iii) Correct installation of guides and supports.
- iv) Proper installation of (temporary) blind discs to be employed during testing.
- v) The correct application of pre-established pressure.
- vi) Sectioning of the line in correspondence with those materials and/or equipment which are not a part of the test.

### **Testing system:**

#### **Hydro Testing**

The minimum hydrostatic test pressure shall be as indicated in the specification. The test procedure shall be adopted as given in ANNEXURE - 04

Depending upon the above requirements and based on construction progress, maximum length of piping shall be included in each test.

Though the piping can be tested in segment as per site progress, contractor shall offer testing of complete piping at once as single loop before handing over.

Also after hydro test, contractor shall be responsible for clearing the piping of all the water used for testing. No water shall remain at any point before handing over.

During the testing (Hydro/Pneumatic) of piping valve installed in the system shall be tested to ensuring that valve flaps, discs etc. experience testing pressure as directed by Client / Consultant.

#### **Pneumatic Testing**

The minimum Pneumatic test pressure shall be as indicated in the specification. The test procedure shall be adopted as per given in ANNEXURE - 05

Depending upon the above requirements and based on construction progress, maximum length of piping shall be included in each test.

Though the piping can be tested in segment as per site progress, contractor shall offer testing of complete piping at once as loop before single handing over.

**Compressed Air Pipeline shall be subjected to Pneumatic/Hydraulic Test as per requirement of statutory body/ Laws as may be applicable.**

#### **Dye Penetration Test**

The location of this test shall be on all piping – butt weld root joints or as instructed by Site-in-charge. The test procedure shall be adopted as per instructions given by client/consultant's representatives

#### **Radiography Test**

The Radiography scope for all pipe Weld Joints shall be applicable as indicated in the specification. Contractor shall arrange the access with surface preparation on selected joints. If any defect is found, the Repair and Re Radiography Cost will be owned by the contractor; the test procedure shall be adopted as per instructions given by client/consultant's representatives.

### 3.9 Structural Steel Works

This specification covers the supply, fabrication, and erection of piping supports as per drawing or as instructed by site-in-charge.

i) Fabrication and erection of supporting elements i.e. shoes, Clamps, clips, cradles, Support guides and anchors for piping shall be done as shown in the drawings. No Anchors on piping shall be used except at locations shown in the drawings. The pipe shall be secured firmly at anchor supports.

ii) Fabrication and erection of supporting elements and structural fixtures wherever required and pointed out by the Engineer-in-charge, whether that is in the drawing or not, to prevent vibration and / or providing Access etc. shall be carried out by the contractor. No separate payment will be made for erection of these additional supports and it will be deemed as part of piping erection work.

Providing corrosion protection painting on installed structural steel shall be as per IS – 180-1967(Scheme2)

#### Materials:

Piping Material specification shall be as per given in ANNEXURE – 02

Valves & Other Special Part Materials shall be as per given in ANNEXURE - 03

#### Documents:

##### Reference Working Documents

Latest Edition of the standards shall be referred

Construction/Fabrication/Machining work shall be carried out in accordance with the following working reference documents:-

Approved drawings, sketches and specifications issued **BY CONSULTANT**.

Approved drawings and sketches issued **BY EQUIPMENTS SUPPLIERS**.

Approved Process & instrumentation diagram **BY CLIENT**.

Drawings, sketches, Procedure specifications and documents prepared by contractor duly approved **BY ENGINEER-IN-CHARGE**

**CONSULTANT** specifications / documents are as below:

1. General Piping Layout/General arrangement drawing
2. Set of typical Isometrics / general requirement
3. Piping Materials Specification(PMS)
4. Valve Material Specification / Data sheets
5. Piping support standards.
6. Standard Specification for Pressure Testing
7. Bill of Quantity
8. Any other specifications or special condition of contract.

All the piping rates will be quoted with supply of necessary elbows, tees, Nipple, coupling, U clamps, Gaskets, Nut Bolts and Washers. BOQ has been specified in Tender.

This Bill of quantities is to be read in conjunction with P&ID/Piping Layout/Isometric Enclosed herewith.

**Handing Over Documents (Hod):**

After successful testing and commissioning of the equipment along with accessories in total as desired by the Architect/Consultants/PM/CLIENT. Contractor shall submit four sets of handing over documents neatly bound to incorporate standards along with two soft copies in CD.

