UPGRADATION AND AUGMENTATION OF FIRE WATER SYSTEM AT VIZAG DT & CHERALAPALLY RT FOR VSPL NETWORKS

BID DOCUMENT FOR

COMPOSITE WORKS OF FIRE PROTECTION FOR VIZAG & CHERALAPALLY

OPEN DOMESTIC COMPETITIVE BIDDING

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TECHNICAL SPECIFICATIONS FOR FIRE PROTECTION WORKS
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1.0 Specifications for erection

1.1 Erection of Equipment

Major activities involved in erection, testing & commissioning are enumerated below. However, any other activity not mentioned but required for total work execution shall be included in the scope of work of the Tenderer.

Receiving of equipment/ material, unpacking, storage, transporting the same to respective erection site.

Safe custody of equipment/ material from time of receipt till these are installed and handed over.

Cleaning, flushing and lubricating equipment / material before assembly, erection and testing. Servicing, greasing, packing the supplied valves as required by MECON/HPCL

Checking of foundation levels, centre lines, orientation, locations etc.

Assembling, coupling, fitting, fixing, jointing, aligning various sections of equipment etc. by welding /bolting etc. as per the drawings.

Servicing of anchor bolts.

Supply and fabrication of liner plates, shim plates.

Installing the equipment on foundation /structures/ platforms / walls/ columns as the case may be in proper orientation.

Construction of civil pedestals for supporting the pipelines and construction of foundations for structural columns of pipe bridge

Fixing and grouting of anchor bolts and base frame for pumps including supply of non-shrink grouting mix.

Supply, assembly, positioning, fixing of all accessories (platform, ladder, internals) on the main equipment.

Providing temporary supports, scaffolding, staging etc for supporting equipment, pipes etc as required during the construction, installation, and erection or testing. Removing the same after the completion of the job and keeping the area clean. Wooden ladders are not acceptable. Tenderer shall use metallic ladders only.

Protecting properly all installed and uninstalled equipment/ material from theft, damage, pilferage and becoming a hazard to life and property. Protecting nozzles, flanges, machined parts, open pipe ends etc. by covering them with plastic pipe caps/ flange caps, wooden blanks, etc.

Cleaning of equipment (internal & external) before testing.
Testing of pipelines, equipment as per the requirement, specifications and standards.

Draining, emptying and cleaning the pipelines, equipment after testing and painting providing necessary drain points.

Opening/closing manholes/ nozzles etc. as required during pre-commissioning.

The following jobs are also included under Tenderer's scope of work for pumps, motors (Fixing, aligning etc of equipment shall be done only by skilled millwright fitter who will be approved by HPCL/MECON before commencement of such work in case felt necessary).

Servicing of coupling, stuffing box, and bearings.

### 1.2 Erection of Fire Fighting Pipeline

The handling, laying and welding of pipelines shall be carried out conforming to relevant codes / standards unless otherwise stated in the specification given below.

There may be variation between dimensions shown in drawings and actually existing at site due to minor variations in the location of equipment, inserts, structures, etc. To take care of these variations "Field welds" shall be provided during piping fabrication. An extra pipe length of 100 mm over and above the dimensions indicated in the drawings may be left on one side of the pipe at each of the field welds. During erection, the pipe end with extra length at each field weld, shall be cut to obtain the actual dimension occurring at site. Isometrics, if supplied may have the field welds marked on them. However, it is the responsibility of the Tenderer to provide adequate number of field welds. In any case no extra claims will be entertained from the Tenderer on this account. Wherever errors / omissions occur in drawings and Bills of materials, it shall be the Tenderer's responsibility to notify the Engineer-in-charge prior to fabrication or erection.

Based on the site conditions, the routing of pipelines shown in the drawings may require modification. The Tenderer shall execute the work under his scope of work accordingly as directed by the Engineer in charge.

The measurement for laying of pipelines shall be based on measurement along the centre line of the pipeline, inclusive of fittings but exclusive of items such as valves, strainers, etc.

The anti-corrosive treatment to the pipes to be laid underground shall be provided as specified in 11.00.

### 1.3 Erection of pipe above ground

Fire fighting pipelines shall be routed and located as per final approved piping
drawings keeping in view the piping specifications. No deviations from the arrangement shown shall be permitted without the written consent of MECON / HPCL.

In general, pipelines shall be routed above ground. However, where road crossing is involved as indicated in the layout drawing, the pipelines shall be routed underground.

Pipelines shall be routed in a pipe bridge at about 6.5m height between the pump house and Tank lorry-filling gantry. At the Tank lorry-filling gantry, the pipelines shall be laid at around 5m level supported from building structures.

All pipe work shall be designed with sufficient flexibility to prevent development of undesirable forces or movements at the point of connection to equipment at anchorage or due to thermal expansion. Flexibility shall be provided by change of direction or by use of bends, loops or offsets.

Location and design of pipe supports shown in approved arrangement drawings/support drawings should be strictly adhered to. Pipe supports i.e. restraints, such as guides, stops, anchors must be made in such a manner that they will not contribute to the over stressing of a line, while protecting a weaker or more sensitive component, e.g. pump.

Flanged joint shall be used for connections to vessels, equipment, flanged valves and road crossings and also on suitable straight lengths of pipelines at strategic points to facilitate erection and subsequent maintenance work.

While fitting/ welding of matching flanges care shall be exercised to properly align the pipes and to check the flanges for trueness, so that faces of the flanges can be pulled up together without inducing any stress at the pipes and equipment nozzles.

All flange facings shall be true and perpendicular to the axis of pipe to which they are attached. Boltholes of the flanges shall straddle the normal centerlines unless different orientation is shown in the drawing.

Steel to cast iron flange joints shall be made up with extreme care, tightening the bolts uniformly after bringing flange flush with gaskets with accurate parallel and lateral alignment.

Flanged connections at the pumps, fittings, accessories, etc. shall be made in such a way as not to induce any stress due to misalignment, excessive gap etc. The final tightening shall be carried out when the machines are aligned completely and specifically authorised by Engineer-in-Charge. Temporary protection covers shall be provided at all flanged connections of pumps, until the piping is finally connected.

Pipelines shall be laid sloping towards drainage points.

The Tenderer shall maintain slopes specified for various lines in the drawing. Corrective action shall be taken by the Tenderer in consultation with Engineer-in-
charge wherever the Tenderer is not able to maintain the specified slope.

Vents and drains shall be provided on each line at the highest and lowest points respectively to release the trapped air during hydraulic testing and to drain out the test fluid after testing. These openings shall be plugged and welded after the test.

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

All valves shall be provided with the operating handle/lever/wrench within easy reach. Where necessary, operating platforms shall be provided.

Installation of line mounted equipment/items like filters, strainers, sight glasses, etc., including their supporting arrangements shall form part of piping erection work and no separate payment shall be made for this work.

The Tenderer shall provide all required supports, anchors, saddles, hangers, rollers, clamps, u-bolts, guides, spring supports, sway bracings, vibration dampers etc. for aligning and controlling the pipe work. Supports shall prevent, under operating conditions, excessive stresses and excessive vibration of supporting elements from possible resonance with imposed vibrations.

Wherever additional flange joints/valve fittings are required, the same shall be provided after taking approval of the Engineer-in-charge.

All suitable hoisting tackles/equipment should be used for speedy and safe handling of pipes while laying the pipes on supports, specifically in case of surface coated pipes. Such tackles/equipment shall be provided with cushioning material to avoid damage to the lining/coating of the pipes.

The inside of the pipes shall be cleaned of stones, sand, dirt, oil, grease etc. thoroughly before laying. 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 ordinary water.

### 1.4 Buried Pipe

All buried pipe work shall be laid with earth cover sufficient to avoid damage from pressure of vibration caused by surface traffic. Minimum earth covering over the pipe shall be 1200 mm from the finished ground level area in areas subject to temporary loads and 1000 mm from finished ground level in areas not subject to temporary loads. Where the buried depth is less than these limits, permission from the Engineer-in-charge shall be taken. All buried pipelines shall be provided with anti-corrosion wrapping and coating as specified.

The excavation of trenches shall be so carried out that the digging of trenches does not go far ahead of the pipe laying operations, so as to prevent risk of landside. All
work shall be so organized that trench digging, pipe laying, testing and back filling of trenches follow one another closely.

All buried pipes shall be hydro tested before wrapping and coating.

Where loose earth is met during excavation or where trench is very deep, sidewalls shall be shored properly with timber or other means.

The trench shall be excavated to proper width (min. for single pipe 800mm) and depth. In case of pipeline passing through existing RCC/ asphalt driveway, Tenderer shall refill the excavated driveway and bring it to its original finish. No additional claim for such work will be entertained.

All underground pipelines crossing rail tracks or roads shall be through culverts or RCC non pressure pipes of the approximate class as indicated in the drawings to suit the site conditions.

It should be ensured that while laying the pipes no foreign materials like stones, sand, gunny bags, bits of welding rods, muck, weld materials etc. are left inside the laid pipes. The Tenderer should ensure that the coating / wrapping of the pipes are not damaged while drawing the pipes through RCC pipes. If there is any damage, it shall be rectified by the Tenderer at his cost.

At the end of each day of work, the free ends of the laid pipes must be kept properly sealed.

Special care shall be taken to place the pipes in the trenches. If any damages are caused during laying/ residual welding of pipes in trenches, floating of pipes in water in trenches, it shall be the Tenderer's responsibility to get them repaired and no claim whatsoever on this account will be entertained by MECON/ HPCL.

On completion of testing and painting of pipelines, the trenches shall be filled as per specification. The entire responsibility lies with the Tenderer for taking care of the pipes including lining/ coating of the pipes.

### 1.5 Pipe Sleeves

Pipe sleeves shall be provided for pipes passing through foundations, walls, floors, roofs etc., they shall be of sufficient size to permit the passage of flanges or fittings assembled with the line. The annular space at the ends between the sleeve and the pipe shall be sealed with cement concrete.

All required operating platforms, valve stands, access ladders, handrails, pipe crossovers etc shall be erected after the piping has been installed. Structural steelwork in connection with those items shall conform to the relevant Indian Standards for structural steel work.
2.0 **Welding**

All pipe work shall be of butt weld construction. Flanged joints shall also be provided to match the connecting ends of equipment, valves or where specified. Where specific equipment-piping connection necessitates several joints, unions shall also be provided. Only qualified welders proficient in welding in the vertical and overhead positions shall be allowed to weld these pipelines. Preferably welders with proficiency certificate from Govt. Test House or equivalent recognised authority should be put on the job. It shall be Tenderer's responsibility to arrange for and bear all costs towards testing of welders.

The following steps shall be taken besides controlling quality in general, to make effective control in carrying out welding:

- **Welding procedure (PQR & WPS)** shall be prepared in line with ASME SEC. IX and tests shall be carried out to qualify the procedures. Number of procedures will depend on variables like positions of welding, thickness range, etc. Once a welding procedure is qualified, strict adherence to it shall be made during actual welding.

- Welders employed shall be qualified as per ASME SEC. IX. MECON / HPCL will have the right to check/ witness the certificate(s) / test(s) before and / or during execution of work.

- Makes of welding consumables such as electrodes, filler wires, argon, etc. shall be approved by MECON / HPCL before they are used. Such consumables are, however, subject to qualifying initial check tests as per ASME codes.

- The Tenderer shall submit batch test certificates, from the electrode manufacturers, giving details of physical and chemical tests carried out by them, for each batch of electrodes to be used.

- **Guidelines for acceptance of weld defects detected by radiographic / ultrasonic tests**, wherever applicable, shall be governed by ASME SEC.VIII, Div-I.

- All electrodes shall be purchased in sealed containers and stored properly to prevent deterioration. The electrodes removed from the containers shall be kept in holding oven at temperatures recommended by the electrode manufacturer. “Out of the oven time” for electrodes, before they are consumed, shall not exceed the limits recommended by the electrode manufacturer. The electrode shall be handled with care to avoid any damage to the flux covering.

- All low hydrogen type of electrodes shall be rebaked at 350°C for 1-hour minimum and stored in ovens kept at 80-100°C before use. Recommendation of the electrode manufacturer shall be followed if available.

- The electrodes, filler wire and flux used shall be free from rust, oil, grease, earth and other foreign matter, which affect the quality of welding.
Welder's qualification test report as per IS: 817, electrode and material test certificate from manufacturer shall be furnished.

Welding process shall be manual shielded metal arc process. Standard quality line up jigs and fixtures should be used to ensure sound welds. The cutting of pipes and welding shall conform to specifications and to the satisfaction of MECON/ HPCL site engineers.

Welding shall not be performed when surfaces to be welded are wet, when rain is falling on such surfaces or during the period of high winds unless the welder and the works are shielded in an approved manner.

Joint preparation for welding shall be so as to leave a smooth finished profile free of cavities and conforming to standard practice. Edges shall be cleaned of paint, rust, scale, slag, dirt and other foreign matter before welding.

The throat thickness of the tack welds shall be similar to that of the initial root to be deposited in the groove and where necessary the extremities of the tack welds shall be dressed by grinding, chipping and flame gauging to facilitate proper fusion when they are incorporated in the initial root run. Bridge tacks (above the weld) shall be removed.

All slag and scales etc. shall be removed from the surfaces of each completed bead before depositing the next bead.

The finished weld shall present a smooth bright and shiny surface of constant width and uniformly spaced ripples. The welds shall be free from slag pockets, porosity, undercutting, incomplete penetration and fusion and other weld defects.

The weld protrusions, spatter etc., on the weld surface and adjacent area shall be removed so as to leave the surface smooth and clean.

The weld shall not project beyond the plain surface in butt weld by more than 2mm.

All valves, flanges, risers, bends and other fittings shall be in perfect plumb and care shall be taken to align the pipelines and bends properly to keep the symmetry of the pipeline layout.

To maintain the specified alignment and gap during welding the pipes shall be securely held in position by technical means, tack welding or by welding on bridge pieces. Electrodes or filler rods used for tack welding shall be of the same quality as those for completing the first run of the weld. Welding electrodes used shall have approval from HPCL/MECON. The following make of electrodes are acceptable:

- Advani Oerlikon,
- Philips,
- D & H Sechron,
- GEE,
- Esab,
Any other reputed make with the approval of HPCL / MECON

Welding Electrodes for wall thickness up to 14mm shall be 6013 AWS and for wall thickness more than 14mm the electrode shall conform to 7018 AWS.

For root welding of pipe joints, the electrodes shall be 6010 AWS

All electrodes shall be purchased in sealed containers and stored properly to prevent deterioration. The electrodes removed from the container shall be kept in holding ovens at temperature recommended by the manufacturer.

2.1 Visual Inspection

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

2.2 Preparation of pipe ends

For pipes intended to be in axial alignment, the plane of the pipe ends shall be square with the axis of the pipe.

The pipes, which were intentionally out of the axial alignment, the plane of the joint shall bisect the angle between adjacent pipes.

All tack welded butt joint assemblies shall be inspected to ensure root gap alignment, quality of tack welds, their root penetration section and cleaning and freedom from crack. Any substandard tack weld shall be cut out and remade up to the standard before starting the welding.

2.3 MS pipe joints

The ends of pipe 4.5mm and under in wall thickness need not to be bevelled. The ends of all pipes over 4.5mm wall thickness shall be bevelled to an angle of 30 degree for electric arc welding and to an angle 37-1/2 degree for gas welding. Where bevel is made with a cutting torch, the cut edge shall be mechanically cleaned to remove all scale, oxides and irregular edges.

In aligning the ends of pipe for welding, a space at the root of the joint about 1.5mm wide shall be allowed before tack welding. Where chill rings are used spacing up to 4.5mm should be allowed.
A wire spacer of suitable diameter may be used for maintaining the weld root opening while tacking, but it must be removed after tack welding and before laying the root bead.

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

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

While practical aligning, clamps should be used and the ends shall be tack welded to retain their position during welding. The number of tack welds shall be not less than:

- 3 tacks - for pipe sizes smaller than 50mm NB.
- 4 tacks - for pipe sizes more than 50mm NB upto 300mm NB.
- 6 tacks - for pipe sizes more than 350mm NB.

The tack welds shall be approximately 25mm long and well fused along with sides of end to the bottom of “V" or groove.

Welding shall commence only after approval of fit-up by the Engineer – in – charge.

### 3.0 Welding Techniques

#### 3.1 Root Pass

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

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

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

Any deviation desired from the recommended welding technique and electrodes indicated in the welding specification chart should be adopted only after obtaining
express approval of the Engineer - in - charge.
Welding shall be uninterrupted.
While the welding is in progress care should be taken to avoid any kind of movement of the components, shocks, vibrations and stresses to prevent occurrence of weld cracks.
Peening shall not be used.

3.2 Joint Completion

Joint shall be completed using the class of electrodes, recommended in the welding specification chart. Size of the electrode shall not exceed 4mm in diameter for stainless steel and alloy steels used for low temperature applications.
Two weld beads shall not be started at the same point in different layers.
Butt joint shall be completed with a cover layer that would ensure good fusion at the joint edges and a gradual notch free surface.
Each weld joint shall have a workmanship like finish. Weld identification mark shall be stamped clearly at each joint, just adjacent to the weld. Metal stamping shall not be used on thin pipe having wall thickness less than 3.5mm. Suitable paint shall be used on thin wall pipes for identification.
Rust preventive / protective painting shall be done after the weld joint has been approved.
The weld shall be thoroughly fused to both sides of the "V" or groove and through the bottom of the joint. The pipes shall be welded with three runs of weld. There shall be good fusion between each run and scale shall be thoroughly removed from the surface of each bead or layer of scaling or moderately peeling before the next one is applied. In the event of any cracks occurring, tack welds shall be chipped out before welding is continued. Special care shall be exercised to remelt the tack welds to fuse them with the weld.
Where the pipe can be turned, all welding shall be carried out in the down hand position.
The finished weld shall be uniform and of smooth finish. There shall be no overlapping or excessive undercutting of the pipe at the edge of the weld.

3.3 Repairs of welds

Defects ascertained, through the inspection methods, which are beyond acceptable limits shall be removed after the joint is completely radio graphed by the process of chipping and grinding.
When the entire joint is judged unacceptable, the welding shall be completely cut and edges suitably prepared as per required alignment tolerances. The rewelded joint shall again be examined following standard practices.

No repair shall be carried out without prior permission of the Owner’s inspector.

Repairs and / or rework of defective welds shall be done in time to avoid difficulties in meeting the construction schedules.

3.4 **Riser and Branch Connections**

The end of the riser or branch connection and the opening in the line or header shall be prepared by gas cutting or machining along templates lines to ensure accurate cutting and proper fit up. After gas cutting the edge forming the pipes, opening shall be beveled so as to permit welding completely around the joint for connections. Any rough gas cut edges shall be cleaned and or removed by chipping or other mechanical means. The riser may be fitted inside the opening in the header, or set in top. In the latter case the branch shall be beveled for welding. It is preferable to have the riser at least one size smaller than the header but risers of the same sizes as the header are permitted. The use of welding toes in such case is recommended.

After beveling the work shall be assembled and checked as regards matching of ends, uniformity of spacing and bevel angle and any defects noted shall be corrected prior to welding.

The joint shall be tack welded in a manner similar to that required for ‘Pipe line joint’.

Where the riser is set in, the weld shall be thoroughly fused to both the beveled edge of the header and to the sidewalls of the riser. Where the branch or riser is beveled for setting on top of the opening care shall be exercised to penetrate well, metal shall be fused through at the root. Where the riser is placed on top of the header it should be back welded on the inside, wherever possible.

All set in connections shall be prepared so that the ends are at least flush with the inside wall of the header.

In the case of an off set riser subjected to excessive stresses, knee braces gaskets shall be used.

3.5 **Supports**

Cement concrete/ brick masonry pedestal supports with metal inserts shall be provided for yard piping by the civil works Tenderer. Sliding contact between the support and the pipe is achieved by providing 25mm dia MS rod supplied and erected by the Tenderer. This rod shall be welded to the insert plate. If the level of the top of the rod does not match the required level, proper level of the bottom of
the pipe is achieved by raising the rod by means of packing plates between the rod and insert plate. After leveling, the packing plate is welded to the insert and the rod in turn welded to the packing plate.

The heights of the supports shall be adjusted so as to suit the pipeline gradient required and also the pipe work installed. The underside of the pipe should have a minimum distance of 300mm from the ground level. This enables easy maintenance of the pipelines and fittings. Special consideration should be given to the control valves etc. in the pipe run.

Grade stakes set to correct levels shall be provided along the pipeline alignment at suitable intervals for checking the levels of the pipe supports/ pipeline during construction of supports/ laying of pipelines.

Due care shall be taken while laying the pipeline on the supports. The Tenderer shall correct any damage caused to supports. No claims whatsoever will be entertained by MECON/ HPCL on this account.

The Tenderer shall provide pipe supports on steel structures:

Near changes in direction, branch lines and particularly near valves

On pipe and not on valves, fittings or expansion joints

On pipe and not on sharp radius bends or elbows

On runs which do not require frequent removal for maintenance

As close as practical to heavy load concentrations such as vertical runs which do not require removal for maintenance.

As close as practical to heavy load concentrations such as vertical runs, branch lines, heavy valves, separators, strainers etc. and as per direction of site engineer.

In establishing the location of pipe supports, the Tenderer should be guided by two requirements:

The horizontal span must not be so long that sag in the pipe will impose an excessive stress in the pipe wall

The pipeline must be pitched downward so that outlet of such span is lower than maximum sag in the span in order to facilitate drainage.

4.0 Flushing

Flushing of all lines shall be done before pressure testing.

Flushing shall be done by fresh potable water or dry compressed air, wherever water flushing is not desirable, to clean the pipe of all dirt, debris or loose foreign material.

Required pressure for water flushing shall meet the fire hydrant pressure or utility
water pressure. For air flushing, the line / system will be pressurised by compressed air at the required pressure which shall be 50 psi maximum. The pressure shall then be released by quick opening of a valve, already in line or installed temporarily for this purpose. This procedure shall be repeated as many times as required till the inside of the pipe is fully cleaned.

In line instruments like control valves, orifice plates, rotameters, safety valves and other instruments like thermo wells, which may interfere with flushing, shall not be included in flushing circuit.

The screens / meshes shall be removed from all permanent strainers before flushing. Screens / meshes shall be reinstalled after flushing but before testing.

During flushing temporary strainers shall be retained. These shall be removed, cleaned and reinstalled after flushing but before testing.

In case equipment such as column, vessel, exchanger etc. form part of a piping circuit during flushing, this shall be done with the approval of Engineer – in – charge. However, equipments thus included in circuit shall be completely drained and dried with compressed air after flushing is completed.

During flushing discharged water / air shall be drained to the place directed by the Engineer – in – charge. If necessary, proper temporary drainage shall be provided by the Tenderer.

Care shall be taken during flushing so as not to damage / spoil work of other agencies. Precautions shall also be taken to prevent entry of water / foreign matter into equipments, electric motors, instruments, electrical installation etc. in the vicinity of lines being flushed.

The Tenderer shall carry out all the activities required before, during and after the flushing operation, arising because of flushing requirements, such as but not limited to the following:

Removing of valves, specials, distance pieces, inline instruments and any other piping part before flushing. The flanges to be disengaged for this purpose shall be envisaged by the Tenderer and approved by the Engineer – in – charge. These flanges shall be provided with temporary gaskets at the time of flushing.

After flushing is completed and approved, the valve distance pieces, piping specials, etc. shall be reinstalled by the Tenderer with permanent gaskets. However, flanges at equipment nozzles and other places where isolation is required during testing, only temporary gaskets shall be provided.

Records in triplicate shall be prepared and submitted by the Tenderer for each piping system for the flushing done.
5.0 Testing

5.1 General:

Soundness of the welds shall be tested by means of hydrostatic tests. The test shall be conducted only after fulfilling the requirements of visual inspection, radiography, etc., and when the entire work is certified by the engineer-in-charge for performance of such tests.

This specification recommends minimum procedure to be followed, equipment to be used and conditions to be considered during the hydrostatic testing of pipelines.

Nothing in this recommended procedure should be considered as a fixed rule for application without regard to sound engineering judgment. Certain Governmental requirements may differ from the criteria set forth in this recommended procedure and its issuance is not intended to supersede/override such requirements.

5.2 Extent of testing

With the exclusion of instrumentation, piping systems fabricated or assembled in the field shall be tested irrespective of whether or not they have been pressure tested prior to site welding or fabrication.

To facilitate the testing of piping systems, vessels and other equipments may be included in the system with the prior approval of Engineer – in – charge if the test pressure specified is equal to or less than that for the vessel and other equipments.

Pumps, Compressors and other rotary equipments shall not be subjected to field test pressure.

Lines, which are directly open to atmosphere such as vents, drains, safety valves discharge need not be tested, but all joints shall be visually inspected. Wherever necessary, such lines shall be tested by continuous flow of fluid to eliminate the possibility of blockade. However, such lines if provided with block valve shall be pressure tested up to the first block valves.

Seats of all valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Test pressure applied to valves shall not be greater than the manufacturer’s recommendation nor less than that required by the applicable code. Where allowable seat pressure is less than test pressure, test shall be made through an open valve.

Instruments in the system to be tested shall be excluded from the test by isolation or removals, unless approved otherwise by the Engineer – in – charge.

Restrictions, which interfere with filling, venting and draining such as orifice plates etc. shall not be installed unless testing is complete.
Control valves shall not to be included in the test system. Where bypasses are provided test shall be performed through the bypass and / or necessary spool pieces shall be used in place of the control valve.

Pressure gauges, which are part of the finished system, but cannot withstand test pressure, shall not be installed until the system has been tested. Where piping systems to be tested are directly connected at the battery limits to piping for which the responsibility rests with other agencies, the piping to be tested shall be isolated from such piping by physical disconnection such as valve or blinds.

5.3 General Requirement / Preparation for Testing

Testing shall be carried out with permanent gaskets installed unless specified otherwise or instructed by the Engineer - in - charge

No pressure test shall be carried out against closed valve unless approved by the Engineer - in - charge.

The Engineer- in - charge shall be notified in advance by the Tenderer, of the testing sequence and programme, to enable him to be present for witnessing the test.

Before testing, all piping shall be cleaned by flushing to make it free from dirt, loose scale, debris and other loose foreign materials.

All piping system to be hydrostatically tested shall be vented at the high points and the systems purged of air before the test pressure is applied.

Wherever in the line any void exists due to any reasons, like absence of control valves, safety valves, check valves etc. it shall be filled with temporary spool pieces.

All joints welded, screwed or flanged shall be left exposed for examination during the test. Before pressuring the lines, each weld joint shall be cleaned by wire brush to free it from rust and any other foreign matter.

Where a system is to be isolated at a pair of companion flanges, a blank shall be inserted between the companion flanges. Minimum thickness of the blank shall be designed in accordance with applicable design code.

Open ends of piping system where blanks cannot be used, such as pumps, compressors, turbines or wherever equipment or pipe spool pieces have been removed or disconnected prior to hydrostatic testing, shall be blinded off by using standard blind flanges of same rating as the piping system being tested.

Pressure gauges used in testing shall be installed as close as possible to the lowest point in the piping system to be tested, to avoid overstressing of any of the lower portions of the system. For longer lines and vertical lines two or more pressure gauges shall be installed at locations decided by the Engineer – in – charge.
For lines containing check valves any of the following alternatives shall be adopted for pressure testing:

Wherever possible pressurise up-streamside of valve.

Replace the valve by a temporary spool pieces and reinstall the valve after testing.

Provide blind on valve flanges and test the upstream and downstream of the line separately and remove the blind after testing. At these flanges, temporary gaskets shall be provided during testing and shall be replaced by permanent gaskets subsequently.

For check valves in lines 1 ½” and below flapper or seat shall be removed during testing (if possible). After completion of testing the flapper / seat shall be refitted.

Gas lines when hydrostatically tested shall be provided with additional temporary supports during testing as directed by the Engineer - in - charge.

Piping which is spring or counter weight supported shall be temporarily supported, where the weight of the fluid would overload the support. Retaining pins for spring supports shall be removed only after testing is completed and test fluid is completely drained.

When testing any piping system, air or steam of approximately 2 kg / cm² g may be used as preliminary test to detect missing gaskets etc. as this avoids the necessity of draining the line to make repairs. However, steam shall not be used for this purpose, if the steam temperature is more than the design temperature of the line.