The following are to be included in the HOD:

1. List of suppliers
2. As built-in Drawings
3. Approvals/Documents from CLIENT/Consultant.
4. Test Readings/ Reports. (Full testing and commissioning record)/ certificates from Vendor/ supplier/ manufacturer.
5. Installation and commissioning Reports.
6. Warranties/ Guarantees of equipments.
7. Emergency operation details.
8. Test Certificates of all supplied materials with proper correlation with purchase order items
9. Site-Test Report / Certificate for all fabrication / installation
10. Valves & Equipment Operation & Maintenance manual

#### **4.0 Work execution Methodology**

Fire fighting pipelines shall be internally coated by Polymer, provided by various polymeric coaters. For this, contractor has to procure Bare pipes and get them coated in their / coater's shop, before unloading to site. And for compressed air pipe line, Fabrication is advised to be in contractor's workshop.

#### **Fabrication of Piping**

##### **Checklist for Pre-Fabrication of Piping**

1. Approval of Method Statement, Quality Plan/ ITP
2. Approval of WPS covering all the material specifications.
3. Welder qualification list review and approval.
4. All the required Engineering drawings and documents latest revisions.
5. All personnel and procedures for NDT are approved.
6. Spool drawings marking field and shop weld joints shall be prepared, numbered and reviewed.
7. All tools, equipment and temporary items like pipe stands; pipe clamps etc. are ready in sufficient quantities.
8. Consumables shall arrange in sufficient quantities as per the WPS.
9. Welding data base set up prior start of welding activities.

##### **Isometric Mark-Up**

1. All lines shall be clearly marked to easily identify the flow direction, service, pipeline identification number, size, class and specification.
2. The line diagram shall include weld location, weld numbers, tie point location, piece numbers and weld type, including: Field weld, shop Weld, tie point, butt joint, socket joint, fillet weld.
3. Straight run of pipe shall contain the minimum number of welds.
4. Piping butt welds shall be spaced a minimum of 50 mm or four times the thinnest wall thickness measuring between the heat affected zones, whichever is greatest.
5. Care shall be taken to ensure that the longitudinal welds clear branch connections.
6. Length, height and width of the spools shall be within the limits of road transport and erection possibility in MDL site, unless specifically requested.

##### **Cutting and Beveling**

1. All pipes and fittings shall be cleaned before pre-fabrication by air blowing.
2. Proper Safety procedure shall follow before starting the job
3. Marking should be done as per Isometric spool number measurement.
4. Cutting of pipes, fittings and edge preparation as per the drawing and WPS.
5. Based on spool breakdown of piping isometrics, pipe length shall be cut. Extra length for pipe shall be provided in spools for field adjustment.
6. The edges to be welded shall be prepared to meet the joint design requirements by any of the following method recommended:  
Gas cutting, Machining or grinding methods shall be used. After gas cutting, oxides shall be smoothed / removed by chipping and grinding.

##### **Fit- Up and Track Welding**

1. Fit-up assembly and joint alignment shall be carried out, by using couplers or clamps. All the required pipe holding work benches, assembling brackets, 'U' bolts etc. would be made to suit the pipe sizes.
2. For butt welds a uniform root gap shall be maintained as per WPS.

3. For all socket weld joints the pipe end shall be free from cutting burrs, the axial gap between male and female component shall be maximum of 3 mm and minimum of 1.5mm.
4. Seam orientation of welded straight pipe and pipe to fittings shall be in such a way that, circumferential angle between seam is at an angle of 30°.
5. The pipes shall be tack-welded in equidistant positions to avoid cracking and bending or joint during welding. Tack weld shall be done by a qualified welder as per approved WPS.
6. In case of pipes with different thickness, the larger thickness shall be tapered in compliance with standard to match smaller thickness.
7. Line numbers, Sheet numbers, Spool numbers, material code and Joint numbers are to be clearly marked on the spools with the welder identification for each joint

#### **Branch Connections**

1. Branch connection requirements shall be in accordance with isometric drawings.
2. The lateral offset of branches and connections from the centreline of run shall not exceed  $\pm 1.6\text{mm}$ .
3. All cuts shall be carefully beveled and accurately matched to form a suitable preparation for welding and to permit full penetration of welds between the branch and the run pipe at all points.
4. Branch connections and other attachments including reinforcing pads shall not be welded over or near longitudinal or circumferential welds in the piping. The minimum distance from a longitudinal or circumferential weld to the next weld shall be 50mm measured between the heat affected zones.

#### **Flange Connections**

1. Unless otherwise indicated on the drawings, the bolt holes of all flanges shall be offset to vertical and horizontal centre lines. The maximum angular deviation of bolt holes shall not exceed 1.5mm measured across the bolt pitch circle.
2. The flange faces shall be square to the pipeline in which they are fitted.
3. Shop fabrication of flanged spool pieces for connection to existing pipe work, shall have the mating flange tack welded to the spool and an additional allowance of 100mm of pipe shall also be provided for the correct field fitment.

#### **Cleaning of Spools**

1. All pipes shall be internally cleaned by air blowing.
2. All pre-fabricated pipe spools shall be visually inspected for cleanliness, and shall have foreign material removed from the inside.
3. The piping ends shall be covered after inspection to prevent unauthorized removal of the end cover prior to making the joint to the succeeding section of piping.
4. During assembly and erection, the construction agency shall ensure that no foreign materials (such as welding consumables, ladders, gloves, etc.) are left inside the piping system.
5. After assembly and installation, the piping shall be cleaned inside to remove all loose material.

### **Erection of Above Ground Piping**

#### **Pre-erection Guidelines**

1. All lifting tools, Cranes, equipments and ropes used for erection shall be inspected and certified by HSE regulations. Activities shall be done according to the proper method statement for lifting and handling.
2. Pre-fabricated spools shall be shifted to site carefully; care shall be taken while handling and stacking of spools to prevent any possible damage.
3. Pre-Fabricated spools shall be identified by spool and line numbers before erection
4. Before erection of spools ensure for inside cleaning of the spools and their items.
5. The pre-fabricated supports shall be installed as per drawings, the pipe supports details shall be followed in the piping layout drawings and Isometric drawing for location and supports detail drawing.
6. All pipe openings shall be sealed before, during and after erection to prevent the ingress of moisture and foreign matter. Threaded ends shall be plugged and sealed by waterproof grease tape or purpose made plastic caps or plugs. End cap or cover shall be placed on the open valve ends.
7. Approved and safe scaffolding and temporary platforms shall be arranged to carry out erection, fit up and welding of field joints at elevated positions.

### **Piping Erection & Fit up guidelines.**

Following steps need to be checked during erection /fit up for any spool

1. Fit-up is acceptable; vertical lines are plumb; and horizontal lines are level, except where slope is indicated on the design drawings
2. Slopes are as indicated on isometrics drawings.
3. Pipe size, schedule and type of material are correct.
4. Flange ratings are as per specification
5. Routing and tie-ins of lines are in the correct location.
6. Correct type reducers (eccentric or concentric and correct schedule) are located and Orientated as per specification, standards.
7. Branch lines are located correctly on headers.
8. Tees, sock lets, weld lets are used as specified for branch connections.
9. Temporary supports provided, if required, to avoid.
10. Vents are installed at high points and drains at low points.
11. Vents and Drains installed/welded after hydro-testing as required by specifications.
13. Welding and NDT is in compliance with codes and specifications.
14. Pipe coating is protected from damage during all handling, transportation or installation  
Operation. Special care should be given to paint system which damage easily to prevent Scratching, marring or damage.
15. Piping is free of tape, wire, slings, chain falls and other installation tools and materials.
16. Verify internal pipe cleanliness and hand clean pipe during installation process.

### **Valves installation guide lines**

Following steps need to be checked during erection /fit up for any spool

1. Check, globe and control valves are installed with flow in correct direction as indicated on Isometric.
2. Manufacturer TC details must match with valve
3. Valves are accessible and operable and chain wheels or extensions are installed and operable, as required.
4. Control Valve Positioners and accessories are accessible.
5. Rising stem valves are free of obstructions and protectors are installed
6. Special packing's are installed as required and if repacking is required, a tagging or colour Code system is used to identify repacked valves



7. Drains or flushing connections to valve bodies are installed, accessible and operable, as Required
8. By-passes around valves are installed and operable, as required
9. Valves are internally clean
10. Temporary Supports provided, if required.
11. Valves have been tested and calibrated prior to installation, if specified