5.4 Testing media, test pressure and test pressure gauges

a. Testing Media

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

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

b. Test Pressure

The hydrostatic / pneumatic test pressure shall be as indicated in the line list or as per the instruction of Engineer - in - charge.

The selection of the piping system for one individual test shall be based on the following:

Test pressure required as per piping drawing.

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

c. **Test Pressure Gauge**

All gauges used for field-testing shall have suitable range so that the test pressure of the various systems falls in 40% to 80% of gauge scale range. Gauge shall be of a good quality and in first class working condition.

Prior to the start of any test or periodically during the field test programme, all test gauges shall be calibrated using a standard dead weight gauge tester or other suitable approved testing apparatus. Any gauge showing an incorrect zero reading or error of more than +2% of full scale range shall be discarded. The Engineer – in – charge shall check the accuracy of master pressure gauge used for calibration.

5.5 **Testing Procedure**

a. **Air Test**

When testing with air, pressure shall be supplied by means of a compressor. The compressor shall be portable type with a receiver, after cooler and oil separator.

Piping to be tested by air shall have joints covered with a soap and water solution so that the joint can be examined for leaks.

All other details shall be same as per hydro testing procedure (specified above).

b. **Completion of Testing**

After the hydrostatic test has been completed, pressure shall be released in a manner and at a rate so as not to endanger personnel or damage equipments.

All vents and drains shall be opened before the system is to be drained and shall remain open till all draining is complete, so as to prevent formation of vacuum in the system. After draining, lines / systems shall be dried by air.

After testing is completed the test blinds shall be removed and equipment / piping isolated during testing shall be connected using the specified gaskets, bolts, and nuts. These connections shall be checked for tightness in subsequent pneumatic tests to be carried out by the Tenderer for complete loop / circuit including equipments (except rotary equipments).

Pressure test shall be considered complete only after approved by the Engineer – in – charge. Defects, if any, noticed during testing shall be rectified immediately and retesting of the system / line shall be done by the Tenderer at his cost.
c. **Test Records**

Records in triplicate shall be prepared and submitted by the Tenderer for each piping system, for the pressure test done.

d. **Hydraulic test**

The Tenderer shall ensure that the pipelines have been thoroughly cleaned up by flushing with clean water/ compressed air of any foreign matter inside the pipes and dried before taking up for hydro test. The procedure adopted for cleaning shall be indicated by the Tenderer and subject to approval by MECON / HPCL.

All equipments materials, consumables including water and services required for carrying out the pressure testing of piping system shall be provided by the Tenderer at his own cost.

In case of buried pipes the trenches shall be kept free of water and the pipeline surfaces dry. The pipeline shall be filled with water and the pressure built up by means of test pump with a gauge to the specified pressure.

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.

The site - in - charge shall be notified in advance by the Tenderer of testing sequence / Programme, to enable him to be present for witnessing the test.

All vents and other connections used as vents shall be left open while filling the line with test fluid for complete removal of air. In all lines, for pressurising and depressurising the system, temporary isolating valves shall be provided if valved vents and drains do not exist in the system.

Pressure shall be applied only after the system / line is ready and approved by the Engineer - in - charge.

Pressure shall be applied by means of a suitable test pump or other pressure source, which shall be isolated from the system, as soon as test pressure is reached and stabilized in the system.

A pressure gauge shall be provided at the test pump discharge for guidance in bringing the system to the required pressure.

The test pump shall be attended constantly during the test by an authorized person. The pump shall be isolated from the system whenever the pump is to be left unattended.

Test pressure shall be maintained for a sufficient length of time to permit thorough inspection of all joints for leakage or signs of failure. Any joint found leaking during a
pressure test shall be retested to the specified pressure after repair. Test pressure shall be maintained for a minimum of two hours.

The pump and the piping system to be tested are to be provided with separate pressure indicating test gauge. These gauges are to be checked by the standard test gauge before each pressure test.

Care shall be taken to avoid increase in the pressure due to temperature variation during the test.

5.6 **Equipment for a Hydrostatic Test**

Equipment for the hydrostatic test should be properly selected and in good working order.

Equipment affecting the accuracy of the measurements used to validate the specified test pressure should be designed to measure the pressures to be encountered during the hydrostatic test.

Equipment for conducting the hydrostatic test may include the following:

- A high volume pump capable of filling the line at minimum velocity of 2 km/hr.
- A test medium supply line filter capable of ensuring a clean test medium.
- An injection pump to introduce corrosion inhibitors or other chemicals into the test segment, if their use is required.
- A meter or other comparable means of measuring line fill.
- A variable speed positive displacement pump capable of pressurising the line at 7 kg/cm² (approximately 100 psi) in excess of the specified test pressure. The pump should have a known volume per stroke and should be equipped with a stroke counter (a constant speed pump having a variable flow rate control may be used in lieu of the above if the liquid test medium injected into the pipeline is measured during pressurisation).
- Portable tank, if required, capable of providing a source of liquid test medium.
- A large diameter bourdon tube type pressure gauge with a pressure range and increment divisions necessary to indicate anticipated test pressures.
- A deadweight tester certified for accuracy and capable of measuring increments of 0.1 kg/cm² (1.5psi).
- A 24-hours recording pressure gauge with charts and ink. This gauge should be deadweight tested immediately prior to and after use.
- Two glass laboratory thermometers, with a 75mm. (approximately 3”) immersion capability of measuring temperatures from 0 deg.C (32 Degree F) to 50 Degree C
A 24 hours recording thermometer capable of recording temperatures from 0 deg.C (32 Degree F) to 50 Degree C (122 Degree F).

Pigs, spheres and similar devices to be used to clean the test segment and to facilitate the removal of air from the line.

Temporary manifolds and connections as necessary.

Equipment, materials and fluids needed to displace the test medium from the test segment.

5.7 Test Plan

The following factors should be considered in planning a hydrostatic test:

- Maximum operating pressure anticipated through the life of the facility.
- Location of pipe and other piping components in the test segment by size, wall thickness, grade type and internal design pressure(s).
- Shell pressure rating and location of pipeline valves, air vents and connections to the segment.
- Anticipated temperature of test medium, atmosphere and ground.
- Source(s) of test medium and any inhibiting or other treating requirements.
- Locations and requirements for test medium disposal.
- Profile and alignment drawing maps.
- Safety precautions and procedures.

5.8 Test Procedures

A hydrostatic test procedure diagram with explanatory notes and data should be prepared prior to testing and should indicate in a detailed fashion the following:

- The length and location of the test segment(s).
- Test medium to be used.
- Procedures for cleaning and filling the line.
- Procedures for the pressurisation of test segment(s) including the locations of the injection points and the specified minimum and maximum test pressures.
- Minimum test duration for test segment(s).
- Procedures for removal and disposal of test medium.
- Safety precautions and procedures.

A specified test pressure is defined as the minimum test pressure, which should be applied to the most elevated point in the test segment. A detailed analysis of the profile to determine static and dynamic pressures while the pipeline is being tested should be performed so that the pipeline will not be over pressurized at points, which are at low elevations.
5.9 **Line fill and Cleaning**

The line fill operation should serve the dual function of cleaning the line and introducing the necessary test medium into the test segment. Screens or filters should be installed in the test medium supply line to control the contamination of the test medium by debris or sediment. The quality and source of water should be determined. Water, which is not free of sediments and may be injurious to the pipe, valves, equipments, etc., should not be used unless it is filtered. The filling operation should be planned and executed in a manner, which prevents the infusion of air into segment to permit the purging of trapped air.

5.10 **Pressurization**

Personnel conducting the test should maintain continuous surveillance over the operation and ensure that it is carefully controlled.

The test segment should be pressurised at a moderate and constant rate. When approximately 70% of the specified test pressure is reached, the pumping rate should be regulated to minimise pressure variations and to ensure that increments of no greater than 1 kg/cm² may be accurately read and recorded. Pipe connections should be periodically checked for leaks during pressurization.

5.11 **The Test Hold**

When the test pressure is reached, pumping should be stopped and all valves and connections to the line should be inspected for leakage, a period of conservation to the line should follow during which test personnel verify that specified test pressure is being maintained at the line pressure and temperature has stabilized. Upon completion, the injection pump should be disconnected of its connection to the pipelines and checked for leakage. Pressure should be monitored and recorded continuously during the duration of the test.

5.12 **Displacement of test medium**

Water should be completely drained off. Water should be disposed of at approved locations in a manner that will cause minimal environment effects.

The pressure shall be maintained for a minimum period of 1/2 hour unless otherwise specified by the client. The hydrostatic test shall be considered positive only if there is no drop in pressure at the end of the specified period.

All welded and flange joints and the seam welds on the ERW pipe shall be inspected for leaks.

Leaky joints shall be repaired by chipping or gauging out such defects as required.
and re-welded. The cut out of joints shall be just sufficient to correct the defects. After repairing the leaky joints, the line shall be tested to prescribed pressure. No claims for expenditure incurred by the Tenderer towards such repairs of defective work and testing will be entertained.

After test, the water shall be completely emptied out and the line shall be made free of water.

All underground piping shall be tested and ensured of no leakage at test pressure before filling up trenches.

No painting shall be done at weld joints till the system is accepted in all respects.

6.0 Painting

6.1 General

This specification covers the requirement of selection, supply, application and workmanship of protective coating system for piping.

It is deemed that the work will be carried out by the Tenderer with the best quality of specified material and workmanship at his own cost.

Adequate numbers of required tools, brushes, blast material, scaffolding, shot / sand blast cleaning equipment, air compressors, etc., shall be arranged by the Tenderer at site.

During storage and application of paints, the paint manufacturer's instructions shall be strictly followed. Particular attention shall be paid to the following:

Proper storage avoiding exposure and extreme temperature.

Specified surface preparation.

Mixing and thinning.

Application of paints and the recommended time intervals between consecutive paint coats.

Two-pack paint system shall be mixed by mechanical means. The Engineer – in – charge may allow hand mixing of small quantities at his discretion.

Final Painting of pipelines / structural steel works shall be done only after the mechanical completion and testing of the system are completed.

‘Fire Red’ colour paint shall be used for painting firewater network, hydrant monitors, hoses, boxes, etc.

Colour schemes shall be in line with standard industrial codes in line with HPCL practices, which will be indicated to the successful Tenderer.
Scope of pipeline painting work covered in the specification shall include:
Structural steel work, walkways, pipes supports, ladders, etc.
All above ground piping and fittings including identification marks.
Painting of valves.
Identification colour bands and directions on all piping as required.
Supply of all primers, paints and all other material required for painting.
Coating and wrapping of underground pipelines.

6.2 Surface Preparation

All rough welds, burrs, weld splatter, indentations and all other sharp surface
projections shall be ground smooth prior to further surface preparation. Surface shall
be blast cleaned to SA 2 ½. Maximum peak of surface profile shall be less by 5 - 10
microns from the primer DFT. Any protective coating used by the pipe manufacturer/
supplier shall be removed during blast cleaning.

All boltholes shall be drilled and smoothened before cleaning.

Any oil, grease, dust or foreign matter deposited on the surface after the surface
preparation is completed shall be removed prior to painting. In the event rusting
occurs after completion of surface preparation and before application of the primer
the surfaces shall again be cleaned in accordance with the specified method.

Name plates, Manufacturer's identification tags, machined surfaces, instrument
glass, control valve stems and other items in contact with or near the surface being
coated shall be removed or marked as appropriate for protection, prior to protective
coating application.

In order to achieve maximum durability, one or more of following methods of
surface preparation shall be followed before blast cleaning:

a. Manual or Hand Tool Cleaning

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

b. Mechanical or Power Tool Cleaning
Power tool cleaning shall be done by mechanical striking tools, chipping hammers, grinding wheels or rotating steel wire brushes. Excessive brushing of surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust, mill scale, etc. shall be removed by clean rags and / or washed by water or steam and thoroughly dried with compressed air jet before application of paint.

c. **Blast Cleaning**

The sand / shots used for blasting shall be free from moisture, salt. Sand size should be 16 mesh to 30 mesh in order to have surface profile range 55 – 65 microns.

Size of abrasive: 16 – 30 mesh. The particle should pass through 100% when sieved with 16 mesh and nothing to pass through when sieved with 30 mesh i.e., size below 16 and above 30 mesh are not recommended.

Shape of abrasive: Shape, semi-sharp, spherical or near spherical. Semi-sharp means some sharp as well as round edge in one particle grit.

The total surface shall then be blast cleaned to Swedish standard SA 2 ½.

The blasting has to be carried out at a pressure of 7 kg/cm2 at the nozzle tip. Compressed air is to be free from moisture and oil.

On completion of blasting operation, the blasted surface shall be made clean and free from any dust and scale or rust and must show a grey white metallic lustre as demonstrated in SA 2 ½.

Blast cleaning shall not be done in bad weather without adequate protection or when there is dew on the metal, which is to be cleaned, or humidity exceeding 85%. Surface profile shall be uniform to provide good key to the paint.

Primer or first coat of paint shall be applied within 3 hours of sand blasting or as directed by Engineer – in – charge depending on weather conditions.

6.3 **Coating Procedure**

a. **Coating System**

Painting system for the pipelines and other structures shall be as indicated in this specification.

b. **Application**

Before application of primer, the surface shall be cleaned of dust etc. Surfaces shall not be coated in adverse weather conditions, rain, wind, snow, fog, mist, or / and in areas where injurious airborne elements exist.
Cleaned surfaces shall be coated with one complete application of primer as soon as practicable but in no case more than three hours after surface preparation.

Application of coats shall not be carried out if the atmospheric temperature is less than 5°C or if the temperature exceeds 40°C in the shadow, 50°C due to the influence of sun or if relative humidity exceeds 85% or in case of adverse weather conditions like rain, fog, dust storm etc.

All paints shall be thoroughly stirred up prior to and during their application.

To the maximum extent practicable, each coat of material shall be applied as a continuous film of uniform thickness free of pores.

Coating media shall be applied in uniform thickness. All slots, recesses, grooves, corners, angles and interstices shall be covered by paint. Sag and runs shall be distributed or removed and new paint shall be applied uniformly.

Any thin spots or area missed in the application shall be recoated and allowed to dry before the next coat is applied.

Each coat shall be in proper state of cure / dryness before the application of the succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without development of any detrimental line irregularities, such as lifting or loss of adhesion of the undercoat.

When successive coats of the same colour have been specified, alternate coats shall be tinted, when practical, sufficient to produce enough contrast to indicate complete coverage of the surface. When the material is of the same colour as of the steel, or when the tinting of the final coat is objectionable, the first coat to be applied shall be tinted. The tinting material shall be compatible with the material and not detrimental to its service life. Shade of each coat shall be got approved by Engineer - in - charge.

All containers of coating material shall remain as unopened original Manufacturer's containers until required for use. Coating materials that have jelled or deteriorated during storage shall not be used.

Paint containers shall be opened only prior to utilisation and shall be carefully closed immediately after withdrawal of paint. Expiry date of the paint should be checked before opening the container. Paints, which have become unserviceable during storage, shall not be applied. All painting material shall be kept in weatherproof barracks and shall be kept cool and dry.

All ingredients shall be thoroughly mixed before use to a smooth and uniform consistency using mechanical means. No air bubbling shall be used for this purpose.

All pigmented material shall be strained after mixing so as to remove any skin, etc. before use. Coating material shall not remain in spray pots or buckets over night but shall be gathered into a closed container and remixed before use.
All thinning and mixing shall be done strictly in accordance with the Manufacturer's instructions for the particular materials and under the supervision and direction of the engineer-in-charge or his representative.

Where brush coating is applicable, brushes shall be of a style and quality that will enable proper application of paint. Wide flat brushes are suitable for large flat areas but they shall not have width over five inches. Rough or oval shaped brushes shall be used for irregular and rough surfaces.

The brushes shall conform to IS: 384. The width of the brushes shall not be more than 15 cms.

Paint shall be applied by brush / conventional spray / airless spray. During spraying the paint shall be maintained thoroughly mixed in the spray gun.

Tenderer shall obtain approval for specification for spraying installation concerned, the type of equipment, nozzle diameter, pressure setting etc. The paint shall be sprayed uniformly. Surfaces impossible to be coated by spraying must be painted by brush.

Painting work shall be done in daytime only preferable between 9 am and 5 pm.

### 6.4 Repair of damaged paint surface

The Tenderer shall rectify painting work found defective under this specification at no additional cost to HPCL.

Where shop paint has been damaged in handling, all damaged and loosely adhering paint shall be removed and the surface thoroughly cleaned. Edges of the breaks shall be lathered and the designated number of prime and finish coats applied.

### 6.5 Paint Material

Primer and finish coats shall be of first class quality and shall conform to the specification indicated below:

**a. Specification for paints:**

**Zinc Ethyl Silicate Primer (P1)**

The zinc ethyl silicate consists of two packs. One pack contains the ethyl silicate binder with suitable solvents. The other pack contains zinc dust with additives. They have to be mixed in suitable proportions before application as recommended by manufacturer.

- Colour: Grey
- Application: Spray (airless / air)
- Dry film thickness per coat: 65-75 microns
Theoretical coverage : 8 sq.m / litre
Drying time : 4 hours
Re-coating time : 10 hours (min)
% of total metallic zinc in dry film : 85 – 90 % by wt.
(As per the ASTM D520 - Spherical size storage life) : 4 months under sealed conditions.

b) Epoxy primer (P2)

The primer is a two pack anti corrosive epoxy primer for use on steel surfaces.

Volume of solids : 40 ± 2%
Composition : Epoxy resin/ Zinc Phosphate
Colour : Red Oxide
Pigment volume concentration: 25-35%
Application : Brush or spray
Dry film thickness per coat : 40-50 µm
Theoretical coverage : 8-10 sq.m/ litre
Drying time : Touch dry – 1 hour; Hard dry – over night
Storage life : 9 months under sealed conditions.

c) Two pack epoxy - polyamide mio undercoat (U1)

These coatings are high build paints based on cold cured epoxy polyamide system pigmented with chemically inert pigments and extenders formulated to permit application at a DFT higher than 100 microns per coat.

Type of epoxy : Condensation product of bisphenol A and epichlorohydrin with terminal epoxides groups.
Epoxide equivalent : 450 - 500
Curing agent : Polyamide
Volume of solids : 55 – 60 %
Pigment : The main pigment shall be micaceous iron oxide (MIO - Lamellar) constituting a minimum of about 65% w/w of total pigments.
Pigment volume concentration: 40 – 45 %
Application : Airless spray
Dry film thickness / coat : 110 - 120 microns
Spreading rate : 5- 5.5 sq. m / litre
Drying time : Touch dry in 2 hours, hard dry in 48 hours
Over coating time : 24 – 48 hours. This should be very strictly
adhered to in order to avoid peeling of subsequent coat.

Storage life : 12 months under sealed conditions.

d) Epoxy high build finish paint (F1)

Type and composition : Two pack poly amide/polyamine cured epoxy resin medium suitably pigmented.

Volume of solids : 62%
DFT(dry film thickness) : 100-125microns
(As per coat app.)
Theoretical coating capacity : 5-6
Weight per litre (app) kgs/lts : 1.4
Touch dry at 30°C : 3hrs
Hard dry at 30°C : Overnight
Over coating interval : Min: Overnight
                      Max: 5days
Pot life at 30°C for two component: 4-6 hrs
Paints (app.)

e) Two pack aliphatic acrylic polyurethane finish paint (F2)

Part-A: Part-A consists of polyacrylate polyl with appropriate primary extenders, solvent and additives.

Part-B: Part-B consists of an aliphatic polyisocyanate with appropriate solvents and additives.

Part A and Part B are to be mixed together to form a pigmented polyurethane paint in suitable proportions as recommended by manufacturer.

Volume of solids : 45 %
Main pigment : Rutile TiO2 (min. 80% w/w on total pigment weight) and extenders with other suitable pigments to get the desired colour

Colour : As desired
Pigment volume concentration : 15 - 20 %
Application : Brush or spray
Dry film thickness per coat : 40-50 microns
Theoretical coverage : 11 - 13 sq.m / litre
Drying time    : Surface dry 1 hr. Full cure 7 days.
Storage life   : 3 months under sealed conditions

f) Synthetic Enamel (F3)
A high quality enamel based on synthetic resignt vehicle stable weather resistant pigment designed for both protection and decoration.

Volume of solids   :  38-40%
Application    : by brush or conventional spray
DFT/Coat    :  30-35 microns
Spreading rate    :  11-13 sq. m/ lt
Drying time    : Surface dry-4hrs
                    Hard dry-18hrs
Storage life   : 12 months under scaled conditions

g) Painting System
For coastal area- Ennore Terminal

Painting specification for pipes and other connected item

<table>
<thead>
<tr>
<th>Surface preparation</th>
<th>Blast clean to SA 2½</th>
</tr>
</thead>
</table>
| Paint system recommended | One coat of P1 (65-75 µm each)  
                        | One coat of F1 (100-125 µm  
                        | each)+                    
                        | Two coats of F2 (40-50 µm  
                        | each)                    |
| Total DFT (Min)     | 245 µm               |

For Structural

<table>
<thead>
<tr>
<th>Surface preparation</th>
<th>Blast clean to SA2 ½</th>
</tr>
</thead>
</table>
| Paint system recommended | First coat of P2 (50 µm each)  
                        | +second coat (intermediate) of  
                        | U1 (75 µm) To be deleted + third  
                        | coat of F1 (90µm)               
                        | +Finish coat of F2 (35µm)       |
| Total DFT(min)      | 250 µm               |

6.6 Paint Manufacturers
An indicative list given below of the paint manufacturers whose product conforming to the respective qualities specified herein may be considered for use. However, the site engineer has the right to reject any material of these manufacturers, which do not conform to the specifications.

M/s Asian Paints India Ltd.
M/s Berger Paints India Ltd. Mumbai.
M/s Ameron / Goodlass Nerolac Paints Ltd. Mumbai.
M/s Jenson & Nicholson India Ltd. Kolkata.
M/s CDC Carboline, Chennai.
M/s Shalimar Paints Ltd. Mumbai.
M/s Solvo-Sol Paints (P) Ltd. Hyderabad.
M/s Grand Polycoats Company Pvt Ltd. Vadodara.
Sigma Coatings Mumbai
Akzo Noble coatings India Ltd., Bangalore or
Any other reputed make with the approval of HPCL/ MECON

7.0 Inspection and final acceptance

Required painting materials for application shall be procured directly from manufacturers as per specification. Manufacturer’s test certificates for every batch should be submitted to Engineer - in - charge without which paints will not be accepted.

Engineer - in - charge at his discretion may call for tests for paint formulation. Tenderer shall arrange to have tests performed including batch wise test of wet paints for physical and chemical analysis at no extra costs to HPCL.

Painting work shall be subject to inspection and approval by MECON/ HPCL.

The painting work shall be subject to inspection by Engineer - in - charge at all times. Following aspects will be considered during inspection and Tenderer shall offer the work for inspection and approval of site Engineer before proceeding with the next stage. Stages of inspection are as follows.

- Surface preparation
- Primer Application
- Each coat of paint

Any defect noticed during the inspection is to be rectified by the Tenderer to the satisfaction of Engineer - in - charge before proceeding further.

Each batch of paint shall be offered to him for approval before commencing application. Preparation of surface shall be subject to spot examination and approval, and where it is evident that surface preparation has been inadequate, the Engineer may require the surface to be stripped, cleaned etc. as necessary. Paint
film thickness shall be examined at random locations after completion of primary coat, and also as completion of the final finishing coat.

Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make up the DFT specified without any extra cost to the Tenderer.

The Tenderer has to position an ELCOMETER at site for checking the paint thickness by the site engineer.

The Tenderer shall arrange and keep a Holiday Detector at site for testing of wrapping coating of underground pipelines.

Paint operations shall be aimed at producing smooth and neat finished surfaces and inspection of edge and lining details will take this requirement into consideration in accepting each part of the work. All splashes shall be cleaned up as they occur, and empty paint containers and other debris shall be removed from site.

All inspecting and examining instruments shall be calibrated and checked to indicate their proper functioning.

Irrespective of the inspection, repair and approval at intermediate stages of work, Tenderer shall be responsible for making good any defects found during the final inspection / guarantee period / defect liability period as defined in general conditions of contract.

8.0 Treatment of underground pipelines

a. Surface Preparation and primer application

The pipe shall be sand blasted to SA 2 ½. Primer shall be applied over the pipe at 150-gm/ sq.m. The primer shall be allowed to dry until the solvent evaporates and the surface become tacky.

b. Wrapping

Underground pipes shall be wrapped with 4mm thick polymeric corrosion protection tape, which shall conform to IS: 10221-1982 / AWWA C 203.

Polymeric tape (4mm) shall then be wound around the pipe in spiral fashion and bonded completely to the pipe by thermo fusion process. The same thermo-fusion process shall seal the overlaps.

Polymeric protection tape shall incorporate a center core of approx. 100-micron HDPE film. It shall have a second center core of textile fabric to give mechanical strength and dimensional stability to the tape. 3 layers of polymeric based coal tar, rubber and other polymers shall be interleaved between the above centre cores. All
the seven layers shall be calendared together to create the above protection tape.

c. Testing of wrapping

Holiday test shall be conducted over the coated surface accordingly to AWWAC 203. After testing, the defective coating should be repaired and holiday test carried out again.

d. Adjacent Pipelines, Structures, etc.

If any damage is caused to the coating and wrapping of adjacent pipes or any other existing structure during excavation or subsequent work or during coating or wrapping of flanged joints, the Tenderer shall carry out necessary repairs at his own cost in a manner as directed by the Engineer-in-Charge.
STANDARD SPECIFICATION FOR
WATER CUM FOAM MONITOR
CONTENTS

1. SCOPE
2. MATERIAL
3. DESIGN AND CONSTRUCTION
4. HYDRAULIC PERFORMANCE
5. WORKMANSHIP AND FINISH
6. ANTICORROSIVE TREATMENT AND PAINTING
7. TEST
8. MARKING
1.0 SCOPE

This specification covers the general requirements regarding the material, design and construction, performance and test for stand post type water cum foam monitor.

2.0 MATERIAL

2.1 Monitor body, swivel joints, worm wheel, base flange and change over valve assembly shall be made of copper alloy confirming to IS:8442 Cl. 3.3.1. Body shall be of C.S. pipe heavy grade to IS: 1239 and base flange shall be of M.S. to IS 226 or IS 6392.

2.2 Foam and water barrel shall be extruded aluminium pipe to IS: 1285. Water barrel can be from M.S. seamless pipe to IS: 1239 heavy grade.

2.3 Water nozzle shall be made from aluminium alloy to IS: 617 designations 4450 when water barrel is made from extruded aluminium pipe. It shall be made from copper alloy as specified in IS: 8442 Cl. 3.3.1 when water barrel is of MS pipe to IS: 1239 H. gr.

2.4 Pick up tube shall be made from rubber hose with chrome plated brass strainer.

2.5 Worm gear for traverse mechanism shall be made from phosphorus bronze or copper alloy as per Cl. 3.3.1 of IS: 8442.

2.6 Nuts and bolts for base flange and change over valve shall confirm to IS: 1367 Cl.10.9 and 12 respectively while gasket shall be of CAF 40 to IS:2712.

2.7 Drain valve shall confirm to IS: 778 class 2. Locks on swivels shall be made of brass to IS:291.

3.0 DESIGN AND CONSTRUCTION

3.1 Monitor shall be capable of discharging 1750 lpm at a pressure of 7 Kg/cm².

3.2 It shall have traversing mechanism to give 360° in either direction in horizontal plane and 125° in vertical plane (80°, -45°) through geared unit with worm wheel operated by separate hand wheel for horizontal and vertical rotation. Swivel joints shall be provided both for horizontal and vertical rotation. The arrangement shall be such that monitor shall be self locking type and operated by a single person.

3.3 The monitor shall be provided with a change over valve along with its assembly for instantaneous switch over of discharge from water to foam or vice versa as desired. The valve shall be lever operated type.
3.4 A foam inductor shall be provided behind the air intake chamber of foam maker in foam monitor. A flexible rubber pick up tube of 3m length having strainer at the inlet shall be provided. A foam compound control valve capable of metering and inducing 3% to 6% of foam compound shall also be provided.

3.5 The monitor shall be mounted on a 100mm (4") N.B. flat face slip on type flange confirming to ANSI B 16.5 150lbs rating. Bolts and nuts for base flange shall have dimension confirming to ANSI B 16.5 Gasket shall be full face 3mm thick with drilling dimension same as for flange.