### **Bolts and studs**

1. Bolts and studs are not interchanged
2. Bolting is appropriate length, diameter, and material
3. Verify the thread pitch for 1 inch (25mm) and larger bolting materials
4. Thread lubricant is used if required.
5. All bolts or studs are installed and tight or torque/tensioned, as required. Studs have Minimum one threads past nuts and have equal projection beyond nuts per project Specifications (normal is 1-3 exposed threads), unless otherwise specified by project Specification)

### **Gaskets**

1. Gaskets are installed and are the correct type, style, material, size and rating
2. Specification changes at equipment block valves are carefully checked for correct gaskets
3. All gaskets on blind flanges are checked and verified
4. Temporary gaskets may be used at temporary blinds, and then line specification gaskets are Installed after pulling temporary blinds. Punch list should specify the right gasket. High Pressure ring gaskets should be verified oval or hex material as installed.

### **Pipe supports**

1. Line is supported properly. Drawings must be checked to confirm that major supports are installed; small lines are most often field supported
2. Remove all temporary supports - wire, wooden blocks, chain falls etc
3. Check all supports for conformance with support detail drawings or standards
4. Pipe supports are straight and plumb
5. Pad plates or supports are not tack welded where they should be able to slide
6. Base plates should be grouted to ground.
7. U-Bolts should be verified for compliance to the design details. Guides should have the proper gap while anchors are tightened per the design drawing.

### **Installation of Under Ground Piping**

The ends of the pipes shall be kept securely closed to prevent entry of any foreign Material / moisture after lowering into the trench. Before making joints the pipe shall be carefully laid so as to be perfectly aligned in both plan and profile and the end closures provided shall be removed. Free access shall be provided for the welding of the circumferential joints. There should be no obstruction to the welder from any side so that good welded joint is obtained. The pipeline shall be cleaned of all rust, grease, dirt, weld burs etc. It shall be scrubbed manually with stiff wire brushed and scrapped

where necessary. Pipe coat primer should be applied immediately after the cleaning of pipes. The entire pipe length shall be cleaned & coated.

### **Anti-Corrosive Protection on Under Ground Pipe:**

Corrosion protection tape shall be wrapped on Pipes to be buried in ground. This corrosion protection tape shall comprise of bituminous component supported on fabric of organic or inorganic fiber and minimum 4mm. thick and conform to requirement of IS: 10221-Code of practice for coating and wrapping of underground mild steel pipe line. Before application of corrosion protection tape all foreign matter on pipe shall be removed with the help of wire brush and suitable primer shall be applied over the pipe thereafter. The primer shall be allowed to dry until the solvent evaporates and the surface becomes tacky. Both primer and tape shall be furnished by the same manufacturer. Corrosion protection tape shall then be wound around the pipe in spiral fashion and bound completely to the pipe. There shall be no air pocket or bubble beneath the tape. Tape shall be overlap minimum 15mm to each spiral. Length 250m.m. shall be left uncoated on either end of pipe to permit installation and welding. This area shall be coated and wrapped after the pipe line is installed.

### **Structural Steel supports**

In open yards pipeline will be supported on steel structures sections, suitably clamped to avoid vibrations, operational movements.

Steel plates, rolled section ISA, ISMC, ISMB will be used for this. Before utilizing these sections Heat No., visual condition, material grade, material test certificates shall be documented.

in workshops, Pipeline will be supported on existing steel structure by suitable clamping, hanging supports, nut bolts; wherever pipe is to be supported on wall, anchor fastened steel plate with hanging bracket will be provided to support pipeline.

### **Welding works:**

SMAW welding method is adopted in this project .before starting the welding approved WPS, PQR shall be maintained. Only certified welders will be utilized in this project .welders certified by any government agencies can be utilized but welder qualification certificate should not be older than 6 months.

Frequency of Inspections for welding shall be according to approved QAP.

### **Purpose of WPS.**

A Welding Procedure Specification (WPS) is a written document that provides direction to the welder or Welding operator for making production welds in accordance with Code requirements.

The purpose for qualification of a WPS is to determine that the weldment proposed for construction is capable of providing the required properties for its intended application. Welding procedure qualification establishes the properties of the weldment, not the skill of the welder or welding operator.