3.6 Near the base flange a drain connection shall be provided with a 15mm (1/2") NB drain valve at the end of pipe. The drain pipe shall be long enough to drain water away from the base flange.

3.7 The threaded end of the water nozzle shall be hexagonal to facilitate screwing of the nozzle on the water barrel with nozzle spanner. Threads shall confirm to IS: 2643 (Pt.-1) with class A tolerance.

3.8 The inner surface of the nozzle shall be finished smooth and polished for the converging length of the nozzle.

4.0 HYDRAULIC PERFORMANCE

4.1 Monitor shall be capable of discharging 1750lpm at a pressure of 7 Kg/cm2.

4.2 The horizontal ranges for water and foam jet shall be 60m and 45m respectively while the vertical throw shall be 30m and 20 to 25m respectively.

5.0 WORKMANSHP AND FINISH

5.1 All the parts shall have good workmanship and finish. All burrs and sharp edges shall be removed particularly water way foam way and nozzle shall have smooth finish.

6.0 ANTI CORROSI VE TREATMENT AND PAINTING

6.1 All steel components subject to direct water or foam contact shall be hot dipped galvanized to a minimum thickness of 0.12mm. The thickness of coating shall be measured as per IS: 3203. External surfaces and non ferrous components may wet with lead tin alloy by electrical deposition process.

6.2 Monitor’s steel part shall be painted with fire red color confirming to IS: 5 shade no. 536 and the paint shall confirm to IS: 2932 and copper alloy part shall be polished.

TS-WM-4
7.0 TEST

7.1 Monitor shall be tested to fulfill requirements at clause 4.0.

7.2 The entire assembly shall be hydraulically tested to a pressure of 2.1 MN/M2 (21 Kgf/Cm2) for 5 minutes without any leakage.

8.0 MARKING

8.1 Each monitor shall be clearly and permanently marked with the following:

a) Manufacturer’s name or trade mark
b) Year of manufacture
c) Purchaser’s name
STANDARD SPECIFICATION FOR
LANDING VALVE
1.0 **SCOPE:**

The specification covers the general requirement regarding the material, design and construction, performance, test and type of landing valve.

The single / double outlet landing valve mainly consists of landing valve with complete set.

2.0 **MATERIAL:**

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>ITEM / COMPONENT</th>
<th>MATERIAL OF CONSTRUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Valve body</td>
<td>Shall be of corrosion resistant alloy steel or nickel brass casting conforming to IS: 3444</td>
</tr>
<tr>
<td>2.</td>
<td>Bonnet, check-nut, stop valve, instantaneous female outlet and blank cap</td>
<td>Shall be of leaded tin bronze conforming to grade LT B-2 of IS: 318 or aluminium alloy conforming to IS designation 4225, 4450 and 4600 of IS: 617. All aluminium parts shall of be die-cast.</td>
</tr>
<tr>
<td>3.</td>
<td>Valve spindle</td>
<td>Shall be made of brass rod conforming to IS: 320 for valve body of leaded tin bronze and of stainless steel conforming to IS: 6603 for valve body of aluminium.</td>
</tr>
<tr>
<td>4.</td>
<td>Handle wheel</td>
<td>Shall be made of M.S. conforming to IS: 1030.</td>
</tr>
<tr>
<td>5.</td>
<td>Seat valve and washer</td>
<td>Shall be of leather conforming to IS: 581</td>
</tr>
<tr>
<td>6.</td>
<td>Gland packing</td>
<td>Shall be asbestos threaded conforming to IS: 4687.</td>
</tr>
<tr>
<td>7.</td>
<td>Spring</td>
<td>Shall be of phosphor wire conforming to IS: 7608 for valve body of leaded tin bronze and of stainless steel wire conforming to IS: 6528 for valve body of aluminium.</td>
</tr>
<tr>
<td>8.</td>
<td>Tooth</td>
<td>Shall be forged from forged brass material conforming to grade FLB of IS: 6912 of IS: 291</td>
</tr>
<tr>
<td>9.</td>
<td>Blank cap</td>
<td>ABS plastic</td>
</tr>
</tbody>
</table>

The materials shall be as per IS: 5290. The various alternatives available in the BIS for landing valve body are aluminium alloy, Lead–Tin-Bronze and stainless steel.
However, materials selection shall be as per data sheet (if available) / Company’s approval.

Flanges for hydrant valve shall have dimensions conforming to ANSI B 16.5 150 lbs rating flat slip-on type or MS plate flange as per IS 6392 table 17.

3.0 Design and Construction:

The design and construction of landing valve shall be as per IS: 5290, TAC guidelines and other government codes / regulations and as mentioned in this specification.

1. Water mains coming to post shall be of φ 150 & 100mm M.S construction and provided with Double outlet landing valve.

2. All hydrant outlets shall be situated 1m above floor level.

3. Only oblique hydrants with outlet angled towards floor shall be used. The hydrant couplings shall be of the instantaneous spring lock (female) type of 60mm dia and valves shall be of the slow down type.

4.0 Performance Requirements

4.1 Water Tightness Test for the valve

The stop valve shall be fully closed by screwing down the spindle. A hydrostatic pressure of 1.4 MN/m² (14 kgf/cm²) shall then be applied to each valve on its inlet side. There shall be no leakage through the valve and its seat.

4.2 Hydrostatic Pressure Test.

Each assembled landing valve shall be subjected to a hydrostatic pressure of 2.1 MN/mm² (21 kg/cm²) as per IS: 5290 with the valve open and outlet closed for a period of 2½ minutes for the purpose of locating porosity in the casting when so tested, it shall not fail or show any sign of leakage either through the valve body or through the gland of the spindle.

4.3 Flow Test

Test shall be discharged through the valve assembly and its flow shall be measured using flow meter or V-notch. The flow shall not be less than 900 LPM for Type A and 1800 LPM for Type B at 7MN/m² (7kgs/cm²) provided feed to the valves is not less than these figures.

5.0 Workmanship and Finish

5.1 All parts shall be of good finish, clear of burrs and sharp edges. All castings shall clean...
and sound and shall be free from plugging, welding or repair of any defects.

The valve top except the face of the flange and the instantaneous outlet shall be painted fire red of shade no. 536 of IS: 5. The outside of instantaneous outlet shall be highly polished. The hand wheel shall be painted black. Paints shall conform to IS: 2932: 1974.

6.0 **Anticorrosive Treatment and Painting**

6.1 All steel components subject to direct water contact shall be hot dipped galvanized to minimum thickness of 0.12mm. The thickness of coating shall be measured as per IS 3203. External surfaces and non-ferrous components may be wetted with lead tin alloy by electrical deposition process.

6.2 The stand post and its arms, valve top except the face of the flange and the instantaneous outlet from outside shall be painted with three coats of anticorrosive fire red paint of shade No. 536 of Is 5. The outside of instantaneous outlet shall be highly polished. The hand wheel shall be painted black. Paints shall conform to IS: 2932. Internal surface shall be painted with three coats of chlorinated rubber based resin paint or zinc chromate paint.

7.0 **Marking**

1. Each assembled valve shall be clearly and permanently marked on the valve body as follows:

   a) Manufacturers name or trade-mark
   b) Code letter indicating the type of valve (Inscribing type of instantaneous female outlet),
   c) Year of manufacture
   d) The valve assembly shall also be marked with the BIS certification mark and IS: 5290.

8.0 **Inspection**

There shall be provision for inspection by third party inspection agency at contractor’s cost. The agency shall have access at all reasonable times to the manufacturer’s works, where hydrants are being manufactured and / or tested. However specifically prior call for inspection shall be communicated for performance test of hydrants.
**TECHNICAL DATA SHEET FOR LANDING VALVE AND ACCESSORIES**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.0 Type</strong></td>
<td>Type A Single outlet or Type B Double outlet</td>
</tr>
<tr>
<td><strong>2.0 Code Standard</strong></td>
<td>IS:5290</td>
</tr>
<tr>
<td><strong>3.0 Material of construction</strong></td>
<td></td>
</tr>
<tr>
<td><strong>3.1 Body</strong></td>
<td>Leaded Tin Bronze Gr. LTB-2 of IS:318 or Aluminium alloy of IS designation 4225,4450 and 4600 of IS:617</td>
</tr>
<tr>
<td><strong>3.2 Stop Valve</strong></td>
<td>Leaded Tin Bronze to Gr. LTB-2 of IS:318</td>
</tr>
<tr>
<td><strong>3.3 Spindle</strong></td>
<td>Brass Rod to IS 320 or IS 319</td>
</tr>
<tr>
<td><strong>3.4 Spindle Body</strong></td>
<td>S.S. to IS 6603</td>
</tr>
<tr>
<td><strong>3.5 Hand wheel</strong></td>
<td>M.S to IS 1030 or C.I. to IS 210</td>
</tr>
<tr>
<td><strong>3.6 Washer, Gasket etc.</strong></td>
<td>Rubber IS:937 or leather to IS 581</td>
</tr>
<tr>
<td><strong>3.7 Spring</strong></td>
<td>Phospher Bronze wire to IS:7608</td>
</tr>
<tr>
<td><strong>4.0 Inlet flange</strong></td>
<td>Size 100mm (100 NB) the drilling dimension including O.D. of flange shall be as per ANSI-B-16.5 class 150.</td>
</tr>
<tr>
<td><strong>5.0 Working pressure</strong></td>
<td>3.5 to 12 kg/cm²</td>
</tr>
<tr>
<td><strong>6.0 Hydrostatic test pressure</strong></td>
<td>21 kg/cm²</td>
</tr>
<tr>
<td><strong>7.0 Flow/Hydrant</strong></td>
<td>900 LPM for Type A or 1800 LPM at 7 kg/cm² for Type B</td>
</tr>
<tr>
<td><strong>8.0 Approval</strong></td>
<td>TAC approved</td>
</tr>
</tbody>
</table>
1.0 **Scope:**

This specification covers the general requirement regarding the material, design and construction, performance and test for non-percolating flexible fire fighting delivery hose with gunmetal male & female type instantaneous coupling.

2.0 **Material:**

2.1 The material for Delivery hose shall be rubberized fabric lined as per IS: 636 TYPE A.

2.2 The material for Male and Female instantaneous type coupling shall be of Gunmetal as per IS: 903.

3.0 **Design and Construction:**

3.1 The hose shall be constructed from a circular woven jacket having a waterproof rubberized fabric lining on the inside, facing the waterway. The jacket shall be seamless and compactly woven from good quality cotton yarn or from yarn made from suitable synthetic fiber of polyamide or polyester type of good quality or from their combinations.

3.2 Fire hose with outer coating/covering shall be manufactured using synthetic yarn only.

3.3 The Fire hose shall be of 15m length and of φ 63mm.

3.4 If cotton yarn is used in the construction of jacket, this shall be root proofed as per IS: 636 and method as per IS: 11662.

3.5 The average mass of hose per meter length shall not exceed 0.425kg.

3.6 The delivery hose couplings shall be of φ 63mm and consist of male half and female half coupling assembled with washer as per IS: 903.

4.0 **Performance Requirements**

4.1 The delivery hose pipe shall be tested for kink, hydrostatic burst pressure, change in length and diameter, adhesion, abrasion resistance, moisture absorption and heat resistance as per methods and parameters mentioned in IS: 636.

4.2 The couplings shall be subjected to a hydraulic pressure of 2.1MN/mm² for a period of 2.5 minutes for the purpose of locating porosity in the casting and other defects. The couplings shall not show any sign of leakage or sweating.

5.0 **Workmanship and Finish**

5.1 The jacket shall be practically free from dirt, knots, lumps, irregularities of the yarn and
other visible defects.

5.2 Inner lining shall be of rubberized fabric and shall be generally smooth and practically free from pitting and other imperfections.

5.3 All fittings shall be of good workmanship, finish, clear of burrs and sharp edges. All forgings and castings shall be clean and sound and shall be free from porosity, blowholes, scales, cracks and other imperfections and shall not be repaired or filled so as to hide casting defects. The water way of the fillings shall have a smooth finish.

6.0 Packing and Marking

6.1 Packing

The hoses may be dusted with French Chalk as per IS: 380 on the inside and shall be packed and delivered in a length of 15M in neat, clean and dry condition in Polyethylene bags.

6.2 Marking

A) Fire Hose

Beginning at a point not less than one meter from each end, each length of hose shall be marked with clear and indelible letters at least 20mm in height indicating:

a) Manufacturers name or trade-mark or both
b) Type, length and size of Hose
c) Month and year of manufacture
d) The Fire Hose shall also be marked with the BIS certification mark.

B) Delivery Couplings

The male and female instantaneous couplings shall be separately, clearly and permanently marked with following information:

a) Manufacturers name and trade-mark
b) Size of couplings
c) Year of manufacture
d) The Couplings shall also be marked with the BIS certification mark.
STANDARD SPECIFICATION FOR
HOSE CABINET
CONTENTS

1.0 SCOPE
2.0 DESCRIPTIONS
3.0 MATERIAL OF CONSTRUCTION
4.0 PAINTING AND MARKING
1.0 **SCOPE**

This standard lays down overall requirements regarding construction, material, design, shape and fixing arrangements of fire hose cabinet to be installed near fire hydrants and to be used for keeping fire fighting accessories.

2.0 **DESCRIPTION OF CABINET**

2.1 Depending upon place of installation to suit the requirement, hose cabinets shall be of two sizes and types for accommodating delivery hose, jet nozzle with branch pipe, or universal branch pipe, fireman axe (if required). The two types of hose cabinets have been defined as Type-A and Type-B.

2.2 Type-A hose cabinets are suitable for wall mounting installations. They shall be able to accommodate, one 63mm delivery hose having length 15m with end male / female coupling, one jet nozzle with branch pipe or alternately one universal branch pipe.

2.3 Type-A cabinet shall have single panel glass door. Necessary hangers and brackets for proper keeping / positioning of delivery hose, nozzles and branch pipe or universal branch pipe inside shall be provided with the cabinet.

2.4 Type-B hose cabinet shall be of self-supporting type and shall be suitable for outside installation. They shall be capable to accommodate two 63mm delivery hoses of 15m length with end couplings, two jet nozzles with branch pipe or two universal branch pipes.

2.5 Type-B hose cabinet shall have double panel glass door. Necessary hangers and brackets for proper keeping / positioning of delivery hose, nozzles and branch pipe or universal branch pipe inside shall be provided with the cabinet.

2.6 Both types of hose cabinets shall be provided with handle type lock, a small recess to keep cabinet key under glass cover, a small hammer secured to the cabinet with a chain to break open the key glass cover.

3.0 **MATERIAL OF CONSTRUCTION**

3.1 The hose cabinet shall be made of 16 gauge M.S. sheet suitably welded with single / double MS door frame glass covered, depending upon the type of hose cabinet. Glass shall be fitted to the door with gasket and rubber bidding so that it fits securely.

3.2 Door of the hose cabinet shall be provided with standard handle type lock - Godrej, Mortise or equivalent with prior approval of owner / MECON.

3.3 Hammer shall be made of M.S. whereas Chain for securing purpose of hammer shall

TS-PE-CO2-6.8-2
be made of G.I.

3.4 Angle iron or M.S. round pipe of suitable size as per instruction of owner / MECON shall be provided for supporting Type-B cabinet.

3.5 Universal branch pipe shall confirm to IS: 2171. End coupling jet nozzle and branch pipe shall confirm to IS:903.

4.0 MARKING AND PAINTING

4.1 Each hose cabinet shall be painted with 3 coats of anti-corrosive paint of fire red color from outside and white paint from inside. Each cabinet shall be clearly and permanently marked as following:

   i. The word in bold letters marked as “FIRE HOSE CABINET”
   ii. Method of operation regarding opening and operation of equipments placed inside.
   iii. List of equipments placed inside the fire cabinet.
   iv. Year of manufacture.
STANDARD SPECIFICATION FOR
DELUGE VALVE
# CONTENTS

1.0 SCOPE  
2.0 CODES AND STANDARDS  
3.0 DESIGN REQUIREMENT  
4.0 MATERIAL OF CONSTRUCTION  
5.0 CONSTRUCTION AND PERFORMANCE  
6.0 INSPECTION AND MARKING  
7.0 INFORMATION REQUIRED FROM VENDOR
1.0 **SCOPE**

This standard lays down requirements regarding construction, material, shape, and method of operation, performance and test of automatic deluge valve for fire water distribution.

2.0 **CODES AND STANDARDS**

The following codes and standards shall be followed for deluge valve:

1. Rules for automatic sprinkler installation published by TAC.
2. Applicable ISI codes
3. NFPA guidelines

3.0 **DESIGN REQUIREMENT**

3.1 An automatic deluge valve shall consist of following:

a) Deluge Valve unit
b) Diaphragm Unit
c) Integral Test and drain valve manifold
d) Alarm System
e) Priming Equipment
f) Installation stop valve with pressure gauge and outlet valve
g) Detector pipe work manifold
h) Emergency release box
i) Solenoid valve system for remote actuation of deluge valve

3.2 Size and capacity of deluge valve shall be as under:

<table>
<thead>
<tr>
<th>Size</th>
<th>Rated Flow</th>
<th>Working Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inch(mm)</td>
<td>M³/hr</td>
<td>Kg/cm² g.</td>
</tr>
<tr>
<td>2(50)</td>
<td>10 to 50</td>
<td>7.0 to 10.5</td>
</tr>
<tr>
<td>3(75)</td>
<td>50 to 100</td>
<td>7.0 to 10.5</td>
</tr>
<tr>
<td>4(100)</td>
<td>100 to 200</td>
<td>7.0 to 10.5</td>
</tr>
<tr>
<td>6(150)</td>
<td>200 to 450</td>
<td>7.0 to 10.5</td>
</tr>
<tr>
<td>8(200)</td>
<td>450 to 1000</td>
<td>7.0 to 10.5</td>
</tr>
</tbody>
</table>

3.3 The deluge valve shall be provided with solenoid operated air release valve for remote operation. If deluge valve in located in hazardous area, alarm switch shall be intrinsically safe and flameproof.

4.0 **MATERIAL OF CONSTRUCTION**

4.1 For non saline water service, the material of construction shall be as follows:

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MECON LIMITED
Delhi

TECHNICAL SPECIFICATION FOR
DELUGE VALVE
MEC/TS/05/21/081F/B

MECON LIMITED

Body : Cast Iron to Is 210 Gr. FG 200
Seat : Bronze
Clapper : Bronze
Clack : Graphite Iron
Diaphragm spindle & hinged pin : SS 304
Test and drain valve : Cast Iron
Installation stop valve & outlet valve : Cast Iron to Is:780 Class PN 1.6
Check Valve : IS: 5312 Part-II
Diaphragm & Seat Rubber : Neoprine

4.2 For saline water service, aluminum bronze material shall be used in place of cast iron.

5.0 CONSTRUCTION AND PERFORMANCE

5.1 The deluge valve unit shall be provided with a clack to keep the valve close through a diaphragm unit.

5.2 The deluge valve shall also be fitted with an integral test and drain manifold. It shall consist of 50mm test and drain valve, air body drain valve and a drip valve.

5.3 The test valve shall allow water to flow through the deluge valve to drain during testing of deluge valve and to drain water from distribution pipe after fire. At open position the valve clack shall be held against its seating by an internal compression spring of sufficient strength to keep it in closed position till the pressure acting on underside of it does not exceed approx. 0.3 Kg/cm2. The clack will open at pressure exceeding 0.3 Kg/cm2.

5.4 The drain valve shall drain all the water from the deluge valve body and the outlet connections during maintenance of the deluge valve. The drain pipe work is to be designed to periodically check the rate of flow available in the system to satisfy the requirements appropriate to the hazard class for which the deluge valve is provided. Flow measurement shall be checked with differential pressure.

Water operated alarm motor gang shall be connected to the test and drain valve so that it gives an alarm as the deluge valve opens.

5.5 On detector pipe work manifold, test valve shall be provided at one end while on air supply pipe one air pressure regulator, check valve and gate valve shall be provided. Both detector pipe work and air supply line shall be terminated with flanged ends. Piping shall be GI to IS 1239 medium grade. Instrument air shall be supplied at a specified pressure by the owner. Vendor shall supply suitable air pressure regulator.

In addition to above an electric pressure switch shall be provided to give alarm at “Low air pressure” and “fire condition”. Low air pressure alarm shall be set at 1.7Kg/cm2 while for fire it shall be set at 0.7Kg/cm2. When fire occurs and deluge
valve opens, the two alarms shall be given in rapid succession.

Provision for changing the set pressure of both the alarms shall also be provided. A test plunger shall be provided to test the alarm switches without disturbing the valves.

An additional low air pressure alarm shall be provided to indicate low-low air pressure at approx. 1.4 Kg/cm². The alarm switches shall thus activate at low pressure of 1.7 Kg/cm² and dangerously low pressure of 1.4 Kg/cm² along with alarm to initiate warning of fire. Vendor shall confirm these set pressure based on inlet water supply pressure.

For manual remote operation of the valve, solenoid operated air release valve or gas based detection system activated valve shall be provided.

5.6 Installation stop valve and outlet valve above deluge valve shall be as per IS: 780 class PN 1.6. In addition following provision shall be made:

Both the valve must be strapped (not chained) and padlocked in open position at all normal times. End flanges of both the valves shall be flat face, dimensions confirming to ANSI B 16.5 150 lb rating.

5.7 The deluge valve shall be tested for operation / opening at set pressure and operation of the alarms at set pressures.

5.8 For testing and setting of deluge valve, a priming valve and a vent shall be provided with deluge valve assembly. At all normal times and when testing the deluge valve according to various tests required, the body of the deluge valve shall remain full of water.

5.9 Pressure guage shall be fitted immediately above the deluge valve on water supply line. Another pressure guage shall be provided on detector pipe work manifold.

Pressure gauge shall be bourdon type and shall be weather proof to NEMA-4. Vendor shall specify the range of the pressure gauge and also submit detailed specification / data sheet of the instrument.

5.10 The complete valve assembly shall be of good workmanship and furnish and shall be free from burrs and sharp edges. All waterways shall have smooth finish.

5.11 The deluge valve shall be tested for a test pressure of 25Kg/cm².

6.0 INSPECTION AND MARKING

6.1 Owner / MECON shall have access at all reasonable times to the manufacturer’s works where the deluge valve assembly are being manufactured or being tested.

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6.2 Deluge valve assembly shall be clearly permanently marked with the purchaser’s name, design and test pressure.

7.0 INFORMATION REQUIRED FROM VENDOR

7.1 The vendor shall furnish the following information along with the offer and for approval, prior to fabrication:

a) General arrangement of deluge valve assembly and elevation.
b) Constructional features of deluge valve assembly
c) Data sheet of the deluge valve
d) Initial setting procedure and details of deluge valve
e) Automatic and manual operational procedures
f) Periodic testing and safety procedures.

7.2 Following information shall be furnished by the vendor along with the supply of the deluge valve:

7.2.1 Instruction books for the guidance of the user including both the operating and normal maintenance procedures. The books shall include an itemized and illustrated part list / spare parts list giving reference no. of all the wearing parts.

7.2.2 Duly approved final drawings listed above in clause 7.1
STANDARD TECHNICAL SPECIFICATION FOR EMULSIFIER SYSTEM
1.0 SCOPE OF SUPPLY OF EQUIPMENT AND SERVICES

1.1 GENERAL

This specification lays down the broad technical specification for the automatic emulsifier system to be provided for the main power transformers of the main step down station of GGS being set up by M/s GEECL.

1.2 SCOPE

This specification covers design, supply, fabrication, erection, testing and commissioning complete with all mechanical and electrical items as elaborated in the following paragraphs. The system shall consist of the following as mechanical part of the system.

- Deluge valve assembly
- Piping for Water, pipe support, flanges etc.
- Quartzoid bulb detectors
- High velocity spray nozzles
- Fittings and valves viz. sluice valve, non-return valve, float valve, drain valve etc.

2.0 DESCRIPTION OF THE SYSTEM

The system shall comprise water supply at high pressure, adequate number of spray nozzles and quartzoid bulb detectors to be located at strategic points, deluge valve, piping, audio-visual alarm system, control panel etc. Water shall be tapped from nearby sprinkler line. Water from static water tank shall be pumped to the system by means of the main pump to obtain the required minimum pressure at the remotest nozzle. Provision for 100% standby pump set to meet the emergency requirement shall be made. The delivery side of the pump shall be connected through a set of back pressure valves and stop valves to the Emulsifier System. These pumps shall have automatic starting facility which will start the pumps whenever the delivery pressure drops below a preset valve.

High velocity water spray nozzles shall be installed all around the transformers. The number, spacing and discharge angles shall be so decided as to give effective coverage.
The quartzoid bulb heat detectors shall be placed on all sides of the transformer. The detectors shall be planned to be mounted on independent pipe line of compressed air. The heat sensing quartzoid bulb detectors shall shatter at 79 deg. C in case of a fire, creating a drop in the air pressure in the detector pipe line.

Under normal condition the system shall be kept in automatic mode. Due to leakage of water in the system, the water level in the tank shall fall resulting in pressure drop in the system. This shall actuate the pressure switch to start the pump. The jockey pump shall be automatically started by the actuation of level switch. When the water level rises beyond a preset level, the jockey pump shall be stopped automatically by the actuation of the level switch.

In case of fire, the temperature will rise and the gas inside the quartzoid bulb detector will expand to shatter the bulb. Water will then be released through the detector openings reducing the pressure rapidly. This will cause the deluge valve clack to get lifted by the hydraulic thrust on the downside of the deluge valve, which in turn shall allow water to get sprayed through the nozzles. This will result in rapid fall in pressure in the water line which will actuate the pressure switch to start the main electrically driven pump. In case of power failure the pressure shall drop further to actuate the pressure switch for starting the standby pump.

**3.0 EQUIPMENT DETAILS (MECHANICAL)**

3.1 AUTOMATIC DELUGE VALVE

The deluge valve shall be basically hydraulically operated water valves actuated by release of water in the detector pipe work. The deluge valve assembly shall be provided with `Y` type strainers in order to segregate foreign matter.

3.2 QUARTZOID BULB DETECTORS

Quartzoid bulb detectors shall be provided as heat sensing elements. The detectors shall be placed encompassing the entire surface of the transformer. The detectors shall be mounted on independent pipe line charged with water at pressure of about 4 kg/sq.cm. The heat sensing quartzoid bulb shall operate at 79 deg. C. Area covered by each detector shall not be more than 9.0 sq.m.

3.3 SPRAY NOZZLES

High velocity water spray nozzles shall be installed all around the transformer in such a manner that the entire surface of the transformers is encompassed for uniform spray of water. For this a piping cage shall be erected around the transformer. The number, spacing and discharge angles of the nozzles shall be so decided as to give effective coverage with an optimum discharge of water (11 1/sq.m/minute) to minimize the
extent of damage to the equipment.

3.4 VALVES

All the valves shall be provided with matching flanges, bolts, nuts, gaskets, washers etc. Gate valves shall conform to the relevant class of IS: 780/ IS: 2906 while non return valves shall be as per IS: 5312. All the valves shall be provided with proper support.

3.5 PIPES AND FITTINGS

Pipes upto DN 150 shall be ERW steel pipes as per IS: 1239 Part-I (medium) and pipes above DN 150 shall be ERW steel pipes as per IS: 3589. Pipe fittings such as bends, tees, reducers of size less than DN 150 shall be as per IS: 1239 Part-II and of sizes above DN 150 shall be fabricated. All the pipes shall be adequately supported.

The underground pipe shall be laid 1 m below the ground. The MS pipes to be laid underground shall have suitable coating and wrapping with 2 coats of coal tar, hot enamel paint and two wraps of reinforced fiber glass tissue or bituminized hessian.

The piping shall be capable of withstanding for two hours a pressure of 3.5 kg/sq.cm in excess of the maximum working pressure.

All the flanges shall be faced and have jointing of rubber insertion or asbestos compound. Wherever the underground pipes cross the road, suitable encasing pipes shall be provided.

The laying of pipes shall be included in the tenderer's scope of work.
TECHNICAL SPECIFICATION FOR MEDIUM VELOCITY WATER SPRAY SYSTEM
1.0 SCOPE OF SUPPLY OF EQUIPMENT AND SERVICES

1.1 GENERAL

This specification lays down the broad technical specification for the medium velocity water spray system to be provided for various areas as specified in SOR, specifications.

For fluids flashing at below 65° C (150° F), extinguishments is always not possible or even desirable and for these, Medium Velocity Water Sprayers need to be installed to provide cooling, controlling the burning and/or exposure protection to protect processing blocks, processing equipments, structures, flammable liquid and gas vessel, piping and equipment LPG bottling plants, spot protection etc..

1.2 SCOPE

This specification covers design, supply, fabrication, erection, testing and commissioning complete with all mechanical and electrical items as elaborated in the following paragraphs. The system shall consist of the following as mechanical part of the system.

- Deluge valve assembly
- Piping for Water, pipe support & flanges etc.
- Sprinkler based detectors
- Medium velocity spray nozzles or sprayers
- Fittings and valves viz. sluice valve, non-return valve, float valve, drain valve etc.

2.0 DESCRIPTION OF THE SYSTEM

This is a special fixed pipe system connected to a reliable source of fire protection water supply and equipped with water spray nozzles for specific water discharge and distribution over the surface or area to be protected. The piping system is connected to the water supply through an automatically actuated Deluge Valve, which initiates flow of water. Automatic actuation is achieved by operation of automatic detecting equipment installed along with water spray nozzles. The system comprises of:

a) SPRAY NOZZLE
It is normally open water discharging device called Sprayers which, when supplied with water under pressure will distribute the water in a special, directional pattern peculiar to the particular device. These nozzles are made in a range of orifice sizes with varying discharge angles so that discharge can be controlled for optimum protection.

b) DELUGE VALVE

Deluge valve is quick opening valve, which admits water automatically to a system of projectors or sprayers and is operated by a system of detectors and/or sprinklers installed in the same areas as nozzles.

c) DETECTION SYSTEM

In case of water spray systems, detection systems are required for activating the Deluge system for spot protection (outdoors and indoors).

For the above protections, sprinklers are found in extensive application in view of their reliability. However the contractor can recommend / suggest other types of detection systems. The design of detection system by sprinklers varies from risk to risk in case of water spray systems and shall be governed in accordance with TAC guidelines for rules of water spray systems.

The system shall comprise water supply at high pressure, adequate number of spray nozzles and quartzoid bulb detectors to be located at strategic points, deluge valve, piping, audio-visual alarm system, control panel etc. Water shall be tapped from nearby sprinkler line. Water from static water tank shall be pumped to the system by means of the main pump to obtain the required minimum pressure at the remotest nozzle. Provision for 100% standby pump set to meet the emergency requirement shall be made. The delivery side of the pump shall be connected through a set of back pressure valves and stop valves to the Emulsifier System. These pumps shall have automatic starting facility, which will start the pumps whenever the delivery pressure drops below a preset valve.

High velocity water spray nozzles shall be installed all around the transformers. The number, spacing and discharge angles shall be so decided as to give effective coverage.

The quartzoid bulb heat detectors shall be placed on all sides of the transformer. The detectors shall be planned to be mounted on independent pipe line of compressed air. The heat sensing quartzoid bulb detectors shall shatter at 79 deg. C in case of a fire, creating a drop in the air pressure in the detector pipe line.
Under normal condition the system shall be kept in automatic mode. Due to leakage of water in the system, the water level in the tank shall fall resulting in pressure drop in the system. This shall actuate the pressure switch to start the pump. The jockey pump shall be automatically started by the actuation of level switch. When the water level rises beyond a preset level, the jockey pump shall be stopped automatically by the actuation of the level switch.

In case of fire, the temperature will rise and the gas inside the quartzoid bulb detector will expand to shatter the bulb. Water will then be released through the detector openings reducing the pressure rapidly. This will cause the deluge valve clack to get lifted by the hydraulic thrust on the downside of the deluge valve, which in turn shall allow water to get sprayed through the nozzles. This will result in rapid fall in pressure in the water line, which will actuate the pressure switch to start the main electrically driven pump. In case of power failure the pressure shall drop further to actuate the pressure switch for starting the standby pump.

3.0 EQUIPMENT DETAILS (MECHANICAL)

3.1 AUTOMATIC DELUGE VALVE

The deluge valve shall be a basically hydraulically operated water valve actuated by release of water in the detector pipe work. The deluge valve assembly shall be provided with `Y' type strainers in order to segregate foreign matter.

3.2 QUARTZOID BULB DETECTORS

Quartzoid bulb detectors shall be provided as heat sensing elements. The detectors shall be placed encompassing the entire surface of the transformer. The detectors shall be mounted on independent pipeline charged with water at pressure of about 4 kg/sq.cm. The heat sensing quartzoid bulb shall operate at 79 deg. C. Area covered by each detector shall not be more than 9.0 sq.m.

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High velocity water spray nozzles shall be installed all around the transformer in such a manner that the entire surface of the transformers is encompassed for uniform spray of water. For this a piping cage shall be erected around the transformer. The number, spacing and discharge angles of the nozzles shall be so decided as to give effective coverage with an optimum discharge of water (11 l/sq.m/minute) to minimise the extent of damage to the equipment.

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The underground pipe shall be laid 1 m below the ground. The MS pipes to be laid underground shall have suitable coating and wrapping with 2 coats of coal tar, hot enamel paint and two wraps of reinforced fibre glass tissue or bitumenised Hessian.

The piping shall be capable of withstanding for two hours a pressure of 3.5 kg/sq.cm in excess of the maximum working pressure.

All the flanges shall be faced and have jointing of rubber insertion or asbestos compound. Wherever the underground pipes cross the road, suitable encasing pipes shall be provided.

The laying of pipes shall be included in the tenderer's scope of work.
SPECIFICATION FOR SHOP & FIELD PAINTING

SPECIFICATION NO.: MEC/ S/ 05/ 21/ 07

(OIL & GAS SBU) MECON LIMITED DELHI 110 092
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**PREPARED BY:** (Shalini Singh)  
**CHECKED BY:** (Sunil Kumar)  
**APPROVED BY:** (A.K. Johri)  
**ISSUE DATE:** Dec. 2008
1.0 GENERAL

1.1 These technical specifications shall be applicable for the work covered by the contract, and without prejudice to the various codes of practice, standard specifications etc. it is understood that contractor shall complete the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of Engineer-in-charge.

1.2 Wherever it is stated in the specification that a specific material is to be supplied or a specific work is to be done it shall be deemed that the same shall be supplied or carried out by the contractor.

Any deviation from this standard without within deviation permit from appropriate authority will result in rejection to job.

2.0 SCOPE

Scope of work covered in the specification shall include, but not limited to the following.

2.1 This specification defines the requirements for surface preparation, selection and application of paint on external surfaces of equipment, vessels, machinery, piping, ducts, steel structures, external & internal protection of storage tanks for all services RCC Chimney & MS Chimney with or without refractory lining and flare lines etc.

2.2 Extent of Works

2.2.1 The following surface and materials shall require shop, pre-erection and field painting.

a. All uninsulated C. S. & A.S. equipment like columns, vessels, drums, storage tanks, heat exchangers, pumps, compressors, electrical panels and motors etc.

b. All uninsulated carbon and low alloy piping fitting and valves (including painting of identification marks), furnace, ducts and stacks.

c. All items contained in a package unit as necessary.

d. All structural steel work, pipe, structural steel supports, walkways, handrails, ladders, platforms etc.
### Title
**SHOP & FIELD PAINTING**

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#### e. RCC/ MS chimneys with or without refractory lining & Flare lines.

#### f. Identification colour bands on all piping as required including insulated aluminium clad, galvanised, SS and non-ferrous piping.

#### g. Identification lettering/ numbering on all painted surface of equipment/ piping insulated aluminium clad, galvanised, SS and non-ferrous piping.

#### h. Marking/ identification signs on painted surfaces of equipment/ piping for hazardous service.

#### i. Supply of all primers, paints and all other materials required for painting other than owner’s supply.

#### j. Over insulation surface of equipments and pipes wherever required.

#### k. Painting under insulation for carbon steel and stainless steel as specified.

#### l. Repair work of damaged/ preerection/ fabrication shop primer and weld joints at field.

##### 2.2.2 The following surface and materials shall not be painted unless otherwise specified:

- **a.** Uninsulated austentic stainless steel.
- **b.** Plastic and/ or plastic coated materials.
- **c.** Non ferrous materials like aluminium, galvanised “piping”, “gratings” and “handrails” etc. except G. I. Towers.

##### 2.3 Documents

##### 2.3.1 The contractor shall perform the work in accordance with the following documents issued to him for executions of work.

- **a.** Bill of quantities for piping, equipment, machinery and structure etc.
- **b.** Piping line list.
- **c.** Painting specifications including special civil defence requirement.
2.4 Unless otherwise instructed final painting on pre-erection/ shop primed pipes and equipments shall be painted in the field, only after mechanical completion and testing on system are completed as well as, after completion of steam purging wherever required.

2.5 Changes and deviations required for any specific job due to clients requirement or otherwise shall be referred to MECON for deviation permit.

3.0 CODES & STANDARDS

3.1 Without prejudice to the provision of clause 1.1 above and the detailed specifications of the contract, the following codes and standards shall be followed for the work covered by this contract.

- **IS:5** : Colour coding
- **IS-101** : Methods of test for ready mixed paint and enamels.
- **IS-2379:1990** : Indian standard for pipe line Identification – Colour code.
- **ASTM Vol. 6.01 and 6.03** : American standard test methods for Paints and coatings.
- **ANSI A 13.1-1981** : Scheme for Identification of piping systems

3.2 Surface Preparation Standards:

Following standards shall be followed for surface preparations:

(Surface preparation standards for painting steel surfaces).

This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-in-Charge.
3.2.2 Steel structure painting Council, U.S.A (surface preparations specifications (SSPC-SP).

3.2.3 British standard (surface finish or Blast-cleaned for painting) BS:4232

3.2.4 National Associations of Corrosion Engineers, U.S.A. (NACE)

3.2.5 Various International Standards equivalent to swedish Standard for surface preparation are given in Table-I.

3.3 The contractor shall arrange, at his own cost, to keep a set of latest edition of any one of the above standards and codes at site.

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

   a. Instructions for storage to avoid exposure as well as extremes of temperature.
   b. Surface preparations prior to painting.
   c. Mixing and thinning.
   d. Application of paints and the recommended limit on time intervals between coats.

4.0 EQUIPMENT

4.1 All tools, brushes, rollers, spray guns, abrasive materials hand/ power tools for leaning and all equipments, scaffolding materials, shot/ wet abrasive blasting, water blasting equipments & air compressors etc. required to be used shall be suitable for the work and all in good order and shall be arranged by the contractor at site and in sufficient quantity.

Mechanical mixing shall be used for paint mixing operations in case of two pack systems except that the Engineer-in-Charge may allow the hand mixing of small quantities at his discretion.

5.0 SURFACE PREPARATION, SHOP COAT, COATING APPLICATION & REPAIR AND DOCUMENTATION

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

a. Manual or hand tools cleaning.

b. Mechanical or power tool cleaning.

c. Blast cleaning.

5.1.2 Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. The minimum acceptable standard in case of manual or hand tool cleaning shall be St. 2 or equivalent, in case of mechanical or power tool cleaning it shall be St. 3 or equivalent, in case of blast cleaning it shall be Sa 2½ or equivalent as per Swedish Standard SIS-055900-1967/ ISO-8501-1-1988. Where highly corrosive condition exits, then blast cleaning shall be Sa3 as per Swedish Standard.

Remove all other contaminants, oil, grease etc. by use of an aromatic solvent prior to surface cleaning.

5.1.3 Blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceeding 85%.

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

5.1.5 The external surface of R.C.C. chimney to be painted be dry and clean. Any loose particle of stand, cement, aggregate etc. shall be removed by rubbing with soft wire brush if necessary, acid etching with 10-15% HCL solution about 15 minutes shall be carried out and surface must be thorough washed with water to remove acid & loose particles then dry completely before application of paint.

5.2 Procedure of Surface Preparation.
5.2.1 Blast Cleaning

5.2.1.1 Air Blast Cleaning

The surface shall be blast cleaned using one of the abrasives: $\text{Al}_2\text{O}_3$ particles chilled cast iron or malleable iron and steel at pressure of 7kg. Cm$^2$ at appropriate distance and angle depending on nozzle size maintaining constant velocity and pressure. Chilled cast iron, malleable iron and steel shall be in the form of shot or grit of size not greater than 0.055" maximum in case of steel and malleable iron and 0.04" maximum in case of chilled iron. Compressed air shall be free from moisture and oil. The blasting nozzles should be venturei style with tungsten carbide or boron carbide as the material for liners. Nozzles orifice may vary from 3/16” to ¾”. On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey white metallic luster. Primer or first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall bot be done outdoors in bad weather without adequate protection or when there is dew on the metal which is to be cleaned, surface profile shall be uniform to provide good key to the paint adhesion (i.e.35 to 50 $\mu$). If possible vacuum collector shall be installed for collecting the abrasive and recycling.

5.2.1.2 Water Blast cleaning

Environmental, health and safety problems associated with abrasive blast cleaning limit the application of air blast cleaning in many installations. In such case water blast cleaning is resorted to.

Water blast cleaning can be applied with or without abrasive and high-pressure water blasting. The water used shall be inhibited with sodium chromate/ phosphate. The blast cleaned surface shall be washed thoroughly with detergents and wiped solvent and dried with compressed Air. For effective cleaning abrasives are used. The most commonly used pressure for high pressure water blast cleaning for maintenance surface preparation is 3000 to 6000 psi at 35-45 liters/ minute water volume and pressure upto 10000 psi and water volume of 45 liters/ minute provide maximum cleaning.

The water blast cleaned surface shall be comparable to SSPC-SP-12/ NACE No. 5. The operation shall be carried out as per SSPC guidelines for water blast cleaning. The indicative values for sand injection is

Air : 300 to 400 Cu.ft/ min.
Water : 5-10 liter/ min. with corrosion inhibitor
Sand : 200-400 lbs/ hr.
Nozzle : 0.5 to 1” dia

Special equipments for water blast cleaning with abrasives now available shall be used.

5.2.2 Mechanical of Power tool cleaning

Power tool cleaning shall be done mechanical striking tools, chipping hammers, grinding wheels or rotating steels wire-brushes. Excessive burnish of surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust mill scale etc. shall be removed by clean rags and/ or washed by water or stream and thoroughly dried with compressed air jet before application of paint.

5.2.3 Manual or hand tool cleaning

Manual or hand tool cleaning is used only where safety problems limit the application of other surface preparation procedure and hence dones not appear in the specifications of paint systems.

Hand tool cleaning normally consists of the following:

a. Hand descaling and/ or hammering
b. Hand scraping
c. Hand wire brushing

Rust, mill scale spatters, old coating and other foreign matter, shall be removed by hammering, scrapping tools, emery paper cleaning, wire brushing or combination of the above methods. On completion of cleaning, loose materials shall be removed from the surface by clean rags and the surface shall be brushed, swept, deducted and blown off with compressed air/ steam to remove all loose matter. Finally the surface may be washed with water and dried for effective cleaning.

5.3 Non compatible shop coat primer

The compatibility of finishing coat should be confirmed from the paint manufacturer. In the event of use of primer such as zinc rich epoxy, inorganic zinc silicate etc. as shop coat the pant system shall depend on condition of shop coat, if shop coat is in satisfactory condition showing no major defects, the shop
coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer-in-Charge.

5.4 Shop coated (coated with primer & finishing coat) equipment should not be repainted unless paint is damaged.

5.5 Shop primed equipment and surface will only be 'spot cleaned' in damaged areas by means of power tool brush cleaning and then spot primed before applying one coat of filed primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer should be completely removed before applications of selected paints system for particular environment.

5.6 For packaged units/ equipment, shop primer should be as per the paint system given in this specification. However, manufacturer's standard can be followed after review.

5.7 Coating Procedure and Application:

5.7.1 Surface shall not be coated in rain, wind or in environment where injurious airbone elements exists, when the steel surface temperature is less than 5° F above dew point when the relative humidity is greater then 85% or when the temperature is below 40° F.

5.7.2 Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hrs. the same day.

5.7.3 To the maximum extent practicable, each coat of material shall be applied as a continuous film uniform thickness free of probes. Any spots or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

5.7.4 Each coat shall be proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can applied without the development of any detrimental film irregularities such as lifting or loose of adhesion of the under coat. Manufacturer instruction shall be followed for intercoat interval.

5.7.5 When the successive coat of the same colour have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life.
5.7.6 Air spray application shall be in accordance with the following:

a. The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied, and shall be equipped with suitable pressure regulators and gauges. The air caps, nozzles, and needles shall be those recommended by the manufacturer of the equipment for the material being sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.

b. Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. The air from the spray gun impinging against the surface shall show condensed water or oil.

c. **Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous mechanical agitation.**

d. The pressure on the material in the pot and of the air at the gun shall be adjusted for optimum spraying effectiveness. The pressure on the material in the pot shall be adjusted when necessary for change in elevation of the gun above the pot. The atomizing air pressure at the gun shall be high enough to properly atomize the paint but not so high as to cause excessive fogging of paint, excessive evaporation of solvent, or less by overspray.

e. Spray equipment shall be kept sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film.

Any solvents left in the equipment shall be completely removed before applying paint to the surface begin painted.

f. Paint shall be applied in a uniform layer, with overlapping at the edge of the spray pattern. The spray patterns shall be adjusted so that the paint is deposited uniformly. During application the gun shall be held perpendicular to the surface and at a distance which will ensure that a wet layer of paint is deposited on the surface. The trigger of the gun should be released at the end of each stroke.

g. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface repainted.
h. Areas inaccessible to the spray gun shall be painted by brush: if not accessible by brush, daubers or sheepking shall be used.

i. All nameplates, manufacturer’s identification tags, machined surface instrument glass, finished flange faces, control valve items and similar items shall be masked to prohibit coating disposition. If these surface are coated, the component shall be cleaned and restored to its original condition.

j. Edges of structural shapes and irregular coated surface shall be coated first and an extra pass made later.

k. If spray gun shown choking, immediately dechoking procedure shall be followed.

5.7.7 Airless spray application shall be in accordance with the following procedure: as per steel structure paint manual vol. 1 & vol. 2. By SSPC, U.S.A., Air less spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor is used to operate a pump to produce pressures of 1,000 to 6,000 psi. Paint is delivered to the spray gun at this pressure through a single hose within the gun, a single paint stream is divided into separate streams, which are forced through a small orifice resulting in atomization of paint without the use of air. This result in more repaid coverage with less overspray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional airspray.

Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have in built agitator that keep the paint uniformly mixed during the spraying. The unit shall consists of in built strainer. Usually very small quantities of thinning is required before spray. Incase of High Build epoxy coating (two pack), 30:1 pump ratios and 0.020-0.023” tip size will provide a good spray pattern. Ideally fluid hoses should no be less than 3/8” ID and not longer than 50ft to obtain optimum results.

In case of gun choking, decoking steps shall be followed immediately.

5.7.8 Brush application of paint shall be in accordance with the following:

a. Brushes shall be of a style and quality that will enable proper application of paint
b. Round or oval brushes are most suitable for rivets, bolts, irregular surfaces and rough or pitted steel. Wide flat brushes are suitable for large flat areas, but they shall not have width over five inches.

c. Paints shall be applied into all corners.

d. Any runs or sags shall be brushed out.

e. There shall be minimum of brush marks left in the applied paint

f. Surface not accessible to brushes shall be painted by spray, duubers, or sheepkin.

5.7.9 Manual application by sling (where 6 O’clock position of pipe is not approachable)

A canvas strip (alternatively a tinplate strip) about 450mm wide and 1.5m longs is hold under the pipe by two men. Liquid coating poured on the sling at each side of the pipe. The men holding this sling move it up and down and walk slowly forward while fresh coating is poured on the pipe and they manipulate the sling so that an even coating is obtained all round the bottom. This work shall be done very carefully and by experienced personnel. There shall not be any formation of “Whiskers” and holes in the coating. The coating film shall be inspected by mirror.

5.7.10 For each coat the painter should know the WFT corresponding to the specified DFT and standardise the paint application technique to achieve the desired WFT. This is to be ensured in the qualification trial.

5.8 Drying of Coated Surface

5.8.1 No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat; if it exceeds the paint material has possible deteriorated or mixing is faulty.

5.8.2 No paint shall be force dried under condition which will cause checking, wrinkling blistering formation of pores, or detrimentally after the condition of the paint.
No drier shall be added to a paint on the job unless specifically called for in the manufacturer’s specification for the paint.

Paint shall be protected from rain, condensation, contamination snow and freezing until dry to the fullest extent practicable.

5.9 Repair of damaged paint surface.

5.9.1. Where paint has been damaged in handling and in transportation, the repair of damaged coating of pre-creation/ fabrication shall be as given below.

5.9.2. Repair of damaged inorganic zinc silicate primer after erection/ welding:

Quickly remove the primer from damaged area by mechanical scraping and emery paper to expose the white metal. Blasts clean the surfaces possible. Feather the primer over the intact adjacent surface surrounding the damaged area by emery paper.

5.9.3 Repair of damaged pre-erection and shop priming in the design temperature of 90° C to 500° C.

- Surface preparation shall be done as per procedure 5.9.2
- One coat of F-9 shall be applied wherever damaged was observed on pre-erection/ pre-fabrication/ shop primer of inorganic zinc silicate coating (F-9) shall not be applied if damaged area is not more than 5 x 5 cm.

5.10 PAINT APPLICATION

5.10.1 Shop priming/ pre-erection priming with F9 of F12 shall be done only on blasted surface.

5.10.2 Shop priming/ pre-erection priming with F-9 or F-12 shall be done only with airless spray.

5.10.3 For large flat surface field painting shall be done by airless spray otherwise brush can be used.

5.11 Assessment of Painting Requirement

The paint system to be applied for a specific job shall be arrived as sequentially as given below:
- Identify the environment from area classification details and chose the appropriate table.

- Identify the design temperature from the technical documents.

- Identify the specific field paint system and surface preparation requirement from the above identified table and temperature range.

- Identify the shop priming requirement from Table 7.1 based on compatibility of the above paint system.

- Identify the need of repair of shop primer and execute as per Table 7.2.

5.12 Documentation.

A written quality plan with procedure for qualification trials and for the actual work.
Daily progress report with details of weather condition, particular of application no of coats and type of materials applied, anomalies, progress of work versus programme.
Result of measurement of temperature relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.
Particular of surface preparation and paint application during trials and during the work.
Details of non-compliance, rejects and repairs.
Type of testing equipments and calibration.
Code and batch numbers of paint material used.
### TABLE-I (for clause 5.0)
SURFACE PREPARATION STANDARDS

<table>
<thead>
<tr>
<th>S. No.</th>
<th>DESCRIPTION</th>
<th>VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)</th>
<th>REMARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MANUAL OR HAND TOOL CLEANING&lt;br&gt;REMOVAL OF LOOSE RUST, LOOSE MILL SCALE AND LOOSE PAINT, CHIPPING, SCRAPING, SANDING AND WIRE BRUSHING, SURFACE SHOULD HAVE A FAINT METALLIC SHEEN.</td>
<td>SWEDISH STANDARD SIS-05-5900 1967</td>
<td>ST.2&lt;br&gt;SSPC-SP-2&lt;br&gt;-&lt;br&gt;-&lt;br&gt;THIS METHOD IS APPLIED WHEN THE SURFACE IS EXPOSED TO NORMAL ATMOSPHERIC CONDITION WHEN OTHER METHODS CANNOT BE ADOPTED AND ALSO FOR SPOT CLEANING DURING MAINTENANCE PAINTING.</td>
</tr>
<tr>
<td>2.</td>
<td>MECHANICAL OR POWER TOOL CLEANING&lt;br&gt;REMOVAL OF LOOSE RUST, LOOSE MILL SCALE AND LOOSE PAINT TO DEGREE SPECIFIED BY POWER TOOL CHIPPING, DESCALING, SANDING, WIRE BRUSHING AND GRINDING, AFTER REMOVAL OF DUST, SURFACE SHOULD HAVE A PRONOUNCED METALLIC SHEEN.</td>
<td>SSPC-SP-3</td>
<td>ST.3&lt;br&gt;-&lt;br&gt;-&lt;br&gt;-DO-</td>
</tr>
</tbody>
</table>
### TABLE-I (for clause 5.0)
#### SURFACE PREPARATION STANDARDS

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESCRIPTION</th>
<th>VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SWEDISH STANDARD SIS-05-5900 1967</td>
<td>SSPC-SP USA</td>
</tr>
<tr>
<td>3.</td>
<td>BLAST CLEANING (AIR &amp; WATER) THERE ARE FOUR COMMON GRADES OF BLAST CLEANING</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>WHITE METAL BLAST CLEANING TO WHITE METAL CLEANLINESS REMOVAL OF ALL VISIBLE RUST, MILL SCALE PAINT &amp; FOREIGN MATTER 100% CLEANLINESS WITH DESIRED SURFACE PROFILE.</td>
<td>SA-3</td>
<td>SSPC-SP-5</td>
</tr>
<tr>
<td>3.2</td>
<td>NEAR WHITE METAL BLAST CLEANING TO NEAR WHITE METAL CLEANLINESS, UNIT AT LEAST 95% OF EACH ELEMENTS OF SURFACE AREA IS FREE OF ALL VISIBLE RESIDUES WITH DESIRED SURFACE PROFILE.</td>
<td>SA 2 ½</td>
<td>SSPC-SP-10</td>
</tr>
</tbody>
</table>
### TABLE-I (for clause 5.0)

**SURFACE PREPARATION STANDARDS**

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESCRIPTION</th>
<th>VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SWEDISH STANDARD SIS-05-5900 1967</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SSPC-SP USA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NACE USA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BRITISH STANDARD BS-4232:1967</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>COMMERCIAL BLAST</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BLAST CLEANING UNIT AT LEAST TWO—THIRD OF EACH ELEMENT OF SURFACE AREA IS FREE OF ALL VISIBLE RESIDUES WITH DESIRED SURFACE PROFILE.</td>
<td>SA-2</td>
<td>SSPC-SP-6</td>
</tr>
<tr>
<td>3.4</td>
<td>BRUSH-OFF BLAST</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BLAST CLEANING TO WHITE METAL CLEANLINESS, REMOVAL OF ALL VISIBLE RUST, MILL SCALE, PAINT &amp; FOREIGN MATTER, SURFACE PROFILE IS NOT SO IMPORTANT.</td>
<td>SA-1</td>
<td>SSPC-SP-7</td>
</tr>
</tbody>
</table>
6.0 PAINT MATERIALS

Paint manufacturers shall furnish all the characteristics of paint material on printed literature, along with the test certificate for all the specified characteristics given in this specifications. All the paint materials shall be of first quality and conform to the following general characteristics as per the table 6.1, 6.2 and 6.3.
### PAINT MATERIALS

**TABLE NO.: 6.1 PRIMERS**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>DESCRIPTION</th>
<th>P-2</th>
<th>P-4</th>
<th>P-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Technical Name</td>
<td>Chlorinated rubber Zinc Phosphpate primer</td>
<td>Etch primer/ wash primer</td>
<td>Epoxy zinc phosphate primer</td>
</tr>
<tr>
<td>2.</td>
<td>Type and composition</td>
<td>Single pack, air drying chlorinated rubber based medium plasticised with unsaponifiable plasticiser, pigmented with Zic phosphate.</td>
<td>Two pack polyvinyl butyral resin medium cured with phosporic acid solution pigmented with zic tetroxy choromate.</td>
<td>Tow component polyamide cured epoxy resin medium, pigmented with zinc phosphate.</td>
</tr>
<tr>
<td>3.</td>
<td>Volume solids (approx)</td>
<td>40%</td>
<td>7-8%</td>
<td>40%</td>
</tr>
<tr>
<td>4.</td>
<td>DFT (Dry dilm thickness) per coat (approx)</td>
<td>40-50μ</td>
<td>8-10μ</td>
<td>40-50μ</td>
</tr>
<tr>
<td>5.</td>
<td>Theoretical covering capacity in M2/ coat/ litre (approx)</td>
<td>8-10</td>
<td>8-10</td>
<td>8-10</td>
</tr>
<tr>
<td>6.</td>
<td>Weight per litre in kgs/ litre (approx)</td>
<td>1.3</td>
<td>1.2</td>
<td>1.4</td>
</tr>
<tr>
<td>7.</td>
<td>Touch dry at 30° C (approx)</td>
<td>30 minutes</td>
<td>2 hrs.</td>
<td>After 30 mins.</td>
</tr>
<tr>
<td>9.</td>
<td>Over Coating Interval (approx.)</td>
<td>Min : 8 hrs Max : No limitation</td>
<td>Min : 4.6 hrs Max : 24 hrs</td>
<td>Min : 8 hrs Max : 3-6 months</td>
</tr>
<tr>
<td>10.</td>
<td>Pot life (approx) at 30° C for two component paints (approx).</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>8 hrs.</td>
</tr>
<tr>
<td>11.</td>
<td>Temperature Resistance</td>
<td>60°C</td>
<td>Not applicable</td>
<td>80°C</td>
</tr>
</tbody>
</table>
### TABLE NO.: 6.2 FINISH PAINT