Welding procedure qualification for all piping, shall as per the latest edition of Standard for welding pipelines and related facilities, ASME-Section - IX.

### **Purpose of PQR**

The Procedure Qualification Record (PQR) documents what occurred during welding of the test coupon and the results of testing of the coupon. As a minimum, the PQR shall document the essential variables specific information identified for each process used during welding the test coupon and the results of the required testing. In addition, when notch toughness testing (impact testing) is required for procedure qualification, the applicable supplementary essential variables for each process shall be recorded.

It is important to remember that ASME Section IX sets out the minimum requirements for compliance with the Code. It must be used in conjunction with the applicable Construction Code e.g. ASME B31.3, B31.1, B31.8.

### **Welder's Qualification**

All welders associated with work must be qualified .Welder qualification for all pipings shall be in accordance with ASME Sec.IX. Client/consultant shall witness the test and certify the qualification of each welder. Welders approved by the Client/consultant only shall be employed.

Each qualified welder and welding operator shall be assigned an identification symbol. Unless otherwise specified in the engineering design, each weld or adjacent area shall be marked with the identification symbol of the welder or welding operator. In addition to marking the weld, appropriate records shall be maintained.

### **Check Points Prior To Production Welding:**

1. Applicable QC documents are approved
2. Welding Procedure Specifications (WPS)
3. Welder Qualification Certificates & ID cards
4. NDT Procedures
5. Welding Consumable Control Procedure
6. Inspection & Test Plan
7. Quality Control Procedure for Main Line Welding

### **Production Check Points Prior to Welding:**

1. Piping material is fully traceable, pipes are strung at the correct locations e.g. road crossings.
2. Proper weather protection is in place prior to welding.
3. WPS is available at the job site.
4. Welders are qualified and have their ID cards with them.
5. Welding consumables, covered electrodes, solid wires and gas if applicable are correct.
6. Weld joint number is clearly identified adjacent to the weld joint.
7. Edge preparation and adjacent area both internally and externally is clean and free from burrs flame cutting scars.
8. Bevel angle and root gap is as specified on the WPS.
9. Proper pre-heat is applied prior to welding as specified on the WPS.

### **In Process Inspections:**

1. Correct number of welding rods is to be used for each pass as specified on the WPS.
2. Clamp whether internal or external is maintained until correct number of passes are complete.
3. Inter-pass cleaning is done correctly.
4. Correct diameter electrode is used for each layer as specified on the WPS.
5. Inter-pass temperature is correct.

6. Welding parameters are as specified on the WPS, volts, amps, travel speed, wire feed speed gas flow rates.
7. This should be done with calibrated equipment and may be done on a random basis or for every joint depending on the project requirement.
8. Weather protection is maintained until the joint is completed.

**Post Welding Inspections:**

1. Visual inspection of the joint for compliance with project specifications.
2. All welder numbers are clearly marked adjacent to the joint.
3. Daily weld report is correct and signed by the inspector.
4. Any NDT is requested and witnessed/reviewed as required by the QAP/ITP.
5. All QC documentation is maintained and retrievable for future reference.

**5 APPROVED BRAND/MAKES OF PIPING COMPONENTS & EQUIPMENTS:**

The following are the list of approved brands/makes of equipments & piping components required under this Tender.

Please note that wherever there is a multiple choice of brands/makes approved, any one make as nominated by the Client/Consultants will have to be supplied by the Contractor without any extra cost to the client. No deviation in this will be accepted by the owners.

In case any of the makes for any of the materials is missed out in the above list, then the contractor shall inform the Consultants about the same and obtain the approval. Thereafter, he can produce with the supply of the equipments.

**List of Approved Makes of Materials:**

**1. PRESSURE VESSELS AND SHOP- FABRICATED TANK / MANIFOLD.**

- M/S. G.R. ENGINEERNIG, MUMBAI
- M/S. S.V. TANKS AND VESSELS, MUMBAI
- M/S. R.D. ENGINEERING, MUMBAI
- M/S. MEXCEL ENGINEERING (I) PVT LTD., NAVI MUMBAI
- M/S. VISHAL TANK & STRUCTURALS, NAVI MUMBAI