<table>
<thead>
<tr>
<th>S. No</th>
<th>DESCRIPTION</th>
<th>F-2</th>
<th>F-3</th>
<th>F-6</th>
<th>F-7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Technical Name</td>
<td>Acrylic polyurethane finish paint</td>
<td>Chlorinated rubber based finish paint</td>
<td>Epoxy-High build finish paint</td>
<td>High build coalta epoxy coating.</td>
</tr>
<tr>
<td>2.</td>
<td>Type and composition</td>
<td>Two-pack aliphatic isocynate cured acrylic finish paint</td>
<td>Single pack plasticised chlorinated rubber based medium with chemical and weather resistant pigments.</td>
<td>Tow- pack polyamide/ ployamine cured epoxy resin medium suitable pigmented.</td>
<td>Tow pack polyamide cured epoxy resin blended with coal/ tar medium, suitably pigmented.</td>
</tr>
<tr>
<td>3.</td>
<td>Volume solids (approx)</td>
<td>40%</td>
<td>40%</td>
<td>62%</td>
<td>65%</td>
</tr>
<tr>
<td>4.</td>
<td>DFT (Dry film thickness) per coat (approx)</td>
<td>30-40μ</td>
<td>40-50μ</td>
<td>100-125μ</td>
<td>100-125μ</td>
</tr>
<tr>
<td>5.</td>
<td>Theoretical covering capacity in M2/ coat/ litre (approx)</td>
<td>10-13</td>
<td>8-10</td>
<td>5-6</td>
<td>5-2-6.5</td>
</tr>
<tr>
<td>6.</td>
<td>Weight per litre in kgs/ litre (approx)</td>
<td>1.3</td>
<td>1.2</td>
<td>1.4</td>
<td>1.5</td>
</tr>
<tr>
<td>7.</td>
<td>Touch dry at 30° C (approx)</td>
<td>1 hrs.</td>
<td>30 minutes</td>
<td>3 hrs.</td>
<td>4 hrs.</td>
</tr>
<tr>
<td>9.</td>
<td>Overcoating interval (approx)</td>
<td>Min.: Overnight (12 hrs. Max.: Unlimited</td>
<td>Min.: Overnight Max.: Unlimited</td>
<td>Min.: Overnight Max.: 5 day</td>
<td>Min.: 24 hrs. Max.: 5 day</td>
</tr>
<tr>
<td>10.</td>
<td>Pot life at 30° C for two component paints (approx)</td>
<td>6-8 hrs.</td>
<td>Not applicable</td>
<td>4-6 hrs.</td>
<td>4-6 hrs.</td>
</tr>
<tr>
<td>11.</td>
<td>Temperature Resistance</td>
<td>80°C</td>
<td>60°C</td>
<td>80°C</td>
<td>125°C</td>
</tr>
</tbody>
</table>
### TABLE NO.: 6.3 FINISH PAINTS

<table>
<thead>
<tr>
<th>S. No</th>
<th>DESCRIPTION</th>
<th>F-8</th>
<th>F-9</th>
<th>F-11</th>
<th>F-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Technical Name</td>
<td>Self priming type surface tolerant high build epoxy coating (Complete rust control coating)</td>
<td>Inorganic Zinc Silicate coating</td>
<td>Heat resistant synthetic medium based two pack aluminum paint suitable upto 250°C dry temperature</td>
<td>Heat resistant silicone aluminum paint suitable upto 500°C temperature</td>
</tr>
<tr>
<td>2.</td>
<td>Type and composition</td>
<td>Two-pack epoxy resin based suitable pigmented and capable pigmented and capable of adhering to manually prepared surface and old coating</td>
<td>A two-pack air drying self-curing solvent based inorganic zinc silicate coating.</td>
<td>Heat resistant synthetic medium based two pack aluminum paint suitable upto 250°C</td>
<td>Single pack silicone resin based medium with aluminum flakes.</td>
</tr>
<tr>
<td>3.</td>
<td>Volume solids (approx)</td>
<td>72%</td>
<td>60%</td>
<td>25%</td>
<td>20%</td>
</tr>
<tr>
<td>4.</td>
<td>DFT (Dry film thickness) per coat (approx)</td>
<td>100-125μ</td>
<td>65-75μ</td>
<td>20-25μ</td>
<td>20-25μ</td>
</tr>
<tr>
<td>5.</td>
<td>Theoretical covering capacity in M2/ coat/ litre</td>
<td>6.0-7.2</td>
<td>8-9</td>
<td>10-12</td>
<td>8-10</td>
</tr>
<tr>
<td>6.</td>
<td>Weight per litre in kgs/ litre (approx)</td>
<td>1.4</td>
<td>2.3</td>
<td>1.2</td>
<td>1.1</td>
</tr>
<tr>
<td>7.</td>
<td>Touch dry at 30° C (approx)</td>
<td>3 hrs.</td>
<td>30 min.</td>
<td>3 hrs.</td>
<td>30 min.</td>
</tr>
<tr>
<td>9.</td>
<td>Overcoating interval (approx)</td>
<td>Min.: 10 hrs. Max.: 6 months</td>
<td>Min.: 8 hrs. at 20°C and 50% RH. Max.: Unlimited</td>
<td>Min.: 16 hrs. Max.: Unlimited</td>
<td>Min.: 16 hrs. Max.: Unlimited</td>
</tr>
<tr>
<td>S. No</td>
<td>DESCRIPTION</td>
<td>F-8</td>
<td>F-9</td>
<td>F-11</td>
<td>F-12</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------------------------------------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>10.</td>
<td>Pot life (approx) at 30° C for two component paints (approx).</td>
<td>90 min.</td>
<td>4-6 hrs.</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>11.</td>
<td>Temperature resistance</td>
<td>80°C</td>
<td>400°C</td>
<td>250° C</td>
<td>500° C</td>
</tr>
</tbody>
</table>

F-14: Specially for mulated polyamine cured coal tal epoxy suitable for -45°C to 125°C for application under insulation
F-15: Two pack cold curved epoxy phenolic coating suitable for 45°C to 125°C for application under insulation
F-16: Eoxy siloxane anser coat 738
### PAINT MATERIALS

#### TABLE NO. 6.4 FINISH PAINTS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>F-14</th>
<th>F-15</th>
<th>F-16</th>
<th>F-17</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Technical name</td>
<td>Polyamine cured coal tar epoxy</td>
<td>Two-component epoxy phenolic coating cured with polyamine adduct hardner system (primer + intermediate coat + finish paint)</td>
<td>Ambient temperature curing Poly Siloxane coating / High build cold applied inorganic copolymer based aluminum coating suitable for under insulation coating of CS and SS piping for high temperature service.</td>
<td>Two component solvent free type high build epoxy phenolic / novalac epoxy phenolic coating cured with Polyamine adduct hardner system.</td>
</tr>
<tr>
<td>2.</td>
<td>Type &amp; composition</td>
<td>Specially formulated polyamine cured coal tar epoxy suitable for application under insulation</td>
<td>Two pack ambient temperature curing epoxy phenolic coating system suitable for application under insulation of CS / SS piping.</td>
<td>Amercoat 738 from Ameron Products, USA / Berger 938 from Berger Paints Ltd., or Intertherm 751 CSA from Akzo Nobel coating. Note: 6</td>
<td>Two component solvent free type high build epoxy phenolic / novalac epoxy phenolic coating cured with Polyamine adduct hardner system.</td>
</tr>
<tr>
<td>3.</td>
<td>Volume Solids (minimum)</td>
<td>70%</td>
<td>65%</td>
<td>60%</td>
<td>98-100%</td>
</tr>
<tr>
<td>4.</td>
<td>DFT (Dry Film thickness) per coat (minimum)</td>
<td>125 μm</td>
<td>75 - 100 μm</td>
<td>75 - 100 μm</td>
<td>125- 150 μm</td>
</tr>
<tr>
<td>5.</td>
<td>Theoretical covering capacity in M² / coat / litre (minimum)</td>
<td>5.5</td>
<td>6.5-8.5</td>
<td>6.0-8.0</td>
<td>6.5-8.0</td>
</tr>
<tr>
<td>6.</td>
<td>Weight per liter in kgs/litre (max paint) (minimum)</td>
<td>1.5</td>
<td>1.7</td>
<td>1.3</td>
<td>1.7</td>
</tr>
<tr>
<td>7.</td>
<td>Touch dry at 30°C (maximum)</td>
<td>4 hrs.</td>
<td>2 hrs.</td>
<td>1 hr.</td>
<td>2 hrs.</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Description</td>
<td>F-14</td>
<td>F-15</td>
<td>F-16</td>
<td>F-17</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>168 hrs.(7 days)</td>
<td>168 hrs.(7 days)</td>
<td>-</td>
<td>168 hrs.(7 days)</td>
</tr>
<tr>
<td>9.</td>
<td>Over-coating interval</td>
<td>Min. 6 hrs. Max. 5 days</td>
<td>Min. 36 hrs. Max. 21 days</td>
<td>Min. 16 hrs. Max. Not applicable</td>
<td>Min. 16 hrs. Max. 21 days</td>
</tr>
<tr>
<td>10.</td>
<td>Pot life at 30°C for two component paints (minimum)</td>
<td>4 hrs.</td>
<td>1.5 hrs.</td>
<td>1 hr.</td>
<td>1 hr.</td>
</tr>
<tr>
<td>11.</td>
<td>Temperature Resistance (min.)</td>
<td>-45°C to 125°C under insulation</td>
<td>-45°C to 125°C under insulation (Note : 5)</td>
<td>Up to 400°C for CS &amp; SS under insulation</td>
<td>-45°C to 150°C for immersion service</td>
</tr>
</tbody>
</table>

**Notes:**

1. Covering capacity and DFT depends on method of application. Covering capacity specified above are theoretical. Allowing the loose during the application, minimum specified DFT should be maintained.

2. All primers and finish coats should be cold cured and air drying unless otherwise specified.

3. All paints shall be applied in accordance with manufacturer's instruction for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured.

4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.

6.4 **List of recommended manufacturers**

The paint shall conform to the specifications given above and the best quality in their products range of the manufacturers listed in Annexure-I.

7.0 **PAINT SYSTEM**

The paint system should vary with type of environment envisaged in and around the plants. Three types of environment as given below are considered for selection of paint system. The paint system is also given for specific requirements.
Primers & finish coats covered in table nos. 7.0 to 15.0

PRIMERS

P-2 : Chlorinated Rubber Zinc Phosphate Primer
P-4 : Etch Primer/ Wash Primer
P-6 : Epoxy Zic Phosphate Primer

FINISH COATS/ PAINTS

F-2 : Acrylic- Polyurethane finish paint
F-3 : Chlorinated Rubber Finish Paint
F-6 : High Build Epoxy finish coating
F-7 : High Build Coal Tar epoxy coating
F-8 : Self-priming surface tolerant high build epoxy coating
F-9 : Inorganic Zinc Silicate Coating.
F-11 : Heat resistant Synthetic medium based Aluminum paint.
F-12 : Heat resistant Silicone Aluminum paint.
F-14 : Specially formulated polyamine-cured coal for Epoxy coating
F-15 : Epoxy phenolic coating
F-16 : Epoxy Siloxane Coating : Amercoat 738
F-17 : Two component solvent free type high built epoxy phenolic / novalac epoxy phenolic coating cured with polyamine.
### TABLE 7.1: PRE-ERECTION/ PRE-FABRICATION AND SHOP PRIMING FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL, STEEL STRUCTURE, PIPING AND EQUIPMENT ETC.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1.1</td>
<td>-90 TO 400</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9</td>
<td>65-75</td>
<td>No overcoating is to be done</td>
</tr>
<tr>
<td>7.1.2</td>
<td>401 To 500</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-12</td>
<td>40-50</td>
<td>Finish Coat at Site</td>
</tr>
<tr>
<td>7.1.3</td>
<td>-40 to 150 for Structures, hand rails and Grating only</td>
<td>SSPC-SP-3</td>
<td>1 COAT OF F-9 OR 2 COATS OF P-7 @ 40μ DFT / COAT</td>
<td>65-75 OF F-9 OR 80 (P-7)</td>
<td>For Damaged Area of more than 5 x 5 Cm2.</td>
</tr>
</tbody>
</table>

### TABLE 7.2: REPAIR OF PRE-ERECTION/ PRE- FABRICATION AND SHOP PRIMING AFTER ERECTION/ WELDING FOR CARBON STEEL LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL, ITEMS IN ALL ENVIRONMENT.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2.1</td>
<td>-90 TO 400</td>
<td>SSPC-SP-3 (FOR REPAIR ONLY) SSPC-SP-10</td>
<td>1 COAT OF F-9</td>
<td>65-75</td>
<td>FOR DAMAGED AREA OF MORE THAN 5X5 CM.</td>
</tr>
<tr>
<td>7.2.2</td>
<td>401 TO 550</td>
<td>SSPC-SP-3</td>
<td>1 COAT OF F-12</td>
<td>20</td>
<td>FOR DAMAGED AREA OF MORE THAN 5X5 CM.</td>
</tr>
</tbody>
</table>
### TABLE 8.0: FIELD PAINT SYSTEM FOR NORMAL CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL)

All normal corrosive areas such as off sites external surface of uninsulated columns, vessels, heat exchangers, blowers, piping, pumps, towers, compressors, structural steel works, RCC chimney with or without refractory line inside chimney (all environments), excluding tank tops, flare lines, D.M. plants, interior of tanks etc. Flare lines for normal corrosive environment also to be painted as per Table 9.0

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>FINISH PAINT</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>-90 TO -15</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @65-75µ DFT/ COAT</td>
<td>NONE</td>
<td>65-75</td>
<td>No over coating to be done follow repair procedure only on damaged areas of pre-erection/ pre-fabrication primer/ coating F-9</td>
</tr>
<tr>
<td>8.2</td>
<td>-14 TO 60</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75µ DFT/ COAT + 2 COATS OF P-2 @ 40µ DFT/ COAT 2 X 40 = 80</td>
<td>2 COATS OF F-3 @ 40 µ DFT/ COAT 2 X 40 = 80</td>
<td>225</td>
<td></td>
</tr>
<tr>
<td>8.3</td>
<td>61 TO 80</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75µ DFT/ COAT + 2 COATS OF P-6 @ 40µ DFT/ COAT 2 X 40 = 80</td>
<td>1 COATS OF F-6 @ 100 µ DFT/ COAT</td>
<td>245</td>
<td></td>
</tr>
<tr>
<td>S. NO.</td>
<td>DESIGN TEMPERATURE IN C</td>
<td>SURFACE PREPARATION</td>
<td>PAINT SYSTEM</td>
<td>TOTAL DFT IN MICRONS (MIN.)</td>
<td>REMARKS</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------</td>
<td>----------------------</td>
<td>--------------</td>
<td>-----------------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>8.4</td>
<td>81 TO 250</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75µ DFT/ COAT</td>
<td>125</td>
<td>FOR MS CHIMNEY OR WITHOUT REFRACTORY LINING 8.3, 8.4 AND 8.5 SHALL BE FOLLOWED.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 COATS OF F-11 @ 20 µ DFT/ COAT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 X 20 = 60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.5</td>
<td>251 TO 400</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75µ DFT/ COAT</td>
<td>105</td>
<td>FOR EXTERNAL SURFACE OF RCC CHIMNEY: 2 COATS OF F-6 @ 100 µ DFT/ COAT TO OBTAIN 2 X 100 = 200µ SHALL BE APPLIED AFTER MAKING SURFACE PREPARATION AS PER GUIDELINES IN 1.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 COATS OF F-12 @ 20 µ DFT/ COAT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 X 20 = 40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.6</td>
<td>401 TO 500</td>
<td>SSPC-SP-10</td>
<td>REPAIR AS PER 7.2.2</td>
<td>80</td>
<td>NOTE 3: WHEREVER REQUIRED S.NO. 8.3 SHALL BE USED FOR 14°C TO 80°C AND S.NO. 8.2 WILL BE DELETED.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 COATS OF F-12 @ 20 µ DFT/ COAT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 X 20 = 40</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 9.0: FIELD PAINT SYSTEM FOR CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL)

FOR ALL CORROSIVE AREAS ABOVE GROUND WHERE H₂S, SO₂ FUMES OR SPILLAGE'S OF ACID/ALKALI/SALT ARE LIKELY TO COME IN CONTACT WITH SURFACE SUCH AS EXTERNAL SURFACE OF UNINSULATED COLUMNS, VESSELS, HEAT EXCHANGERS, BLOWERS, PIPING, PUMPS, TOWERS, COMPRESSORS, FLARE LINES, STRUCTURAL STEEL ETC.

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>FINISH PAINT</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1</td>
<td>-90 TO –15</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75μ DFT/COAT</td>
<td>NONE</td>
<td>65-75</td>
<td>Repair of pre-erection/ pre fabrication primer shall be done wherever damage is observed.</td>
</tr>
<tr>
<td>9.2</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75μ DFT/COAT + 1 COATS OF P-6 @40 μ DFT/COAT</td>
<td>1 COATS OF F-6 @ 100μ DFT/COAT + 1 COAT OF F-2 @ 40μ DFT/COAT</td>
<td>225</td>
<td>Surface preparation is required only for repairing of damaged pre-erection/ fabrication primer</td>
</tr>
<tr>
<td>9.3</td>
<td>81 TO 400</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75μ DFT/COAT</td>
<td>2 COATS OF F-12 @ 20 μ DFT/COAT 2 X 20 = 40</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>9.4</td>
<td>401 TO 500</td>
<td>SSPC-SP-10</td>
<td>REPAIR 2S PER 7.2.2</td>
<td>2 COATS OF F-12 @ 20 μ DFT/COAT</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>
**TABLE 10.0: FIELD PAINT SYSTEM FOR HIGHLY CORROSIVE (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL) EXTERNAL SURFACES OF UNINSULATED COLUMNS, VESSELS, HEAT EXCHANGERS, BLOWERS, PIPING PUMPS, TOWERS, COMPRESSORS, FLARE LINES, STRUCTURE STEEL ETC.**

EXPOSED TO SPILLAGE OR FUMES OF HCL H₂SO₄, SALTY WATER IMPINGEMENT, CHLORIDE ETC.

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>FINISH PAINT</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1</td>
<td>-90 TO −15</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75μ DFT/COAT</td>
<td>NONE</td>
<td>65-75</td>
<td>Repair of pre-erection/fabrication primer shall be followed. No overcoating is allowed.</td>
</tr>
<tr>
<td>10.2</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75μ DFT/COAT + 1 COATS OF P-6 @40 μ DFT/COAT</td>
<td>2 COATS OF F-6 @ 100μ DFT/COAT = 2 X 100 plus 1 COAT OF F-2 @ 40μ DFT/COAT</td>
<td>345</td>
<td>Surface preparation is required only for repairing of damaged pre-erection/fabrication primer.</td>
</tr>
<tr>
<td>10.3</td>
<td>81 TO 400</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75μ DFT/COAT</td>
<td>2 COATS OF F-12 @ 20 μ DFT/COAT = 2 X 20=</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>10.4</td>
<td>401 TO 500</td>
<td>SSPC-SP-10</td>
<td>REPAIR AS PER 7.2.2</td>
<td>3 COATS OF F-12 @ 20 μ DFT/COAT = 2 X 20=</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>

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TABLE 11.0 : FIELD PAINT SYSTEM FOR CARBON STEEL STORAGE TANKS (EXTERNAL) FOR ALL ENVIRONMENTS.

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.1.1</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75μ DFT/COAT + 1 COATS OF F-6 @ 40μ DFT/COAT 65 X 40 = 105</td>
<td>285</td>
<td>F-6 should be suitable for occasional water immersion</td>
</tr>
<tr>
<td>11.1.2</td>
<td>81 TO 500</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75μ DFT/COAT</td>
<td>2 COATS OF F-12 @ 20μ DFT/COAT 2 X 20 = 40</td>
<td>105</td>
</tr>
<tr>
<td>11.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.2</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75μ DFT/COAT</td>
<td>3 COATS OF F-7 @ 100μ DFT/COAT 3 X 100 = 300</td>
<td>365</td>
</tr>
<tr>
<td>S. NO.</td>
<td>DESIGN TEMPERATURE IN °C</td>
<td>SURFACE PREPARATION</td>
<td>PAINT SYSTEM</td>
<td>TOTAL DFT IN MICRONS (MIN.)</td>
<td>REMARKS</td>
</tr>
<tr>
<td>--------</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>FILED PRIMER</td>
<td>FINISH PAINT</td>
<td></td>
</tr>
<tr>
<td>12.1</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75μ DFT/COAT</td>
<td>3 COATS OF F-7 @ 100μ DFT/COAT 3 X 100 = 300</td>
<td>365</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F7 should be suitable for immersion service of the products given.</td>
<td></td>
</tr>
<tr>
<td>12.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.2.1</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>PHOSPHATING TREATMENT WITH PHOSPHATING CHEMICALS (2 COATS)</td>
<td>2 COATS OF @10 μ 2 X 10 = 20</td>
<td>20</td>
</tr>
<tr>
<td>12.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.3.1</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75μ DFT/COAT</td>
<td>3 COATS OF F-6 @ 100μ DFT/COAT 3 X 100 = 300</td>
<td>365</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F-6 should be suitable for immersion service of petroleum produce like ATF, Kerosene, petrol etc.</td>
<td></td>
</tr>
<tr>
<td>12.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.4.1</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75μ DFT/COAT</td>
<td>NONE</td>
<td>65-75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No over coating is allowed same as per pre-erection primer, if any</td>
<td></td>
</tr>
<tr>
<td>12.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.5.1</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>2 COAT OF F-6 @ 40μ DFT/COAT 2 X 40 = 80</td>
<td>2 COATS OF F-6 @ 100μ DFT/COAT 2 X 100 = 200</td>
<td>280</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F-6 shall be suitable for immersion service.</td>
<td></td>
</tr>
<tr>
<td>12.6</td>
<td>D. M. (DEMINERALISED WATER) AND HYDROCHLORIC ACID (HCL): INTERNAL SHELL, BOTTOM PLATE AND ALL ACCESSORIES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.6.1</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>EBIOTITE RUBBER LINING AS PER SMMS SPECIFICATION 6-06-204</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.7</td>
<td>EG TANKS (INTERNAL SHELL, BOTTOM PLATE ROOF AND ALL ACCESSORIES)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.7.1</td>
<td>ALL</td>
<td>SSPC-SP-10</td>
<td>3 COATS VINYL CHLORIDE CO-POLYMER AMERCOAT 23 @ 75μ/COAT</td>
<td>225</td>
<td></td>
</tr>
</tbody>
</table>
## Shop & Field Painting

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Design Temperature in °C</th>
<th>Surface Preparation</th>
<th>Paint System</th>
<th>Total Dft in Microns (Min.)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.8</td>
<td>-14 TO 80</td>
<td>SSPC-SP-3</td>
<td>1 Coat of F-8 @ 100μ DFT/Coat</td>
<td>1 Coat of F-6 @ 100μ DFT/Coat 1 X 100 = 100</td>
<td>200</td>
</tr>
<tr>
<td>12.9</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>1 Coat of F-9 @ 65-75μ DFT/Coat 2 X 40 = 80</td>
<td>2 Coats of F-15 @ 75μ DFT/Coat 2 X 75 = 150</td>
<td>215-225</td>
</tr>
</tbody>
</table>

Inside Pontoon and Inside of Double Deck of All Floating Roofs.
### TABLE 13.0 : COATING SYSTEM FOR EXTERNAL SIDE OF UNDERGROUND CARBON STEEL PLANT PIPING AND TANKS

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.1</td>
<td>CARBON STEEL PLANT PIPING (UNDERGROUND)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.1.1</td>
<td>YARD COATING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.1.1.1</td>
<td>25 TO 60</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF SYNTHETIC FAST DRYING PRIMER TYPE-B AS PER AWWA-C-203 (1991)</td>
<td>4mm THICK COALTAR COATING WRAPPING AS PER AWWA-C-203 IN 2 LAYER OF EACH 2mm THICKNESS</td>
<td>4mm CTE coating shall confirm to 120/5 as per BS: 4164</td>
</tr>
<tr>
<td>13.1.2</td>
<td>OVER THE DITCH COATING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.1.2.1</td>
<td>25 TO 60</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF SYNTHETIC FAST DRYING PRIMER TYPE-B AS PER AWWA-C-203 (1991)</td>
<td>2 LAYERS OF COALTAR BASED TAPE COATING AS PER AWWA-C-203.</td>
<td>4 mm</td>
</tr>
<tr>
<td>13.2</td>
<td>CARBON STEEL PLANT PIPING (UNDERGROUND)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.2.1</td>
<td>61 TO 400</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75μ DFT/COAT</td>
<td>NONE</td>
<td>65-75</td>
</tr>
<tr>
<td>13.3</td>
<td>EXTERNAL SIDE OF UNINSULATED UNDERGROUND STORAGE TANKS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.3.1</td>
<td>40 TO 80</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75μ DFT/COAT</td>
<td>3 COATS OF F-7 @ 100μ DFT/COAT 3 X 100 = 300</td>
<td>365</td>
</tr>
<tr>
<td>13.3.2</td>
<td>-90 TO -41 81 TO 400° C</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75μ DFT/COAT 1 COAT OF AMERCOAT 738 @ 250μ DFT/COAT</td>
<td>NONE</td>
<td>65-75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
### TABLE 14.0: PAINTING UNDER INSULATION FOR INSULATED (HOT COLD SAFETY CARBON STEEL, LOW ALLOY STEEL, LOW TEMPERATURE CARBON STEEL & STAINLESS STEEL PIPING, STORAGE TANKS EQUIPMENTS IN ALL ENVIRONMENT)

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.1</td>
<td>INSULATED CARBON STEEL, LOW ALLOY STEEL AND LTCS PIPING AND EQUIPMENT &amp; TANKS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.1.1</td>
<td>-4 TO 125</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PREFABRICATION PRIMER F-9 @ 65-75μ DFT</td>
<td>2 COATS OF F-14 @ 125μ DFT/ COAT 2 X 125 = 250 OR 3 COATS OF F-15= 3 X 80=240</td>
<td>315 For other temperature ranges no painting is required under insulation.</td>
</tr>
<tr>
<td>14.1.2</td>
<td>OPERATING TEMPERATURE -45 TO 125° C BUT DESIGN TEMPERATURE 126-400° C</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PREFABRICATION PRIMER F-9 @ 65-75μ DFT</td>
<td>3 COATS OF F-12 @ 20μ DFT/ COAT 3 X 20 = 60</td>
<td>105-115</td>
</tr>
<tr>
<td>14.2</td>
<td>INSULATED STAINLESS STEEL INCLUDING ALLOY-20- PIPING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.2.1</td>
<td>BELOW 0° C TO ALL MINUS TEMPERATURE</td>
<td>ALUMINUM SHEETING WITH ALUMINUM FOIL AND CHLORIDE FREE MINERAL SEALANT CONTAINING BARIUM CHROMATE SHALL BE APPLIED</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.2.2</td>
<td>0 TO 120</td>
<td>SSPC-SP-10 ( 15-25μ SURFACE PROFILE)</td>
<td>NONE</td>
<td>2 COATS OF F-14 @ 125μ DFT/ COAT 2 X 125 = 250 OR 3 COATS OF F-15= 3 X 80 = 240</td>
<td>250 If the piping &amp; equipments are already erected then surface shall be prepared by cleaning with emery paper and wash/ flush with chloride free DM water followed by wiping with organic solvent</td>
</tr>
<tr>
<td>S. NO.</td>
<td>DESIGN TEMPERATURE IN °C</td>
<td>SURFACE PREPARATION</td>
<td>PAINT SYSTEM</td>
<td>TOTAL DFT IN MICRONS (MIN.)</td>
<td>REMARKS</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------</td>
<td>---------------------</td>
<td>--------------</td>
<td>-----------------------------</td>
<td>---------</td>
</tr>
</tbody>
</table>
| 14.2.3 | 121 TO 500               | SSPC-SP-10          | NONE         | 3 COATS OF F-12 @ 20μ DFT/ COAT  
|        |                          |                     |              | 3 X 20 = 60                 |         |
|       |                          |                     |              |                             | No pre erection primer to be applied |
| 14.2.4 | 501 TO 1000              | SSPC-SP-10          | NONE         | 1 COAT OF AMERCOAT 738 @ 150μ DFT/ COAT  
|        |                          |                     |              |                             | Only Amorcoat 738 from Amoron is available for this temperature range. |
| 14.2.5 | CYCLIC SERVICE-196 TO 480 EXCEPTING –45 TO 120 | SSPC-SP-10     | NONE         | 1 COAT OF AMERCOAT 738 @ 150μ DFT/ COAT  
|        |                          |                     |              |                             |         |

14.3 NO PAINTING REQUIRED FOR INSULATED MONEL, IN COLOY AND NICKEL LINES
### TABLE 15.0: INTERNAL PROTECTION OF CARBON STEEL WATER BOXES AND TUBE SHEETS OF COOLERS/ CONDENSERS WATER BOXES, CHANNELS, PARTITION PLATES, END COVERS AND TUBE SHEETS ETC.