**2. CS PLATES**

- M/S. TISCO, MUMBAI
- M/S. SAIL, DELHI
- M/S. JINDAL STEEL, MAHARASHTRA
- M/S. ESSAR STEEL, HAZIRA

**3. CS PIPE (SEAMLESS/WELDED)**

- M/S. JINDAL PIPES LIMITED
- M/S. TATA

**4. CS PIPE FITTING & FLANGE**

- M/S. CD INDUSTRIES, MUMBAI
- M/S. GAYATRI FORGE PVT LTD, MUMBAI

M/S. EBY INDUSTRIES, MUMBAI

M/S. AMFORGE INDUSTRIES LTD, PUNE

**5. GATE /GLOBE/NRV/BALL/BUTTERFLY VALVE UP TO “150NB”**

M/S. LEADER VALVES LTD

M/S. L&T / AUDCO LTD

**6. GATE /GLOBE/NRV/BALL/BUTTERFLY VALVE ABOVE “150NB”**

M/S. LEADER VALVES LTD

M/S. L&T / AUDCO LTD

M/S. NUTECH CONTROLS

**7. AIR RELEASE/DRAIN VALVE**

M/S. Leader Valves ltd.

M/S. Winco Valves Pvt. ltd

M/S. Brilliant Engineering works

**8. SINGLE HYDRANT VALVE**

M/s Newage

M/s Minimax

M/s. Essel

M/s Safex

M/s. HD Fire

**9. MOISTURE SEPERATOR WITH MECHANICAL AUTO DRAIN VALVE**

M/S HYDINT

M/S ATLUS CAPCO

**10. HOSE PIPE (STEAM/GAS/AIR/WATER/CHEMICAL)**

M/S. ROYAL INDIA CORPORATION

M/S. GAYATRI INDUSTRIES CORPORATION,

M/S. OM SHREE INDUSTRIES,

**11. PRESSURE GAUGE/ FLOW METER/AIR FILTER**

M/S. GENERAL INSTRUMENTS

M/S. H GURU

**12. MS STRUCTURAL STEEL**

M/S. TISCO

M/S. SAIL

M/S. RASHTRIYA ISPAT

M/S. JINDAL

**13. WELDING ELECTRODES**

M/S. ESAB

M/S. ADVANI ORKELONS

M/S. ADOR

**14. GASKETS (Non Asbestos)**

M/S. HINDUSTAN COMPOSITES  
M/S. CHAMPION  
M/S. KLINGER

**15. STUDS & NUTS**

M/S. PRECISION TAPS & DIES  
M/S. BHARAT ENGINEERING  
M/S. MEGA ENGG  
M/S. TATA STEEL

**16. WRAPPING COATING TAPE & ALLIED MATERIAL**

M/S. PIPE COATING  
M/S. I.W.L

**17. PAINT**

M/S. ASIAN PAINT, MUMBAI  
M/S. BERGER PAINT, KOLKATA  
M/S. JENSON NICHOLSON, MUMBAI  
M/S AKZO NOBEL COATINGS & SEALEANTS PVT. LTD. BANGALORE.  
M/S. JOTUN PAINTS, CHENNAI

**18. INTERNAL/EXTERNAL POLYMER RESIN COATING**

M/S. KIRLOSKAR CORRICOAT, PUNE

Note: **CLIENT/CONSULTANT** reserves the right to approve any other vendor, apart from those listed above, based on requirement and availability of materials, subject to it meeting the required parameters, after due testing. In case of approved makes not available in the market, so based on regret letter with justification from contractor the consultant might suggest other equivalents if needed based on merit.

**6.0 LIST OF STANDARDS****ASME Standards**

ASME B 16.5	Steel Pipe Flanges and Flanged Fittings
ASME B 16.9	Steel Wrought fittings
ASME B 16.10	Face-to-face and end-to-end dimensions
ASME B 16.11	Steel forged Pipe fittings
ASME B 16.20	Metallic Gasket for flanges
ASME B 16.21	Non-Metallic Gasket for flanges
ASME B 16.25	Butt Weld / Bevel End specification
ASME B 16.28	Short Radius Elbow specification
ASME B 16.34	Valve design
ASME B 36.10	Carbon Steel Pipes
ASME B18.2.1	For Stud Bolt Design
ASME B18.2.2	For Hexagonal Nut Design
ASME Sec. IX	Code for Welding Specification