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>PRIMER</td>
<td>FINISH PAINT</td>
<td></td>
</tr>
<tr>
<td>15.1</td>
<td>Upto 65</td>
<td>SSPC-SP-10</td>
<td>1 COATS OF F-6 @ 40μ DFT/ COAT</td>
<td>2 COATS OF F-7 @ 125μ DFT/ COAT&lt;br&gt;2 x 125 = 250</td>
<td>290&lt;br&gt;For C. S.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 COATS OF F-7 @ 125μ DFT/ COAT&lt;br&gt;2 x 125 = 250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.2</td>
<td>Upto 65&lt;br&gt;NON FERROUS AND BRASS TUBE SHEETS</td>
<td>SSPC-SP-10</td>
<td>1 COATS OF P-4 @ 8μ DFT/ COAT&lt;br&gt;1 COATS OF P-6 @ 40μ DFT/ COAT</td>
<td>2 COATS OF F-7 @ 125μ DFT/ COAT&lt;br&gt;2 x 125 = 250</td>
<td>300&lt;br&gt;FOR NON FERROUS SURFACE</td>
</tr>
</tbody>
</table>

### TABLE 16.0 FIELD PAINTING SYSTEM FOR GI TOWERS/ NON-FERROUS TUBE SHEET

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>FILED PAINT</td>
<td>FINISH PAINT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PRIMER</td>
<td>FINISH PAINT</td>
<td></td>
</tr>
<tr>
<td>16.1</td>
<td>Upto 65</td>
<td>SSPC-SP-10</td>
<td>1 COATS OF P-4 @ 8-10μ DFT/ COAT&lt;br&gt;1 COAT OF P-6 @ 4μ DFT/ COAT</td>
<td>2 COATS OF F-2 @ 40μ DFT/ COAT&lt;br&gt;2 x 40 = 250</td>
<td>130&lt;br&gt;SHADE AS PER DEFENCE REQUIREMENTS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 COATS OF F-2 @ 40μ DFT/ COAT&lt;br&gt;2 x 40 = 250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.2</td>
<td>Upto 65&lt;br&gt;NON FERROUS AND BRASS TUBE SHEETS</td>
<td>SSPC-SP-10</td>
<td>1 COATS OF P-4 @ 8μ DFT/ COAT&lt;br&gt;1 COATS OF P-6 @ 40μ DFT/ COAT</td>
<td>2 COATS OF F-7 @ 125μ DFT/ COAT&lt;br&gt;2 x 125 = 250</td>
<td>300</td>
</tr>
</tbody>
</table>
17.0 **STORAGE**

17.1 All paints and painting materials shall be stored only in rooms to be arranged by contractor and approved by Engineer-in-Charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the words “PAINT STORAGE NO NAKED LIGHT-HIGHLY INFAMMABLE” shall be clearly displayed outside.

18.0 **COLOUR CODE FOR PIPING**

For identification of pipeline, the colour code as per Table 18.1 shall be used. Paint material for color-coding shall be as specified in this standard in clause 6.0.

18.1 Colour coding scheme for pipe, equipment, machinery & structure:

<table>
<thead>
<tr>
<th>SR. NO.</th>
<th>DESCRIPTION</th>
<th>GROUND COLOUR</th>
<th>FIRST COLOUR BAND</th>
<th>SECOND COLOUR BAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.1.1</td>
<td>ALL KINDS OF WATER</td>
<td>Sea Gree -do-</td>
<td>French Blue -do-</td>
<td>Signal Red -do-</td>
</tr>
<tr>
<td></td>
<td>DRINKING WATER</td>
<td>-do-</td>
<td>Gulf Red -do-</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>DE-MINERALISED WATER</td>
<td>-do-</td>
<td>French Blue -do-</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>COOLING WATER</td>
<td>-do-</td>
<td>Gulf Red -do-</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>BOILER FEED WATER</td>
<td>-do-</td>
<td>Light Brown -do-</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>CONDENSATE</td>
<td>-do-</td>
<td>Dark Grey -do-</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>QUENCH WATER</td>
<td>-do-</td>
<td>Canary Yellow -do-</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>WASH WATER</td>
<td>-do-</td>
<td>Oxide Red -do-</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>PROCESS WATER</td>
<td>-do-</td>
<td>Crimson Red -do-</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>PROCESS WATER</td>
<td>-do-</td>
<td>White -do-</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>FIRE WATER</td>
<td>Fire red</td>
<td>Signal Red</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>SEA WATER</td>
<td>Sea Green</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>18.1.2</td>
<td>STEAM</td>
<td>Aluminiumto IS2339 -do-</td>
<td>Signal Red</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>VERY HIGH PRESSURE STEAM (VHP)</td>
<td>-do-</td>
<td>French Blue</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>HIGH PRESSURE STEAM (SH) MEDIUM PRESSURE STEAM (SH)</td>
<td>-do-</td>
<td>Gulf Red</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>LOW PRESSURE STEAM (SL) DILUTION STEAM/ PURGE STEAM</td>
<td>-do-</td>
<td>Canary Yellow</td>
<td>-do-</td>
</tr>
</tbody>
</table>
### SHOP & FIELD PAINTING

**MEC/S/05/21/07**

<table>
<thead>
<tr>
<th>SR. NO.</th>
<th>DESCRIPTION</th>
<th>GROUND COLOUR</th>
<th>FIRST COLOUR BAND</th>
<th>SECOND COLOUR BAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.1.3</td>
<td>COMPRESSED AIR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PLANT AIR</td>
<td>Sky Blue</td>
<td>Signal Red</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>INSTRUMENT AIR</td>
<td>-do-</td>
<td>Silver Grey</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>NITROGEN</td>
<td>-do-</td>
<td>French Blue</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>OXYGEN</td>
<td>Canary Yello</td>
<td>Black</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>CO₂</td>
<td>-do-</td>
<td>White</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Light Grey</td>
<td>-</td>
</tr>
<tr>
<td>18.1.4</td>
<td>GASES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FUEL GAS AND SOUR GAS</td>
<td>Canary Yellow</td>
<td>Grey</td>
<td>Dark Violet</td>
</tr>
<tr>
<td></td>
<td>CHARGE GAS</td>
<td>-do-</td>
<td>Signal Red</td>
<td>French Blue</td>
</tr>
<tr>
<td></td>
<td>RESIDUE GAS, LPG</td>
<td>-do-</td>
<td>Oxide Red</td>
<td>White</td>
</tr>
<tr>
<td></td>
<td>ACETYLENE</td>
<td>-do-</td>
<td>Service Brown</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>SWEET GAS</td>
<td>-do-</td>
<td>Grey</td>
<td>-</td>
</tr>
<tr>
<td>18.1.5</td>
<td>ACIDS AND CHEMICALS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SULFURIC ACID</td>
<td>DARK Violet</td>
<td>Brilliant Green</td>
<td>Light Orange</td>
</tr>
<tr>
<td></td>
<td>NITRIC ACID</td>
<td>-do-</td>
<td>French Blue</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>HYDROCHLORIC ACID</td>
<td>-do-</td>
<td>Signal Red</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>ACETIC ACID</td>
<td>-do-</td>
<td>Silver Grey</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>CAUSTIC</td>
<td>smoke Grey</td>
<td>Light Orange</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>CHLORINE</td>
<td>Canary Yellow</td>
<td>Dark Violet</td>
<td>-do-</td>
</tr>
<tr>
<td>18.1.6</td>
<td>HYDRO CARBONS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NAPTHAS</td>
<td>Dark Admiralty Grey</td>
<td>Brilliant Green</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>PROPYLENE</td>
<td>-do-</td>
<td>-do-</td>
<td>Smoke Grey</td>
</tr>
<tr>
<td></td>
<td>PROPYLENE C.G. (LIQ)</td>
<td>-do-</td>
<td>-do-</td>
<td>Gulf Red</td>
</tr>
<tr>
<td></td>
<td>ETHYLENE GLYCOL</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>ETHYLENE DICHLORIDE</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>BENZENE</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>BUTADIENE</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>ETHANE(LIQ)</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>PROPYLENE(LIQ)</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>ETHYLENE(LIQ)</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>TAR</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>AROMATIC GASOLINE</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>METHANOL (LIQ)</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>PYROLYSIS GASOLINE</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>MIXED C4(LIQ)</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>LPG(LIQ)</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>KEROSENE</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>DIESEL OIL (WHITE)</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>DIESEL OIL (BLACK)</td>
<td>-do-</td>
<td>-do-</td>
<td>-</td>
</tr>
</tbody>
</table>
18.2 The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding of a ground colour and colour bands superimposed on it.

18.3 Ground colours as given in Table 18.1 shall be applied throughout the entire length for uninsulated pipes, on the metal cladding & on surfaces covered by Clause 2.2.2, ground colour coating of minimum 2m length or of adequate length not to be mistaken as colour band shall be applied at places requiring colour bands. Colour band(s) shall be applied at the following location.

a. At battery limit points
b. Intersection points & change of direction points in piping ways.
c. Other points, such as midway of each piping way, near valves, junction joints of services appliances, walls, on either side of pipe culverts.
d. For zong stretch/ xard piping at 50M interval.
e. At start and terminating points.

18.4 Identification Sign

18.4.1 Flow direction shall be indicated by an arrow in the location stated in Para a,b,c & d and as directed by Engineer-in-charge.

18.4.2 Colours of arrows shall be black or white and in contrast to the colour on which they are superimposed.

18.4.3 Product names shall be marked at pump inlet, outlet and battery limit in a suitable size as approved by Engineer-in-charge.

18.4.4 Size of arrow shall be either of those given in 18.5.

18.5 Colour Bands
18.5.1 As a rule minimum width of colour band shall conform to the following table:

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>Width : L(mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3” NB and below</td>
<td>25mm</td>
</tr>
<tr>
<td>Above 3” NB upto 6” NB</td>
<td>50mm</td>
</tr>
<tr>
<td>Above 8” NB upto 12” OD</td>
<td>75mm</td>
</tr>
<tr>
<td>Above 12” OD</td>
<td>100mm</td>
</tr>
</tbody>
</table>

Note: For insulated pipes, nominal pipe size means the outside diameter of insulation. Nominal pipe size figures are to be inches.

18.5.2 Colour band(s) shall be arranged in the sequence shown in Table 18.1 and the sequence follows the direction of flow. The relative proportional width of the first colour band to the subsequent bands shall be 4:1, minimum width of any band shall be as per Clause 18.5.1.

18.5.3 Whenever it is required by the Engineer-in-charge to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal strips of black and golden yellow as epr IS:2379 shall be painted on the ground colour.

18.6 Wherever it is required by the Engineer-in-charge to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal strips of black and golden yellow as per IS:2379 shall be painted on the ground colour.

19.0 IDENTIFICATION OF VESSELS, PIPING ETC.

19.1 Equipment number shall be stencilled in black or white on each vessel, column, equipment & machinery (insulated or uninsulated) after painting. Line number in black or white shall be stencilled on all the pipelines of more than one location as directed by Engineer-in-charge, size of letters printed shall be as below:

<table>
<thead>
<tr>
<th>Column &amp; Vessels</th>
<th>150mm (high)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump, Compressor and other machinery</td>
<td>50mm (high)</td>
</tr>
<tr>
<td>Piping</td>
<td>40-150mm</td>
</tr>
</tbody>
</table>
19.2 **Identification of storage tanks**

The storage tanks shall be marked as detailed in the drawing.

20.0 **PAINTING FOR CIVIL DEFENCE REQUIREMENTS**

20.1 Following items shall be painted for camouflaging if required by the client.

   a. All columns
   b. All tanks in offsites
   c. Large vessels
   d. Spheres

20.2 Two coats of selected finishing paint as per defence requirement shall be applied in a particular pattern as per 20.3 and as per the instructions of Engineer-in-charge.

20.3 **Method of Camouflaging**

20.3.1 Disruptive painting for camouflaging shall be done in three colours in the ratio of 5:3:2 (all matt finish).

   Dark Green   Light Green   Dark Medium Brown
   5:3:2

20.3.2 The patches should be asymmetrical and irregular.

20.3.3 The patches should be inclined at 30 degree to 60 degree to the horizontal.

20.3.4 The patches should be continuous where two surfaces meet at an angle.

20.3.5 The patches should not coincide with corners.

20.3.6 Slits and holes shall be painted and dark shades.

20.3.7 Width of patches should be 1 to 2 meters.
### 21.0 INSPECTION AND TESTING

#### 21.1
All painting materials including primers and thinners brought to site by contractor for application shall be procured directly from manufacturers as per specifications and shall be accompanied by manufacturer’s test certificates. Paint formulations without certificates are not acceptable.

#### 21.2
Engineer-in-Charge at his discretion, may call for tests for paint formulations. Contractor shall arrange to have such tests performed including batchwise test of wet paints for physical & chemical analysis. All costs there shall be borne by the contractor.

#### 21.3
The painting work shall be subject to inspection by Engineer-in-Charge at all times. In particular, following stagewise inspection will be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

- a. Surface preparation
- b. Primer application
- c. Each coat of paint

In addition to above, record should include type of shop primer already applied on equipment e.g. Redd oxide zinc chromate or zinc chromate or Red lead primer etc.

Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer-in-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work. Contractor shall be responsible for making good any defects found during final inspection/ guarantee period/ defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra cost to owner, the extra cost should have prior approval of Engineer-in-Charge.
### 21.4 Primer Application

After surface preparation the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-in-Charge.

### 21.5

The shades of successive coats should be slightly different in colour in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer-in-Charge before application of successive coats.

### 21.6

The contractor shall provide standard thickness measurement instrument with appropriate ranges(s) for measuring.

Dry film thickness of each coat, surface profile guage for checking of surface profile in case of blast cleaning. Holiday directors and pinhole detector and positector whenever required for checking in case of immersion conditions.

### 21.7

Prior to application of paints on surface of chimneys the thickness of the individual coat shall be checked by application of each coat of same paint on M. S test panel. The thickness of paint on test panel shall be determined by using guage such as ‘Elkomere’. This thickness of each coat shall be checked as per provision of this specification. This shall be approved by Engineer-in-Charge before application of paints on surface of chimney.

### 21.8

At the discretion of Engineer-in-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations.

### 21.9

Final inspection shall include measurement of paint dry film thickness. Adhesion Holiday detection check of finish and workmanship. The thickness should be measured at as many points/locations as decided by Engineer-in-Charge and shall be within $\pm 10\%$ of the dry thickness, specified in the specifications.
21.10 The contractor shall arrange for spot checking of paint materials for Sp. Gr., flow time (ford cup) and spreading rate.

22.0 GUARANTEE

22.1 The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/ to be provided during execution of work.

22.2 The contractor shall produce test report from manufacturer regarding the quality of the particular batch of paint supplied. The Engineer-in-Charge shall have the right the test wet samples of paint at random, for quality of same as stipulated in clause 11 above. Batch test report of manufacturer's for each batch paint supplied shall be made available by the contractor.

23.0 QUALIFICATION CRITERIA OF PAINTING CONTRACTOR

Painting contractor who is awarded any job for MECON, projects under this standard must have necessary equipments, machinery, tool and tackles for surface preparation, paint application and inspection. The contractor must have qualified trained and experienced surface preparation, paint applicator, inspector, and supervisors. The contractor supervisor, inspector surface perpetrator and paint applicator must be conversant with the standards referred in this specification the contractors capacity, capability and competency requirements for the job shall be quantified in the tender document and shall be assessed by an MECON team before awarding any job.

24.0 PROCEDURE FOR APPROVAL OF NEW COATING MATERIALS AND MANUFACTURER'S

Following procedure is recommended to be followed for approval of new manufacturers.

24.1 The manufacturer should arrange testing of the inorganic zinc silicate coating materials as per the list of tests given in para 24.5 below from one of the reputed Government laboratories.
24.2 Samples of coating should be submitted to the Govt. laboratory in sealed containers with batch no. and test certificate on regular format of manufacturer’s testing laboratory. The sampling shall be certificate and sealed by a certifying agency.

24.3 All test panels should be prepared by govt. testing agency coloured photographs of test panels should be taken before and after the test should be enclosed alongwith test report.

Sample batch. No. and manufacturer’s test certificate should be enclosed along with the report. Test reports contain details of observation and rusting if any, as per the testing code. Suggested government laboratories are:

RRL, Hayderabad
HBTI, Kanpur
DMSRDE, Kanpur
IIT, Mumbai
BIS Laboratory
UDCT, Mumbai
RITES, Calcutta
PDIL

24.4 Manufacturers should intimate the company, details of sample submitted for testing name of Govt. testing agency, date, contact personnel of the Govt. testing agency. At the end of the test the manufacturer should submit the test report to the company for approval. The manufacturer(s) shall be qualified based on the result of these tests and other assessment and the Company’s decision in this regard shall be final and binding on the manufacturer.
24.5 Tests required for evaluation of acceptance of coating materials for offshore application.

Test            ASTM Test Method
Density         D 1475
Dipping properties D 823

Film Characteristics
Drying time     D 1640
Flexibility     D 1737/ D 522
Hardness        D 3363

Adhesion        D 2197
Abrasion resistance D 968/ D 1044
DFT/ Coat       AS PER SSPC GUIDELINES
Storage Stability D 1849

Resistance to
Humidity for 2000 hrs. D 2247
Salt Spray for 2000 hrs. B 117
Accelerated Weathering D 822
% Zn in DFT        G 53

24.6 Coating system for panel test shall be decided after discussion with MECON.
LIST OF RECOMMENDED MANUFACTURERS

Indian Vendors

1.0 Asian Paints(I) Ltd.
2.0 Berger Paints Ltd.
3.0 Goodlass Nerlolac Paints Ltd.
4.0 Jenson And Nicholson Paint Ltd & chokuGu Jenson & Nicholson Ltd.
5.0 Shalimar Paints Ltd.
6.0 Sigma Coating, Mumabai
7.0 CDC Carboline Ltd.
8.0 Premier Products Ltd.
9.0 Coromandel Paints & Chemicals Ltd.
10.0 Anupam Enterprises
11.0 Grand Polycoats
12.0 Bombay Paints Ltd.
13.0 Vanaprabha Esters & Glycer, Mumbai
14.0 Sunil Paints and Varnishes Pvt. Ltd.
15.0 Courtaulds Coating & Sealants India (Pvt.) Ltd.
16.0 Mark-chem Incorporated, Mumbai (for phosphating chemicals only)
17.0 VCM Polyurethane Paint (for polyurethane Paint only)

FOREIGN VENDORS FOR OVERSEAS PRODUCTS

1.0 Sigma Coating, Singapore
2.0 Ameron, USA
3.0 Kansai Paint, Japan
4.0 Hempel Paint, USA
5.0 Valspar Corporation, USA
6.0 Courtaulds Coating, UK.

Note: This list subjected to revision based fresh approval which will be intimated to PDD/ Vendor Cell.
# ANNEXURE-II

## LIST OF RECOMMENDED MANUFACTURER’S PRODUCTS

<table>
<thead>
<tr>
<th>S. No.</th>
<th>MANUFACTURER NAME</th>
<th>P2 CHLORINATED RUBBER Zp PRIMER</th>
<th>P4 ETCH PRIMER/ WASH PRIMER</th>
<th>P6 EPOXY ZINC PH. PRIMER</th>
<th>F9 INORGANIC ZINC SILICATE PRIMER/ COATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ASIAN PAINTS (I) LTD.</td>
<td>ASIOCHL OR HB. ZN.PH PRIMER RO PC 168</td>
<td>APCONYL WP 636 (PC 335)</td>
<td>APCODUR HB. RO.ZP-PC433</td>
<td>APCOCIL 605</td>
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<td>2.</td>
<td>BARGER PAINT LTD.</td>
<td>LINSOL HIGH BUILD ZP PRIMER</td>
<td>BISON WASH PRIMER</td>
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<td>ZINC ANODE 304</td>
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<td>AMERCOAT 71</td>
<td>DIMET COTE-9</td>
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<td>JENSON &amp; NICHOSON PAINTS LTD. AND CHOKUGU JENSON NICHOLSON</td>
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<td>J &amp; N ETCH PRIMER</td>
<td>EPILAC ZINC PHOSPHATE PRIMER</td>
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<td>5.</td>
<td>SHALIMAR PAINTS LTD.</td>
<td>CHIOROKOTE ZINC PHOSPHATE PRIMER GREY</td>
<td>TUFFKOTE ETC PRIMER</td>
<td>EPIGUARD 4 ZINC PHOSPHATE PRIMER GREY</td>
<td>TUFFKOTE ZILICATE TL</td>
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<td>COLTURE CM PRIMER 7412</td>
<td>SIGMASIL MC (7568)</td>
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<td>U17/ 92 ETHYL SILICATE INORGANIC ZINC</td>
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<td>CPC WASH PRIMER</td>
<td>COROPEX EPOXY ZH. PH. HIGH BILD PRIMER</td>
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<td>S. No.</td>
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<td>P2 CHLORINATED RUBBER Zp PRIMER</td>
<td>P4 ETCH PRIMER/WASH PRIMER</td>
<td>P6 EPOXY ZINC PH. PRIMER</td>
<td>F9 INORGANIC ZINC SILICATE PRIMER/COATING</td>
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<td>ANUPAM ANILICOR A-EZP-500</td>
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<td>GRAND POLYCOATS</td>
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<td>HEMPEL'S SHOP PRIMER E-1530</td>
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<td>13.</td>
<td>VANAPRAPHA ESTERS &amp; GLYCERIDES</td>
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<td>INTERZINC</td>
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<td>16.</td>
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**LIST OF RECOMMENDED MANUFACTURER'S PRODUCTS (Contd....)**

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<tr>
<th>S. No.</th>
<th>MANUFACTURER NAME</th>
<th>F2 ACRYLIC-POLYURETHANE FINISH PAINT</th>
<th>F3 CHLORINATED RUBBER FINISH PAINT</th>
<th>F6 HIGH BUILD FINISH PAINT</th>
<th>F7 HIGH BUILD COAL TAR EPOXY COATING</th>
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<td>APCOTHANE CF76 (PC 1109)</td>
<td>ASIOCHLOR CF 621 (PC 161)</td>
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<td>BARGER THANE ENAMEL (81)</td>
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<td>GP COAT 131, 132, GP BOND 141</td>
<td>GP CHLOROGAURD 631</td>
<td>GP GUARD HP 234</td>
<td>POLYGUARD GE</td>
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## LIST OF RECOMMENDED MANUFACTURER’S PRODUCTS

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<td>PENTATHANE FP 4510</td>
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<td>HEMPADUR HIGH BUILD 5520</td>
<td>HEMPADUR 1510</td>
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<td>13.</td>
<td>VANAPRABHA ESTERS &amp; GLYCERIDES,</td>
<td>VEGTHANE FP 3641</td>
<td>VEGCHLOR FP 3140</td>
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<td>VEGPOX 4265</td>
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<td>SUNCHLOR HB CR COATING</td>
<td>LPOXY HB ‘PS 901’</td>
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<td>COURTAULDS COATING LTD.</td>
<td>INTERTHANE</td>
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<td>INTEGARD EM SERIES</td>
<td>INTERTUF JXA 006/007/010</td>
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<td>17.</td>
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<td>PIPCOTHANE ALIPHATIC POLYURETHANE FINISH PAINT</td>
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<td>PENGUARD</td>
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<td>KOPOX TOPCOAT HB ET 5740</td>
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### LIST OF RECOMMENDED MANUFACTURER’S PRODUCTS

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<th>F-8 EPOXY MASTIC COATING Surface Tolerant</th>
<th>F-11 HEAT RESISTANCE SYNTHETIC MEDIUM ALUMINUM PAINT</th>
<th>F-12 HEAT RESISTANCE SILICON AL. PAINT</th>
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<tr>
<td>1.</td>
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<td>APCODOR CF 640</td>
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<td>HR SILICON ALUMINUM PAINT (PC 189)</td>
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<td>3.</td>
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<td>HEAT RESISTING LUSTROL ALUMINUM</td>
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<td>SIGMA ETPC ALUMINUM</td>
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<td>AROSTA FINISH HR</td>
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<td>CPC SILICONE HR ALUMINUM PAINT</td>
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### LIST OF RECOMMENDED MANUFACTURER'S PRODUCTS

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<td>13.</td>
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<td>VEGEPOX MASTIC 2255</td>
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SPECIFICATION FOR HEALTH, SAFETY AND ENVIRONMENT (HSE) MANAGEMENT

SPECIFICATION NO.: MEC/S/05/21/65

(OIL & GAS SBU) MECON LIMITED DELHI 110 092
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<td>ANNEXURE-D</td>
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<td>ANNEXURE-E</td>
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**PREPARED BY:** (Shalini Singh)  
**CHECKED BY:** (Sunil Kumar)  
**APPROVED BY:** (A.K. Johri)  
**ISSUE DATE:** Feb. 2009
## 1.0 SCOPE

This specification establishes the Healthy, Safety and Environment (HSE) management requirement to be compiled with by the Contractors during construction.

This specification is not intended to replace the necessary professional judgement needed to design & implement an effective HSE system for construction activities and the contractor is expected to exceed requirements given in this specification.

Requirement stipulated in this specification shall supplement the requirement of HSE management given in relevant Act (S)/ legislations. General Condition of Contract (GCC) Special Condition of Contract (SCC) and Job Specifications. Where different documents stipulate different requirements, the most stringent shall be adopted.

## 2.0 REFERENCES

This document should be read in conjunction with following:

- General Conditions of Contract (GCC)
- Special Conditions of Contract (SCC)
- Building and other construction workers (regulation of employment and condition of service) Act, 1996
- Job Specifications
- Relevant IS Codes (refer Annexure-A)
- Reporting Formats (refer Annexure-B)
- Statutory requirements

## 3.0 REQUIREMENT OF HEALTH, SAFETY & ENVIRONMENT (HSE) MANAGEMENT SYSTEM TO BE COMPLETED BY BIDDERS.

### 3.1 Management Responsibility

#### 3.1.1

The Contract should have a document HSE policy to cover commitment of the organization to ensure health, safety and environment aspects in their line of operations

#### 3.1.2

The HSE management system of the Contractor shall cover HSE requirement including but not limited to what specified under clause 1.0 & 2.0 mentioned above

#### 3.1.3

Contractor shall be fully responsible for planning and implementing HSE requirement to the satisfaction of the company. Contractor as a minimum requirement shall designate/deploy the following to co-ordinate the above:

- **No. Of workers deployed**
  - Up to 250: Designate one safety supervisor who will guide the workers from time to time, as well as impart training basic guidelines at least weekly once.
Above 250 & upto 500 - Deploy one qualified and experienced safety Engineer/Officer who will guide the workers from time to time as well as impart basic guideline & training at least weekly once. He/She shall possess a recognized Degree in any branch of engineering or technology or architecture and had a post qualification construction experience of minimum two years or possess a recognized Diploma in any branch of engineering or technology or Graduate in Science stream and had a post qualification construction experience of minimum five years.

Above 500 (for every 500 or less) - One additional safety engineer/Officer whose function will be as mentioned above

Contractor shall indemnify and hold harmless OWNER/MECON & their representative’s from any and all liabilities arising out of non fulfillment of HSE requirements.

Above is the minimum requirement and the Contractor shall ensure physical presence of a safety personnel at each place where Hot work permit is required. No work shall be started at site until above safety personnel are physically present at site. The contractor shall submit a safety organogram clearly indicating the lines of responsibility and reporting system. He shall furnish Bio-Data/Resume/Curriculum Vitae of the safety personnel he intends to mobilize, at least 1 month before the intended mobilization, for MECON/Owner’s approval.

3.1.4 The Contractor shall ensure that the Health, Safety and Environment (HSE) requirements are clearly understood & faithfully implemented at all levels, at each and every site/work place.

3.1.5 The Contractor shall promote and develop consciousness for Health, Safety and Environment among all personnel working for the Contractor. Regular awareness programs and fabrication shop/work site meeting shall be arranged on HSE activities to cover hazards involved in various operations during construction.

3.1.6 Arrange suitable first aid measures such as First Aid Box, trained personnel to give First Aid, Stand by Ambulance or Vehicle and install fire protection measures such as: adequate number of steel buckets with sand and water and adequate fire extinguishers to the satisfaction of OWNER/MECON. In case the number of workers exceeds 500, the Contractor shall position an ambulance/vehicle on full time basis very close to the worksite.

3.1.7 The Contractor shall evolve a comprehensive planned and documented system for implementation and monitoring of the HSE requirements. This shall submitted to
OWNER & MECON for approval well in advance, prior to start of work. The monitoring for implementation shall be done by regular inspection and compliance to the observations thereof. The Contractor shall get similar HSE requirements implemented at his sub-contractor(s) work site/Office. However, compliance of HSE requirement shall be the sole responsibility of the Contractor. Any review/ approval by OWNER/MECON shall not absolve the Contractor of his responsibility/liability in relation to all HSE requirements.

3.1.8 Non-Conformance on HSE by the Contractor (including his Sub-contractors) as brought out during review/audit by MECON/OWNER representative shall be resolved forthwith by Contractor. Compliance report shall be possibility submitted to MECON/OWNER at the earliest.

3.1.9 The Contractor shall ensure participation of his Resident Engineer/Site-in-Charge in the Safety Committee/HSE Committee meetings arranged by OWNER/MECON. The compliance of any observation shall be arranged urgently. Contractor shall assist OWNER/MECON to achieve the targets set by them on HSE during the project implementation.

The contractor shall ensure that his staff members & workers (permanent as well casual) shall not be in a state of intoxication during working hours and shall abide by any law relating to consumption & possession of intoxicating drinks or drugs in force. Awareness about local laws on this issue shall form part of the Induction Training.

The contractor shall ensure that all personnel working for him comply with No-smoking requirements of the owner as notified from time to time. Cigarettes, lighters, auto ignition tools or appliances shall not be allowed inside the plant complex. Smoking shall be permitted only inside smoking booths expressly designated & authorized by the Owner/MECON.

3.1.10 The Contractor shall adhere consistently to all provisions of HSE requirements. In case of non-compliance or continuous failure in implementation of any of HSE provisions; OWNER/MECON may impose stoppage of work without any Cost & Time implication to Owner and/or impose a suitable penalty for non-compliance with a notice of suitable period, up to a cumulative limit of 1.0% (one percent) of Contract value with a ceiling of Rs. 10 lakhs.

0.2% (Zero decimal two percent) of the contract value for LSTK, EPC, EPCC or Package contracts with an overall ceiling of Rs. 1,00,00,000/- (Rupees one crore).

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Violation or HSE norms</th>
<th>Penalty Amount</th>
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<tbody>
<tr>
<td>1.</td>
<td>For not using personal protective equipment (Helmet, Shoes, Goggles, person Gloves, Full body harness, Face shield, Boiler suit, etc.)</td>
<td>Rs. 250/- per day / item / person</td>
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<td>2.</td>
<td>Working without Work Permit / Clearance</td>
<td>Rs. 5,000/- per occasion</td>
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<tr>
<td>S. No.</td>
<td>Violation or HSE norms</td>
<td>Penalty Amount</td>
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<td>3.</td>
<td>Unsafe electrical practices (not installing ELCB, using poor joints of cables, using naked wire without top plug into socket, laying wire / cables on the roads, electrical jobs by incompetent person, etc.)</td>
<td>Rs. 3,000/- per item per day</td>
</tr>
<tr>
<td>4.</td>
<td>Working at height without full body harness, using non-standard / rejected scaffolding and not arranging fall protection arrangement as required like Safety Nets.</td>
<td>Rs. 1,000/- per case per day</td>
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<tr>
<td>5.</td>
<td>Unsafe handling of compressed gas cylinders (No trolley, jubilee clips double gauge regulator, improper storage / handling).</td>
<td>Rs. 100/- per item per day</td>
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<td>6.</td>
<td>Use of domestic LPG for cutting purpose.</td>
<td>Rs. 1,000/- per occasion</td>
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<td>7.</td>
<td>No fencing / barricading of excavated areas.</td>
<td>Rs. 1,000/- per occasion</td>
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<tr>
<td>8.</td>
<td>Not providing shoring / strutting / proper slope and not keeping the excavated earth at least 1.5 M away from excavated area.</td>
<td>Rs. 5,000/- per occasion</td>
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<tr>
<td>9.</td>
<td>Non display of caution boards, list of hospitals, emergency services available at work locations.</td>
<td>Rs. 500/- per occasion</td>
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<tr>
<td>10.</td>
<td>Traffic rules violations like over speeding of vehicles, rash driving, wrong parking, not using seat belts, vehicles not fitted with reverse warning alarms.</td>
<td>Rs. 1,000/- per occasion</td>
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<td>11.</td>
<td>Absence of Contractor's top most executive at site in the safety meetings whenever called by MECON / Owner.</td>
<td>Rs. 1,000/- per occasion</td>
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<td>12.</td>
<td>Failure to maintain safety records by Contractor Safety personnel.</td>
<td>Rs. 1,000/- per month</td>
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<td>13.</td>
<td>Failure to conduct daily safety site inspection, HSE meeting and HSE audit at predefined frequencies.</td>
<td>Rs. 1,000/- per occasion</td>
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<tr>
<td>14.</td>
<td>Failure to submit the monthly HSE report by 5th of subsequent month to Engineer-in-Charge.</td>
<td>Rs. 1,000/- per occasion and</td>
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<td>Rs. 100/- per day for further delay</td>
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<tr>
<td>15.</td>
<td>Poor House Keeping</td>
<td>Rs. 1,000/- per occasion</td>
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<tr>
<td>16.</td>
<td>Failure to report &amp; follow up accident (including Near Miss) reporting system.</td>
<td>Rs. 10,000/- per occasion</td>
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<tr>
<td>S. No.</td>
<td>Violation or HSE norms</td>
<td>Penalty Amount</td>
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<td>17.</td>
<td>Degradation of environment (not confining toxic spills oil / lubricants onto ground)</td>
<td>Rs.1,000/- per occasion</td>
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<td>18.</td>
<td>Not medically examining the workers before allowing them to work at height, not providing ear muffs while allowing them to work in noise polluted areas, made them to work in air polluted areas without respiratory protective devices, etc.</td>
<td>Rs.1,000/- per occasion</td>
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<tr>
<td>19.</td>
<td>Violation of any other safety condition as per job HSE plan, work permit and HSE conditions of contract (using crowbar on cable trenches, improper welding booth, not keeping fire extinguisher ready at hot work site, unsafe rigging practices, non-availability of First-Aid box, etc.)</td>
<td>Rs.1,000/- per occasion</td>
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<tr>
<td>20.</td>
<td>Any violation not covered above.</td>
<td>To be decided by MECON / Owner</td>
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This penalty shall be in addition to all other penalties specified else where in the contract. The decision of imposing stoppage of work, its extent & monitory penalty shall rest with MECON/OWNER & binding on the Contractor.

3.1.11 All fatal accidents and other personnel accidents shall be investigated by a team of Contractor’s senior personnel for root cause and recommend corrective and preventive actions. Findings shall documented and suitable actions taken to avoid recurrences shall be communicated to OWNER / MECON. OWNER / MECON shall have the liberty to independently investigate such occurrences and Contractor shall extend all necessary help and co-operation in this regard. MECON / Owner shall have to right to share the content of this report with the outside world.

3.2 House Keeping

3.2.1 Contractor shall ensure that a high degree of house keeping is maintained and shall ensure the followings:

a. All surplus earth and debris are removed/disposed off from the working site to identified location(s).

b. Unused/Surplus Cables Steel items and steel scrap lying scattered at different places within the working areas are removed to identified location(s).

c. All wooden scrap, empty wooden cable drums and other combustible packing materials shall be removed from work place to identified location(s).
d. Roads shall be kept clear and materials like pipes, steel, sand, boulders, concrete chips and bricks, etc. shall not be allowed in the roads to obstruct free movement of men & machineries.

e. Fabricated steel structurals, pipes & piping materials shall be stacked properly for erection.

f. Water logging on roads shall not be allowed.

g. No parking of trucks/ trolleys, cranes and trailors etc. shall be allowed on of roads, which may obstruct the traffic movements.

h. Utmost care shall be taken to ensure over all cleanliness and proper up keep of the working areas.

i. Trucks carrying sand, earth and pulverized materials etc. shall be covered while moving within the plant areas.

j. The contractor shall ensure that the atmosphere in plant area and on roads is free from particulate matter like dust, sand, etc. by keeping the top surface wet for ease in breathing.

k. At least two exits for any unit area shall be assured at all times.

3.3 Healthy, Safety and Environment

a) The Contractor shall provide safe means of access to any working place including provision of suitable and sufficient scaffolding at various stages during all operations of the work for the safety of his workmen, and OWNER/ MECON. Contractor shall ensure deployment of appropriate equipment and appliances for adequate safety and healthy of the workmen and protection of surrounding areas.

Contractor shall ensure identification of all Occupational Health, Safety & Environmental hazards in the type of work he is going to undertake and enlist mitigation measures. Contractor shall carry out Job Safety Analysis (JSA) specifically for high risk jobs like working at height & in confined space, deep excavations, radiography jobs, electrical installations, blasting operations, demolishing / dismantling activities, welding / gas cutting jobs and submit the findings to MECON / Owner. The necessary HSE measures devised shall be in place prior to start of an activity by the contractor.

b) The Contractor shall ensure that all their staff workers including their sub-Contractor(s) shall wear Safety Helmet and Safety shoes. Contractor shall also ensure use of safety belt, protective goggles, gloves etc. by the personnel as per jobs requirements. All these gadgets shall conform to relevant IS specification equivalent.
The Contractor shall ensure that all their staff, workers and visitors including their sub-contractor(s) have been issued (records to be kept) & wear appropriate PPEs like nape strap type safety helmets preferably with head & sweat band with ¾" cotton chin strap (made of industrial HDPE), safety shoes with steel toe cap and antiskid sole, full body harness (C∈ marked and conforming to EN361), protective goggles, gloves, ear muffs, respiratory protective devices, etc. All these gadgets shall conform to applicable IS Specifications / C∈ or other applicable international standards.

Owner may issue a comprehensive color scheme for helmets to be used by various agencies. The Contractor shall follow the scheme issued by the owner. All Safety / Fire personnel shall preferably wear red colour helmet so that workmen can approach them for guidance during emergencies.

For shot blasting, the usage of protective face shield and helmets, gauntlet and protective clothing is mandatory.

For offshore jobs/contracts, contractor shall provide PPEs (new) to MECON & Owner's personnel, at his (contractor's) cost. All personnel shall wear life jacket at all time.

An indicative list of HSE standards/codes is given under Appendix-A.

The contractor shall issue height permit for working at height after verifying and certifying the checkpoints as specified in the attached permit (Format No. HSE-6). He shall also undertake to ensure compliance to the conditions of the permit during the currency of the permit including adherence to personal protective equipments.

The permit shall be issued initially for one week or expected duration of an activity and extended further for the balance duration. This permit shall be applicable in areas where specific clearance from Owner's operation Deptt. / Safety Deptt. is not required. MECON field Engineers / Safety Officers / Area Coordinators may verify and counter sign this permit (as an evidence of verification) during the execution of the job.

In case work is undertaken without taking sufficient precautions as given in the permit, MECON Engineers may cancel the permit and stop the work till satisfactory compliance is arranged. Contractors are expected to maintain a register for issuance of permit and extensions thereof including preserving the used permits for verification during audits etc.

Contractor shall arrange (at his cost) and ensure use of Fall Arrester Systems by his workers. Fall arresters are to be used while climbing / descending tall structures. These arresters should lock automatically against the anchorage line, restricting free fall of the user. The device is to be provided with a double security opening system to ensure safe attachment or release of the user at
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<td>HEALTH, SAFETY AND ENVIRONMENT (HSE) MANAGEMENT</td>
<td>MEC/ S/ 05/ 21/ 65</td>
<td>REVISED : 0</td>
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<td>EDITION : 1</td>
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any point of rope. In order to avoid shock, the system should be capable of keeping the person in vertical position in case of a fall.

Contractor shall ensure that Full body harnesses conforming EN361 and having authorized CC marking is used by all personnel while working at height. The lanyards and life lines should have enough tensile strength to take the load of the worker in case of a fall. One end of the lanyard shall be firmly tied with the harnesses and the other end with life line. The harness should be capable of keeping the workman vertical in case of a fall, enabling him to rescue himself.

Contractor shall provide Roof Top Walk Ladders for carrying out activities on sloping roofs in order to reduce the chances of slippages and falls.

c) Contractor shall ensure that a proper Safety Net System shall be used at appropriate locations. The safety net shall be located not more than 30 feet (9.0 metres) below the working surface at site to arrest or to reduce the consequences of possible fall of persons working at different heights.

d) Contractor shall ensure that flash back arrestors conforming to BS:6158 or equivalent are installed on all gas cylinders as well as at the torch end of the gas hose, while in use. All cylinders shall be mounted on trolleys and provided with a closing key. The burner and the hose placed downstream of pressure reducer shall be equipped with Flash Back Arrester / Non Return Valve device. The hoses for acetylene and oxygen cylinders must be of different colours. Their connections to cylinders and burners shall be made with a safety collar. At end of work, the cylinders in use shall be closed and hoses depressurized. All welding machines shall have effective earthing. In order to help maintain good housekeeping, and to reduce fire hazard, live electrode bits shall be contained safely and shall not be thrown directly on the ground.

e) The Contractor shall assign to his workmen, tasks commensurate with their qualification, experience and state of health for driving of vehicles, handling and erections of materials and equipment’s. All lifting equipments shall be tested certified for its capacity before use. Adequate and suitable lighting at every work place and approach there to shall be provided by the contractor before starting the actual work/ operation at night.

Contractor shall ensure installation of Safe Load Indicator (SLI) on all cranes (while in use) to minimize overloading risk. SLI shall have capability to continuously monitor and display the load on the hook, and automatically compare it with the rated crane capacity at the operating condition of the crane. The system shall also provide visual and audible warnings at set capacity levels to alert the operator in case of violations.

The contractor shall be responsible for safe operations of different equipments mobilized and used by him at the workplace like transport
vehicles, engines, cranes, mobile ladders, scaffoldings, work tools, etc.

f) Hazardous and/or toxic material such as solvent coating or thinners shall be stored in appropriate containers.

g) All hazardous materials shall be labeled with the name of the materials, the hazards associated with its use and necessary precautions to be taken.

The work place shall be checked prior to start of activities to identify the location, type and condition of any asbestos materials which could be disturbed during the work. In case asbestos material is detected, usage of appropriate PPEs by all personnel shall be ensured and the matter shall be reported immediately to MECON / Owner.

h) Contractor shall ensure that during the performance of the work all hazards to the health of personnel have been identified, assessed and eliminated.

i) Chemical spills shall be contained & cleaned up immediately to prevent further contamination.

j) All personnel exposed to physical agents such as ionizing or non-ionizing radiation, ultraviolet rays or similar other physical agents shall be provided with adequate shielding or protection commensurate with type of exposure involved. For ionizing radiation, requirements of Bhabha Atomic Research Centre (BARC)/ Atomic Energy Regulatory Board (AERB) shall be followed.

k) Where contract or exposure of hazardous materials could exceed limits or could otherwise have harmful affects, appropriate personal protective equipment’s such as gloves, goggles, aprons, chemical resistant clothing and respirator shall be used.

l) Contractor shall ensure the following facilities at work sites:

   I) A Crèche where 10 or more female workers are having children below the age of 6 years.

   II) Reasonable Canteen facilities are made available at appropriate location depending upon site conditions.

m) Suitable facilities for toilet, drinking water, proper lighting shall be provided at site and labor camps, commensurate with applicable Laws/Legislation.

n) Contractor shall ensure storage and utilization methodology of material that are not detrimental to the environment. Wherever required Contractor shall ensure that only the environment friendly material are selected.

   Emphasize on recycling of waste materials such as metals, plastics, glass, paper, oil & solvents. The waste that can not be minimized, reused or
recovered shall be stored and disposed of safely. In no way, toxic spills shall be allowed to percolate into the ground. The contractor shall not use the empty areas for dumping the wastes.

o) All person deployed at site shall be knowledgeable of and comply with the environmental laws, rules & regulation relating to the hazardous materials substance and wastes. Contractor shall not dump, release or otherwise discharge or dispose off any such materials without the authorization of OWNER/ MECON.

Suitable scaffolding shall be provided to workmen for all works that cannot be safely done from the ground or from solid construction except such short period work that can be safely done using ladders. When a ladder is used, an extra workman shall be engaged for holding the ladder.

The contractor shall ensure that the scaffolds used during construction activities shall be strong enough to take the designed load. Owner / MECON reserves the right to ask the contractor to submit certification and or design calculations from his Engineering regarding load carrying capacity of the scaffolding.

All scaffolds shall be inspected by a Scaffolding Inspector of the contractor. He shall paste a GREEN tag on each scaffold found safe and a RED tag on each scaffold found unsafe. Scaffolds with GREEN tag only shall be permitted to be used and RED ones shall immediately be removed from the site.

All electrical installations / connections shall be carried out as per the provisions of latest revision of following codes/standards, in addition to the requirements of Statutory Authorities and IE / applicable international rules & regulations:

- ISO 173 : Fire prevention & protection system for electrical installations
- SP 30 (BIS) : National Electric Code

All electrical installations shall be approved by the concerned statutory authorities.

- The contractor shall meet the following requirements:
  i) Ensure that electrical systems and equipment including tools & tackles used during construction phase are properly selected, installed, used and maintained as per provisions of the latest revision of the Indian Electrical / applicable international regulations.
  ii) Shall deploy qualified & licensed electricians for proper & safe installation and for regular inspection of construction power
distribution system / points including their earthing. A copy of the license shall be submitted to MECON / Owner for records. Availability of at least one competent licensed electrician shall be ensured at site round the clock to attend to the normal / emergency jobs.

iii) All switchboards / welding machines shall be kept in well-ventilated & covered shed. The shed shall be elevated to avoid water logging. No flammable materials shall be used for constructing the shed. Also flammable materials shall not be stored in and around electrical equipment / switchboard. Adequate clearances and operational space shall be provided around the equipment.

iv) Fire extinguishers and insulating mats shall be provided in all power distribution centers.

v) Temporary electrical equipment shall not be employed in hazardous area without obtaining safety permit.

vi) Proper house keeping shall be done around the electrical installations.

vii) All temporary installations shall be tested before energising, to ensure proper earthing, bonding, suitability of protection system, adequacy of feeders/cables etc.

viii) All welders shall use hand gloves irrespective of holder voltage.

ix) Multilingual (Hindi, English and local language) caution boards, shock treatment charts and instruction plate containing location of isolation point for incoming supply, name & telephone No. of contact person in emergency shall be provided in substations and near all distribution boards / local panels.

x) Operation of earth leakage device shall be checked regularly by temporarily connecting series test lamp (2 bulbs of equal rating connected in series) between phase and earth.

xi) Regular inspection of all installations (at least once in a month)

- The following features shall also be ensured for all electrical installations during construction phase by the contractor:

i) Each installation shall have a main switch with a protective device, installed in an enclosure adjacent to the metering point. The operating height of the main switch shall not exceed 1.5 M. The main switch shall be connected to the point of supply by means of armoured cable.

ii) The outgoing feeders shall be double or triple pole switches with fuses / MCBs. Loads in a three phase circuit shall be balanced as far as
possible and load on neutral should not exceed 20% of load in the phase.

iii) The installation shall be adequately protected against overload, short circuit and earth leakage by the use of suitable protective devices. Fuses wherever used shall be HRC type. Use of rewirable fuses shall be strictly prohibited. The earth leakage device shall have an operating current not exceeding 30 mA.

iv) All connections to the hand tools / welding receptacles shall be taken through proper switches, sockets and plugs.

v) All single phase sockets shall be minimum 3 pin type only. All unused sockets shall be provided with socket caps.

vi) Only 3 core (P+N+E) overall sheathed flexible cables with minimum conductor size of 1.5 mm² copper shall be used for all single phase hand tools.

vii) Only metallic distribution boxes with double earthing shall be used at site. No wooden boxes shall be used.

viii) All power cables shall be terminated with compression type cable glands. Tinned copper lugs shall be used for multistrand wires / cables.

ix) Cables shall be free from any insulation damage.

x) Minimum depth of cable trench shall be 750 mm for MV & control cables and 900 mm for HV cables. These cables shall be laid over a sand layer and covered with sand, brick & soil for ensuring mechanical protection. Cables shall not be laid in waterlogged area as far as practicable. Cable route markers shall be provided at every 25 M of buried trench route. When laid above ground, cables shall be properly cleated or supported on rigid poles of atleast 2 M high. Minimum head clearance of 6 meters shall be provided at road crossings.

xi) Under ground road crossings for cables shall be avoided to the extent feasible. In any case no under ground power cable shall be allowed to cross the roads without pipe sleeve.

xii) All cable joints shall be done with proper jointing kit. No taped / temporary joints shall be used.

xiii) An independent earthing facility should preferably be established within the temporary installation premises. All appliances and
equipment shall be adequately earthed. In case of armoured cables, the armour shall be bonded to the earthing system.

xiv) All cables and wire rope used for earth connections shall be terminated through tinned copper lugs.

xv) In case of local earthing, earth electrodes shall be buried near the supply point and earth continuity wire shall be connected to local earth plate for further distribution to various appliances. All insulated wires for earth connection shall have insulation of green colour.

xvi) Separate core shall be provided for neutral. Earth / Structures shall not be used as a neutral in any case.

xvii) ON/OFF position of all switches shall be clearly designated / painted for easy isolation in emergency.

The contractor shall identify all operations that can adversely affect the health of its workers and issue & implement mitigation measures.

For surface cleaning operations, sand blasting shall not be permitted even if not explicitly stated elsewhere in the contract.

To eliminate radiation hazard, Tungsten electrodes used for Gas Tungsten Arc Welding shall not contain Thorium.

Appropriate respiratory protective devices shall be used to protect workmen from inhalation of air borne contaminants like silica, asbestos, gases, fumes, etc.

Workmen shall be made aware of correct methods for lifting, carrying, pushing & pulling of heavy loads. Wherever possible, manual handling shall be replaced by mechanical lifting equipments.

For jobs like drilling / demolishing / dismantling where noise pollution exceeds the specified limit of 85 decibels, ear muffs shall be provided to the workers.

To avoid upper limb disorders and backaches, Display Screen Equipments' workplace stations shall be carefully designed & used with proper sitting postures. Power driven hand-held tools shall be maintained in good working condition to minimize their vibrating effects and personnel using these tools shall be taught how to operate them safely & how to maintain good circulation in hands.

The contractor shall arrange health check up for all the workers at the time of induction. Health check may have to be repeated if the nature of duty assigned to him is changed necessitating health check or doubt arises about his wellness. MECON / Owner reserve the right to ask the contractor to submit test reports.
### Weather Protection

Contractor shall take appropriate measures to protect workers from severe storms, solar radiations, poisonous gases, dust, etc. by ensuring proper usage of PPEs like Sun glasses, Sun screen lotions, respirators, dust masks, etc. and rearranging / planning the construction activities to suit the weather conditions.

### Communication

All persons deployed at the work site shall have access to effective means of communication so that any untoward incident can be reported immediately and assistance sought by them.

All health & safety information shall be communicated in a simple & clear language easily understood by the local workforce.

### Unsuitable Land Conditions

Contractor shall take appropriate measures and necessary work permits / clearances if work is to be done in or around marshy areas, river crossings, mountains, monuments, etc.

### Under Water Inspection

Contractor shall ensure that boats and other means used for transportation, surveying & investigation works shall be certified seaworthy by a recognized classification society. It shall be equipped with all life saving devices like life jackets, adequate fire protection arrangements and shall posses communication facilities like cellular phones, wireless, walkie-talkie. All divers used for seabed surveys, underwater inspections shall have required authorized license, suitable life saving kit. Number of hours of work by divers shall be limited as per regulations. MECON / Owner shall have the right to inspect the boat and scrutinize documents in this regard.

### TOOL BOX MEETING (TBM)

Contractor shall conduct daily TBM with workers prior to start of work and shall maintain proper record of the meeting. A suggested format is given below. The TBM is to be conducted by the immediate supervisor of the workers.
**TOOLBOX MEETING RECORDING SHEET**

<table>
<thead>
<tr>
<th>Date &amp; Time</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presenter</td>
<td></td>
</tr>
</tbody>
</table>

**Hazards involved**

**Precautions to be taken**

<table>
<thead>
<tr>
<th>Worker’s Name</th>
<th>Signature</th>
<th>Section</th>
</tr>
</thead>
</table>

**Remarks, if any**

The topics during TBM shall include

- Hazards related to work assigned on that day and precautions to be taken.
- Any forthcoming HSE hazards / events / instruction / orders, etc.

The above record can be kept in local language, which workers can read. These records shall be made available to MECON / Owner whenever demanded.

**TRAINING**

Contractor shall ensure that all his personnel possess appropriate training to carry out the assigned job safely. The training should be imparted in a language understood by them and should specifically be trained about

- Potential hazards to which they may be exposed at their workplace
- Measures available for prevention and elimination of these hazards

The topics during training shall cover, at the minimum;

- Education about hazards and precautions required
- Emergency and evacuation plan
- HSE requirements
- Fire fighting and First-Aid
- Use of PPEs
- Local laws on intoxicating drinks, drugs, smoking in force

Records of the training shall be kept and submitted to MECON / Owner whenever demanded.

For offshore and jetty jobs, contractor shall ensure that all personnel deployed have undergone a structured sea survival training including use of lifeboats, basket landing, use of radio communication etc. from an agency acceptable to Owner / MECON.
INSPECTION

The contractor shall carry out daily HSE inspection and record observations at a central location. These inspection records shall be freely accessible to Owner / MECON representatives. The contractor shall also assist Owner / MECON representatives during the HSE inspections conducted by them.