**ASTM Standards**

ASTM A193	Stud bolts
ASTM A194	Nuts
ASTM A106	Carbon Steel Seamless pipe

ASTM A105	Carbon Steel Forgings fittings
ASTM A234	Carbon Steel Wrought fittings
ASTM A216	Carbon Steel Castings
ASTM A515	Carbon Steel Plates

**API Standards**

API 600	Casting Valve Design
API 602	Forged Valve Design
API 6D	Valve Design

**British Standards**

BS 5351	Ball Valve design
BS 3799	Swage Nipples

**Standards Practices**

MSS SP 95	For Swage Nipples
MSS SP 06	For Face Finish of Flanges

**Indian Standards (IS Codes)**

IS 1239 – Part I	For Carbon Steel Pipes
IS 1239 – Part II	For Carbon Steel Pipe Fittings
IS 10221	For wrapping coating of Carbon Steel Pipes
IS 2712	For Gaskets
IS 3757	For Nuts Bolts
IS 5369	For Washers
IS 778	For Brass / Bronze Valves
IS 12944	For anti-corrosion painting
IS 2379:1992	For Pipeline Painting
IS 2062	For Structural Steel
ASME Section IX	: ASME Boiler and Pressure Vessel Code – Welding and Brazing Qualifications
ASME Section V	: ASME Boiler and Pressure Vessel Code – Non-destructive Examination
ASME Section II Part C	: Specifications for Welding Rods, Electrodes and Filler

Metal

Maharashtra Factory Act 1963

**7.0 ABBREVIATIONS**

BW	:	Butt-Weld
FLGD	:	Flanged
SCRD	:	Screwed
SW	:	Socket Weld
WN	:	Weld Neck
SCH	:	Schedule in accordance with ANSI B 36.10 or B 36.19
FS	:	Forged Steel
SMLS	:	Seamless
WPS	:	Welding Procedure Specification
PQR	:	Procedure Qualification Record
BB OS Y:		Bolted Bonnet outside Screw with Yoke
SB IS	:	Screwed Bonnet inside Screw
NRV	:	Non-Return Valve
AARH	:	Average Arithmetic Roughness Height
CS	:	Carbon Steel
SS	:	Stainless Steel

**8. Technical notes for valves**

1. These notes shall be read in conjunction with valve specification sheet.
2. Bidder shall clearly write all/any deviation against each part /material of value in the space provided for  
Whenever bidder agrees with spec bidder shall indicate "agreed"
3. No cutting/Overwriting by bidder on spec is allowed.
4. Valves can also be supplied in accordance with API 6D. For API 6D valves, main body valve shall be  
as per ASME B 16.34
5. All ball valves shall be fire safe design. Fire safe test shall be as per API 607 (4<sup>th</sup> Edition)/BS6755 (Part-II).
6. Testing shall be as per BS 6755 Part-I/API6D.
7. All casting shall be solution heat treated.
8. For ball valve sizes 4" and above the ball, shall be trunion mounted and body shall be spring loaded.
9. All valves shall be bidirectional.
10. Floating ball valve shall be provided for with pressure equalization sheets to relieve the body-bonnet cavity  
pressure to the upstream side.
11. Bidder shall certify the suitability of valve for intended service condition.
12. Bidder to furnish details and type, grade and class of soft sheet material with manufacturers  
Recommendation like pressure temperature rating curve/table.
13. Stem seal/ body seal material shall be provided with corrosion inhibitor.
14. Valves shall have anti static feature.
15. Valve shall have anti blow out stem features.
16. Valve shall have 100 mm CS Pups at both ends to avoid the damage of seat during welding.



**Annexure-1****9. Procedure-cum-Check List for Hydro-Testing for Piping****A) Before Test**

- a) Make sure that No welding, grinding, glossing, final touch up or any other hot working is balance.
- b) All Flanges are duly tightened & Gasket is properly aligned on raised face between flanges
- c) Tightening activity shall be uniformly 180° sequencing way , with proper Spanner & under skilled Supervisory
- d) All Vents shall be properly welded with isolation valves fully open.
- e) All Drain Valves shall be well welded & Isolation Valves fully Closed
- f) Location of Pressure Gauges shall be minimum - 02 and at different locations & Elevation.
- g) Pressure Gauge shall have Isolation Valves and that will be fully be in open condition.
- h) Range of Pressure Gauge shall be max of 1.5 times of Test Pressure.
- i) Pressure Gauge shall be calibrated and Calibration Certificate shall be submitting to Consultant/Client before starting the test.
- j) Date of Calibration Certificate shall not be 6 Months before, from date of test.

**B) During Test**

- a) Water shall be filled, gradually to avoid any Air-Trap.
- b) Water shall be filled, till it comes out through overflow.
- c) Water shall be filled till all vents start releasing water.
- d) All vent for water release is to make sure that Line / Loop is not clogged/ choked up and free for Uniform pressure Built-up.
- e) After this all vents shall be closed by their isolation valve one by one.
- f) Water supply shall be stopped when pressure reaches at Test Pressure in any Pressure Gauge. Test Pressure shall be 1.5 times at Design pressure.
- g) Care shall be taken to avoid increase in pressure due to temperature variation during the test
- h) During holding time, Pressure Gauge reading shall be taken & recorded at uniform time interval.
- i) Whole Pipeline & vicinity area shall be observed for any water leakage.
- j) If no water leakage is found in all tested lines and there is no deviation in Pressure Gauge reading Till holding time, then pressure can be released.
- k) If any water leakage or deviation in level reading is found, then leakage area shall be Recognized and water shall be released and repeat the procedure after proper rectification.

**C) Releasing of Pressure**

- a) Water shall be released, gradually through drain.
- b) During draining, all vents shall be fully open to avoid any vacuum created.

**D) Completion of Test**

- a) Pressure test shall be considered completed only after approval by Engineer in-charge
- b) All procedures shall be documented & certified in format of Test Reports.
- c) Format for Test documents shall be provided by Consultant/Client.

**Annexure-2****Procedure-cum-Check List for Pneumatic Testing for Piping****A) Before Test**

- a) Make sure that all Flange Joints are duly tightened & Gasket is properly aligned on Raised Face between Flanges
- b) Tightening activity shall be uniformly 180° sequencing way, with proper Spanner & under skilled supervisory.
- c) All Vents shall be properly welded with isolation valve fully open.
- d) All Vents shall have 180° U pipe - opening towards ground to make sure any oil must not splash in vertically up direction at later stage...
- e) All Drain Valves shall be well-welded & Isolation Valve fully Closed
- f) Location of Pressure Gauges shall be minimum - 02 and at different location & Elevation.
- g) Pressure Gauge shall have Isolation Valve and that will be fully in open condition.
- h) Range of Pressure Gauge shall be max of 1.5 times of Test Pressure.
- i) Pressure Gauge shall be calibrated and Calibration Certificate shall be submitted to the Consultant/Client before starting the test.
- j) Date of Calibration Certificate shall not be more than 6 Months before from the date of test.
- k) Soap Solution for Bubble testing shall be ready in various bottles in ample amount.

**B) During Test**

- a) Compressor outlet shall be connected at any lowest point of loop, to be tested.
- b) Compressed air shall be filled till all vents start releasing air.
- c) All vents for air release is to make sure that Line / Loop is not clogged/ choked up and free for uniform
- d) Pressure Built-up. Pneumatic test pressure shall be 1.1 times at Design pressure.
- e) After this all vents shall be closed by their isolation valve one by one.
- f) Compressed air supply shall be stopped, when pressure reaches at test pressure in any pressure Gauge.
- g) Care shall be taken to avoid increase in pressure due to temperature variation during the test

**C) After disconnecting the supply, make sure that -**

- a) All Pressure Gauges show the same reading of Test Pressure
- b) There is no drop in pressure with respect to time till holding Time.
- c) All weld joints shall be poured gently with soap solution & shall be duly observed for the bubble if any.
- d) All flange joints also shall be poured gently with soap solution & shall be duly observed for the bubble if any.
- e) There is no bubble found in all tested joints and there is no deviation in Pressure Gauge reading till holding time,
- f) Then pressure can be released.

**D) Releasing of Pressure**

- a) This shall be done by opening vent valve very gradually & carefully
- b) All vents are to be open after pressure is released one by one.

**E) Completion of Test**

- a) Pressure tests shall be considered complete only after approval by Engineer-in-charge
- b) All procedures shall be documented & submitted with Pressure Gauge Calibration Report.
- c) Format for Test documents shall be provided by consultant/client.