ADDITIONAL SAFETY REQUIREMENTS FOR WORKING INSIDE A RUNNING PLANT

As a minimum, the contractor shall ensure adherence to following safety requirements while working in or in the close vicinity of an operating plant:

a) Contractor shall obtain permits for Hot work, Cold work, Excavation and Confined Space from Owner in the prescribed format.

b) The contractor shall monitor, record and compile list of his workers entering the operational plant/unit each day and ensure & record their return after completing the job.

c) Contractor's workers and staff members shall use designated entrances and proceed by designated routes to work areas only assigned to them. The workers shall not be allowed to enter units' area, tanks area, pump rooms, etc. without work authorization permit.

d) Work activities shall be planned in such a way so as to minimize the disruption of other activities being carried out in an operational plant / unit and activities of other contractors.

e) The contractor shall submit a list of all chemicals / toxic substances that are intended to be used at site and shall take prior approval of the Owner.

f) Specific training on working in a hydrocarbon plant shall be imparted to the work force and mock drills shall be carried out for Rescue operations / First-Aid measures.

g) Proper barricading / cordonning of the operational units / plants shall be done before starting the construction activities. No unauthorized person shall be allowed to trespass. The height and overall design of the barricading structure shall be finalized in consultation with the Owner and shall be got approved from the Owner.

h) Care shall be taken to prevent hitting underground facilities such as electrical cables, hydrocarbon piping during execution of work.

i) Barricading with water curtain shall be arranged in specific/critical areas where hydrocarbon vapors are likely to be present such as near horton spheres or tanks. Positioning of fire tenders (from owner) shall also be ensured during execution of critical activities.
j) Emergency evacuation plan shall be worked out and all workmen shall be apprised about evacuation routes. Mock drill operations may also be conducted.

k) Flammable gas test shall be conducted prior to any hot work using appropriate measuring instruments. Sewers, drains, vents or any other gas escaping points shall be covered with flame retardant tarpaulin.

l) Respiratory devices shall be kept handy while working in confined zones where there is a danger of inhalation of poisonous gases. Constant monitoring of presence of Gas / Hydrocarbon shall be done.

m) Clearance shall be obtained from all parties before starting hot tapping, patchwork on live lines and work on corroded tank roof.

n) Positive isolation of line/equipment by blinding for welding/cutting/grinding shall be done. Closing of valve will not be considered sufficient for isolation.

o) Welding spatters shall be contained properly and in no case shall be allowed to fall on the ground containing oil. Similar care shall be taken during cutting operations.

p) The vehicles, cranes, engines, etc. shall be fitted with spark arresters on the exhaust pipe and got it approved from Safety Department of the Owner.

q) Plant air should not be used to clean any part of the body or clothing or use to blow off dirt on the floor.

r) Gas detectors should be installed in gas leakage prone areas as per requirement of Owner's plant operation personnel.

s) An experienced full time safety personnel shall be exclusively deployed to monitor safety aspects in running plants.

**HSE PROMOTION**

The contractor shall encourage his workforce to promote HSE efforts at workplace by way of organizing workshops / seminars / training programmes, celebrating HSE awareness weeks & National Safety Day, conducting quizzes & essay competitions, distributing pamphlets, posters & material on HSE, providing incentives for maintaining good HSE practices and granting bonus for completing the job without any lost time accident.
4.0 DETAILS OF HSE MANAGEMENT SYSTEM BY CONTRACTOR

4.1 On Award of Contract

The Contractor shall prior to start of work submit his Health, Safety and Environment Manual of procedure and HSE Plans for approval by OWNER/MECON. The Contractor shall participate in the pre-start meeting with OWNER/MECON to finalize HSE plans including the following:

- Job procedure to be followed by Contractor for activities covering Handling of equipment’s, Scaffolding, Electric Installation, describing the risks involved, actions to be taken and methodology for monitoring each.

- Organizations structure alongwith responsibility and authority records/ reports etc. on HSE activities.

4.2 During job execution

4.2.1 Implement approved Health, Safety and Environment management procedure including but not limited to as brought our under para 3.0. Contractor shall also ensure to:

- Arrange workmen compensation insurance, registration under ESI Act, third party liability insurance etc. as applicable.

- Arrange all HSE permits before start of activities (as applicable) like her work, confined space, work at heights, storage of Chemicals/explosives materials and its use and implement all precautions mentioned therein

- Submit timely the completed check list on HSE activities, Monthly HSE report, accident report, investigation report, etc. as per OWNER/MECON requirements. Compliance of instructions on HSE shall be done by Contractor and informed urgently to OWNER/MECON.

- Ensure that resident Engineers/Site-In-Charge of the Contractor shall amend all the Safety Committee/HSE meeting arranged by OWNER/MECON only in case of his absence from site, a seconds senior most person shall be nominated by him in advance and communicated to OWNER/MECON.

- Display at site office and work locations caution boards, list of hospitals for emergency services available.

- Provided posters, banners, for safe working to promote safety consciousness

- Carryout audits/inspection at sub Contractor work as per approved HSE documents & submit the reports for OWNER/MECON review.
5.0 RECORDS

At the minimum, the contractor shall maintain/ submit HSE records in the following reporting formats:

1. Monthly HSE Checklist cum compliance report  
2. Accident / Incident Report  
3. Supplementary Accident / Incident Investigation report  
4. Near Miss Incident Report  
5. Monthly HSE Report  
6. Permit for working at height  
7. Permit for working in confined space  
8. Permit for radiation work  
9. Permit for demolishing / dismantling

- Assist in HSE audits by OWNER/ MECON and submit compliance report.
- Generate & submit HSE records/ reports as per HSE Plan.
- Appraise OWNER/MECON on HSE activities at site.
### ANNEXURE-A

#### A. I.S. CODES ON HSE

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP:53</td>
<td>Safety code for the use, Care and protection of hand operated tools.</td>
</tr>
<tr>
<td>IS: 818</td>
<td>Code of practice for safety and health requirements in electric and gas</td>
</tr>
<tr>
<td></td>
<td>welding and cutting operations</td>
</tr>
<tr>
<td>IS: 1179</td>
<td>Eye and Face precautions during welding, equipment etc.</td>
</tr>
<tr>
<td>IS: 1860</td>
<td>Safety requirements for use, care and protection of abrasive grinding wheels.</td>
</tr>
<tr>
<td>IS: 1989(Part-I &amp; II)</td>
<td>Leather safety boots and shoes</td>
</tr>
<tr>
<td>IS: 2925</td>
<td>Industrial Safety Helmets</td>
</tr>
<tr>
<td>IS: 3016</td>
<td>Code of practice for fire safety precautions in welding and cutting operations.</td>
</tr>
<tr>
<td>IS: 3764</td>
<td>Code of safety for excavation work</td>
</tr>
<tr>
<td>IS: 3786</td>
<td>Methods for computation of frequency and severity rates for industrial injuries and classification of industrial accidents.</td>
</tr>
<tr>
<td>IS: 4082</td>
<td>Recommendation on stacking and storage of construction materials and components at site.</td>
</tr>
<tr>
<td>IS: 4770</td>
<td>Rubber gloves for electrical purposes</td>
</tr>
<tr>
<td>IS: 5121</td>
<td>Safety code for piling and other deep foundations</td>
</tr>
<tr>
<td>IS: 5216 (Part-I)</td>
<td>Recommendations on Safety procedures and practices in electrical works</td>
</tr>
<tr>
<td>IS: 5557</td>
<td>Industrial and Safety rubber lined boots.</td>
</tr>
<tr>
<td>IS: 5983</td>
<td>Eye protectors</td>
</tr>
<tr>
<td>IS:6519</td>
<td>Selection, care and repair of Safety footwear</td>
</tr>
<tr>
<td>IS: 6994 (Part-I)</td>
<td>Industrial Safety Gloves (Leather &amp; Cotton Gloves)</td>
</tr>
<tr>
<td>IS: 7293</td>
<td>Safety Code for working with construction Machinery</td>
</tr>
</tbody>
</table>
IS: 8519  Guide for selection of industrial safety equipment for body protection
IS: 9167  Ear protectors
IS: 11006  Flash back arrestor (Flame arrester)
IS: 11016  General and safety requirements for machine tools and their operation
IS: 11057  Specification for Industrial safety nets
IS: 11226  Leather safety footwear having direct moulded rubber sole
IS: 11972  Code of practice for safety precaution to be taken when entering a sewerage system
IS: 13367  Code of practice-safe use of cranes
IS: 13416  Recommendations for preventive measures against hazards at working place

B. INTERNATIONAL STANDARDS ON HSE

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Glasses</td>
<td>ANSI Z 87.1, ANSI ZZ 87.1, AS 1337, BS 2092, BS 1542, BS 679, DIN 4646 / 58211</td>
</tr>
<tr>
<td>Safety Shoes</td>
<td>ANSI Z 41.1, AS 2210, EN 345</td>
</tr>
<tr>
<td>Hand Gloves</td>
<td>BS 1651</td>
</tr>
<tr>
<td>Ear Muffs</td>
<td>BS 6344, ANSI S 31.9</td>
</tr>
<tr>
<td>Hard Hat</td>
<td>ANSI Z 89.1 / 89.2, AS 1808, BS 5240, DIN 4840</td>
</tr>
<tr>
<td>Goggles</td>
<td>ANSI Z 89.1</td>
</tr>
<tr>
<td>Face Shield</td>
<td>ANSI Z 89.1</td>
</tr>
<tr>
<td>Breathing Apparatus</td>
<td>BS 4667, NIOSH</td>
</tr>
<tr>
<td>Welding &amp; Cutting</td>
<td>ANSI Z 49.1</td>
</tr>
<tr>
<td>Safe handling of compressed Gases in cylinders</td>
<td>P-1 (Compressed Gas Association 1235 Jefferson Davis Highway, Arlington VA 22202 – USA)</td>
</tr>
</tbody>
</table>
### DETAIL OF FIRST AID BOX

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Small size Roller Bandages, 1 inch wide (Finger Dressing small)</td>
<td>6 Pcs.</td>
</tr>
<tr>
<td>2.</td>
<td>Medium size Roller Bandages, 2 inch wide (Hand and Foot Dressing)</td>
<td>6 Pcs.</td>
</tr>
<tr>
<td>3.</td>
<td>Large size Roller Bandages, 4 inch wide (Body Dressing Large)</td>
<td>6 Pcs.</td>
</tr>
<tr>
<td>4.</td>
<td>Large size Burn Dressing (Burn Dressing Large)</td>
<td>4 Pkts.</td>
</tr>
<tr>
<td>5.</td>
<td>Cotton wool (20 gms packing)</td>
<td>4 Pkts.</td>
</tr>
<tr>
<td>6.</td>
<td>Antiseptic Solution Dettol (100 ml.) or Savlon</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>7.</td>
<td>Mercurochrome Solution (100 ml.) 2% in water</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>8.</td>
<td>Ammonia Solution (20 ml.)</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>9.</td>
<td>A Pair of Scissors</td>
<td>1 Piece</td>
</tr>
<tr>
<td>10.</td>
<td>Adhesive Plaster (1.25 cm x 5 m)</td>
<td>1 Spool</td>
</tr>
<tr>
<td>12.</td>
<td>Tourniquet</td>
<td>1 No.</td>
</tr>
<tr>
<td>13.</td>
<td>Safety Pins</td>
<td>1 Dozen</td>
</tr>
<tr>
<td>14.</td>
<td>Tinc. Iodine / Betadin (100 ml.)</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>15.</td>
<td>Ointment for burns (Burnol 20 gms.)</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>16.</td>
<td>Polythene Wash cup for washing eyes</td>
<td>1 No.</td>
</tr>
<tr>
<td>17.</td>
<td>Potassium Permanganate (20 gms.)</td>
<td>1 Pkt.</td>
</tr>
<tr>
<td>18.</td>
<td>Tinc. Benzoine (100 ml.)</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>20.</td>
<td>Band Aid Dressing</td>
<td>5 Pcs.</td>
</tr>
<tr>
<td>21.</td>
<td>Iodex / Moov (25 gms.)</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>22.</td>
<td>Tongue Depressor</td>
<td>1 No.</td>
</tr>
<tr>
<td>23.</td>
<td>Boric Acid Powder (20 gms.)</td>
<td>2 Pkt.</td>
</tr>
<tr>
<td>24.</td>
<td>Sodium Bicarbonate (20 gms.)</td>
<td>1 Pkt.</td>
</tr>
<tr>
<td>25.</td>
<td>Dressing Powder (Nebasulf) (10 gms.)</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>26.</td>
<td>Medicinal Glass</td>
<td>1 No.</td>
</tr>
<tr>
<td>27.</td>
<td>Duster</td>
<td>1 No.</td>
</tr>
<tr>
<td>28.</td>
<td>Booklet (English &amp; Local Language)</td>
<td>1 No. each</td>
</tr>
<tr>
<td>29.</td>
<td>Soap</td>
<td>1 No.</td>
</tr>
<tr>
<td>30.</td>
<td>Toothache Solution</td>
<td>1 No.</td>
</tr>
<tr>
<td>31.</td>
<td>Eye Ointment</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>32.</td>
<td>Vicks (22 gms.)</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>33.</td>
<td>Forceps</td>
<td>1 No.</td>
</tr>
<tr>
<td>34.</td>
<td>Cotton Buds (5 nos.)</td>
<td>1 Pkt.</td>
</tr>
<tr>
<td>35.</td>
<td>Note Book</td>
<td>1 No.</td>
</tr>
<tr>
<td>36.</td>
<td>Splints</td>
<td>4 Nos.</td>
</tr>
<tr>
<td>37.</td>
<td>Lock</td>
<td>1 Piece</td>
</tr>
<tr>
<td>38.</td>
<td>Life Saving/Emergency/Over-the-Counter Drugs</td>
<td>As decided at site</td>
</tr>
</tbody>
</table>

**Box size:** 14” x 12” x 4”

Note: The medicines prescribed above are only indicative. Equivalent medicines can also be used. A prescription, in this regard, shall be required from a qualified Physician.
### ANNEXURE – C

#### TYPE OF FIRES VIS-À-VIS FIRE EXTINGUISHERS

<table>
<thead>
<tr>
<th>Fire Type</th>
<th>Water</th>
<th>Foam</th>
<th>CO₂</th>
<th>Dry Powder</th>
<th>Multi Purpose (ABC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Originated from paper, clothes, wood</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Inflammable liquids like alcohol, diesel, petrol, edible oils, bitumen</td>
<td>x</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Originated from gases like LPG, CNG, H₂</td>
<td>x</td>
<td>x</td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Electrical Fires</td>
<td>x</td>
<td>x</td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

Legend:  
- √ Can be used  
- x Not to be used

Note: Fire extinguishing equipment must be checked at least once a year and after every use by an authorized person. The equipment must have an inspection label on which the next inspection date is given. Type of extinguisher shall clearly be marked on it.
Indicative List of Statutory Acts & Rules Relating to HSE

- The Indian Explosives Act and Rules
- The Motor Vehicle Act and Central Motor Vehicle Rules
- The Factories Act and concerned Factory Rules
- The Petroleum Act and Petroleum Rules
- The Workmen Compensation Act
- The Gas Cylinder Rules and the Static & Mobile Pressure Vessels Rules.
- The Indian Electricity Act and Rules
- The Indian Boiler Act and Regulations
- The Water (Prevention & Control & Pollution) Act
- The Water (Prevention & Control of Pollution) Cess Act
- The Mines & Minerals (Regulation & Development) Act
- The Air (Prevention & Control of Pollution) Act
- The Atomic Energy Act
- The Radiation Protection Rules
- The Indian Fisheries Act
- The Indian Forest Act
- The Wild Life (Protection) Act
- The Environment (Protection) Act and Rules
- The Hazardous Wastes (Management & Handling) Rules
- The Manufacturing, Storage & import of Hazardous Chemicals Rules
- The Public Liability Act
- The Building and Other Construction Workers (Regulation of Employment and Condition of service) Act
- Other statutory acts Like EPF, ESIS, Minimum Wage Act.
# CONSTRUCTION HAZARDS, THEIR EFFECTS & PREVENTIVE MEASURES

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>TYPE OF HAZARD</th>
<th>EFFECT OF HAZARD</th>
<th>PREVENTIVE MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) EXCAVATION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pit Excavation up to 3.0m</td>
<td>Falling into pit</td>
<td>Personal injury</td>
<td>Provide guard rails/barricade with warning signal.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Provide at least two entries/exits.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Provide escape ladders.</td>
</tr>
<tr>
<td></td>
<td>Earth Collapse</td>
<td>Suffocation / Breathlessness Buried</td>
<td>Provide suitable size of shoring and strutting, if required.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Keep soil heaps away from the edge equivalent to 1.5m or depth of pit whichever is more.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Don’t allow vehicles to operate too close to excavated areas. Maintain at least 2m distance from edge of cut.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maintain sufficient angle of repose. Provide slope not less than 1:1 and suitable bench of 0.5m width at every 1.5m depth of excavation in all soils except hard rock.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Battering/benching the sides.</td>
</tr>
<tr>
<td></td>
<td>Contact with buried electric cables Gas/ Oil Pipelines</td>
<td>Electrocution Explosion</td>
<td>Obtain permission from competent authorities, prior to excavation, if required.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Locate the position of buried utilities by referring to plant drawings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Start digging manually to locate the exact position of buried utilities and thereafter use</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
</tr>
<tr>
<td>----------</td>
<td>----------------</td>
<td>-----------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Pit Excavation beyond 3.0m</td>
<td>Same as above plus Flooding due to excessive rain/underground water</td>
<td>Can cause drowning situation</td>
<td>Prevent ingress of water Provide ring buoys Identify and provide suitable size dewatering pump or well point system</td>
</tr>
<tr>
<td></td>
<td>Digging in the vicinity of existing Building/Structure</td>
<td>Building/Structure may collapse Loss of health &amp; wealth</td>
<td>Obtain prior approval of excavation method from local authorities Use under-pinning method Construct retaining wall side by side</td>
</tr>
<tr>
<td></td>
<td>Movement of vehicles/equipments close to the edge of cut.</td>
<td>May cause cave-in or slides Persons may get buried</td>
<td>Barricade the excavated area with proper lighting arrangements Maintain at least 2m distance from edge of cut and use stop block to prevent over-run Strengthen shoring and strutting</td>
</tr>
<tr>
<td>Narrow deep excavations for pipelines, etc.</td>
<td>Same as above plus Frequent cave-in or slides</td>
<td>May cause severe injuries or prove fatal</td>
<td>Battering/benching of sides Provide escape ladders</td>
</tr>
<tr>
<td></td>
<td>Flooding due to Hydrostatic testing</td>
<td>May arise drowning situation</td>
<td>Same as above plus Bail out accumulated water Maintain adequate ventilation</td>
</tr>
<tr>
<td>Rock excavation by blasting</td>
<td>Improper handling of explosives</td>
<td>May prove fatal</td>
<td>Ensure proper storage, handling &amp; carrying of explosives by trained personnel Comply with the applicable explosive acts &amp; rules.</td>
</tr>
<tr>
<td></td>
<td>Uncontrolled explosion</td>
<td>May cause severe injuries or prove fatal</td>
<td>Allow only authorized persons to perform blasting operations Smoking and open</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
</tr>
<tr>
<td>----------</td>
<td>----------------------------------------------------</td>
<td>------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Scattering of stone pieces in atmosphere</td>
<td>Can hurt people</td>
<td>Use PPE like goggles, face mask, helmets etc.</td>
</tr>
<tr>
<td>Rock excavating by blasting (Contd)</td>
<td>Entrapping of persons/animals.</td>
<td>May cause severe injuries or prove fatal</td>
<td>Barricade the area with red flags and blow siren before blasting.</td>
</tr>
<tr>
<td></td>
<td>Misfire</td>
<td>May explode suddenly</td>
<td>Do not return to site for at least 20 minutes or unless announced safe by designated person.</td>
</tr>
<tr>
<td></td>
<td>Failure of pile-driving equipment</td>
<td>Can hurt people</td>
<td>Inspect Piling rigs and pulley blocks before the beginning of each shift.</td>
</tr>
<tr>
<td></td>
<td>Noise pollution</td>
<td>Can cause deafness and psychological imbalance</td>
<td>Use personal protective equipments like ear plugs, muffs, etc.</td>
</tr>
<tr>
<td></td>
<td>Extruding rods / casing</td>
<td>Can hurt people</td>
<td>Barricade the area an install sign boards Provide first-aid</td>
</tr>
<tr>
<td></td>
<td>Working in the vicinity of 'Live-Electricity'</td>
<td>Can cause electrocution / asphyxiation</td>
<td>Keep sufficient distance from Live-Electricity as per IS code.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Shut off the supply, if possible Provide artificial/rescue breathing to he injured.</td>
</tr>
<tr>
<td>(B) CONCRETING</td>
<td>Air pollution by cement</td>
<td>May affect Respiratory System</td>
<td>Wear respirators or cover mouth and nose with wet cloth.</td>
</tr>
<tr>
<td></td>
<td>Handling of ingredients</td>
<td>Hand s may get injured</td>
<td>Use gloves and other PPE.</td>
</tr>
<tr>
<td></td>
<td>Protruding reinforcement rods.</td>
<td>Feet may get injured</td>
<td>Use Safety shoes. Provide platform above reinforcement for movement of workers.</td>
</tr>
<tr>
<td></td>
<td>Earthing of electrical mixers.</td>
<td>Can cause electrocution / asphyxiation</td>
<td>Ensure earthing of equipments and proper functioning of</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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</tr>
<tr>
<td>Super-structure</td>
<td>Falling of materials from height</td>
<td>Persons may get injured</td>
<td>Use hard hats&lt;br&gt;Remove surplus material immediately from work place&lt;br&gt;Ensure lighting arrangements during night hours</td>
</tr>
<tr>
<td></td>
<td>Continuous pouring by same gang</td>
<td>Cause tiredness of workers and may lead to accident.</td>
<td>Insist on shift pattern&lt;br&gt;Provide adequate rest to workers between subsequent pours</td>
</tr>
<tr>
<td></td>
<td>Revolving or concrete mixer/ vibrators</td>
<td>Parts of body or clothes may get entrapped.</td>
<td>Allow only mixers with hopper&lt;br&gt;Provide safety cages around moving motors&lt;br&gt;Ensure proper mechanical locking of vibrator</td>
</tr>
<tr>
<td>(C) REINFORCEMENT</td>
<td>Same as above plus&lt;br&gt;Deflection in props or shuttering material</td>
<td>Shuttering / props may collapse and prove fatal</td>
<td>Avoid excessive stacking on shuttering material&lt;br&gt;Check the design and strength of shuttering material before commencement of work&lt;br&gt;Rectify immediately the deflection noted during concreting</td>
</tr>
<tr>
<td></td>
<td>Passage to work place</td>
<td>Improperly tied and designed props / planks may collapse</td>
<td>Ensure the stability and strength of passage before commencement of work&lt;br&gt;Do not overload and under the passage.</td>
</tr>
<tr>
<td></td>
<td>Curtailment and binding of rods</td>
<td>Persons may get injured</td>
<td>Use PPE like gloves, shoes, helmets, etc.&lt;br&gt;Avoid usage of shift tools</td>
</tr>
<tr>
<td></td>
<td>Carrying of rods for short distance/ at</td>
<td>Workers may injure their hands and shoulders</td>
<td>Provide suitable pads on shoulders and use safety</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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<tr>
<td></td>
<td>heights</td>
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<td></td>
<td></td>
<td></td>
<td>gloves.</td>
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<td></td>
<td>➢ Tie up rods in easily liftable bundles</td>
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<td></td>
<td>➢ Ensure proper staging.</td>
</tr>
<tr>
<td>➢</td>
<td>Checking of clear distance/ cover with hands</td>
<td>Rods may cut or injure the finger</td>
<td>Use measuring devices tape, measuring rods, etc.</td>
</tr>
<tr>
<td>➢</td>
<td>Hitting projected rods and standing on cantilever rods</td>
<td>Persons may get injured and fall down</td>
<td>Use safety shoes and avoid standing unnecessarily on cantilever rods</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>➢ Avoid wearing loose clothes</td>
</tr>
<tr>
<td>➢</td>
<td>Falling of material from height</td>
<td>May prove fatal</td>
<td>Use helmets</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>➢ Provide safety nets</td>
</tr>
<tr>
<td>➢</td>
<td>Transportation of rods by trucks / trailers</td>
<td>Protruded rods may hit the persons</td>
<td>Use red flags/lights at the ends</td>
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<td>➢ Do not protrude the rods in front of or by the side of driver’s cabin.</td>
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<td>➢ Do not extend the rods 1/3rd of deck length or 1.5 m which is less</td>
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<tr>
<td>(D) WELDING AND GAS CUTTING</td>
<td>Welding radiates invisible ultraviolet and infrared says</td>
<td>Radiation can damage eyes and skin.</td>
<td>Use specified shielding devices and other PPE of correct specifications</td>
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<td>➢ Avoid throated tungsten electrodes for GTAW.</td>
</tr>
<tr>
<td>➢</td>
<td>Improper placement of oxygen and acetylene cylinders</td>
<td>Explosion may occur</td>
<td>Move out any leaking cylinder</td>
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<td></td>
<td>➢ Keep cylinder in vertical position</td>
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<td>➢ Use trolley for transportation of cylinders and chain them</td>
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<td>➢ Use flash back arrestors</td>
</tr>
<tr>
<td>➢</td>
<td>Leakage / cuts in hoses</td>
<td>May cause fire</td>
<td>Purge regulators immediately and then turn off</td>
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<td>➢ Never use grease or</td>
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## Activity: Health, Safety and Environment (HSE) Management

<table>
<thead>
<tr>
<th>Activity</th>
<th>Type of Hazard</th>
<th>Effect of Hazard</th>
<th>Preventive Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening-up of cylinder</td>
<td>Cylinder may burst</td>
<td>Always stand back from the regulator while opening the cylinder.</td>
<td>Turn valve slowly to avoid bursting.</td>
</tr>
<tr>
<td>Welding of tanks, container or pipes storing flammable liquids</td>
<td>Explosion may occur</td>
<td>Empty &amp; purge them before welding.</td>
<td>Never attach the ground cable to tanks, container or pipe storing flammable liquids.</td>
</tr>
<tr>
<td>Ionizing Radiation</td>
<td>Radiations may react with the skin and can cause cancer, skin irritation, dermatitis, etc.</td>
<td>Ensure safety regulations as per BARC/AERB before commencement of job.</td>
<td>Cordon off the area and install Radiation warning symbols.</td>
</tr>
<tr>
<td>Transportation and Storage of Radiography source</td>
<td>Same as above</td>
<td>Never touch or handle radiography source with hands.</td>
<td>Store radiography source inside a pit in an exclusive isolated area.</td>
</tr>
<tr>
<td>ACTIVITY</td>
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<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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<td></td>
<td>storage room with lock and key arrangement. The pit should be approved by BARC/AERB</td>
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<td>Radiography source should never be carried either in passenger bus or in a passenger compartment of trains.</td>
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<td>BARC/AERB have to be informed before source movement.</td>
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<td>Permission from Director General of Civil Aviation is required for booking radio isotopes with airlines.</td>
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<td>Loss of Radio isotope</td>
<td>Same as above</td>
<td>Try to locate with the help of Survey Meter.</td>
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<td>Inform BARC/AERB(*)</td>
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<td></td>
<td></td>
<td></td>
<td>(*) Atomic Energy Regulatory Board (AERB), Bhabha Atomic Research Centre (BARC) Anushaktinagar, Mumbai – 400 094</td>
</tr>
<tr>
<td>(F) ELECTRICAL INSTALLATION AND USAGE</td>
<td>Short circuiting</td>
<td>Can cause Electrocution or Fire</td>
<td>Use rubberized hand gloves and other PPE</td>
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<td></td>
<td>Don’t lay wires under carpets, mats or door ways.</td>
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<td>Allow only licensed electricians to perform on electrical facilities</td>
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<td></td>
<td>Use one socket for one appliance</td>
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<td>Ensure usage of only fully insulated wires or cables</td>
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<td>Don’t place bare wire ends in a socket</td>
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<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
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<td>PREVENTIVE MEASURES</td>
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</tbody>
</table>
|          | Overloading of Electrical System | Bursting of system can occur which leads to fire | Display voltage and current ratings prominently with 'Danger' signs.  
Ensure approved cable size, voltage grade and type.  
Switch off the electrical utilities when not in use.  
Do not allow unauthorized connections.  
Ensure proper grid wise distribution of Power. |
|          | Improper laying of overhead and underground transmission lines / cables | Can cause electrocution and prove fatal | Do not lay unarmored cable directly on ground, wall, roof of trees  
Maintain at least 3m distance from HT cables  
All temporary cables should be laid at least 750 mm below ground on 100 mm |
<table>
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<tr>
<th>ACTIVITY</th>
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</thead>
</table>
| (G) FIRE PREVENTION AND PROTECTION | Small fires can become big ones and may spread to the surrounding areas | Cause burn injuries and may prove fatal. | - Fine sand overlying by brick soling  
- Provide proper sleeves at crossings/ intersections  
- Provide cable route markers indicating the type and depth of cables at intervals not exceeding 30m and at the diversions/termination.  
- In case a fire breaks out, press fire alarm system and shout “Fire, Fire”  
- Keep buckets full of sand & water/fire extinguishing equipment near hazardous locations  
- Confine smoking to ‘Smoking Zones’ only  
- Train people for using specific type of fire equipments under different classes of fire  
- Keep fire doors/shutters, passages and exit doors unobstructed  
- Maintain good house keeping and first-aid boxes (for detail refer Annex-2)  
- Don’t obstruct assess to Fire extinguishers  
- Do not use elevators for evacuation during fire  
- Maintain lightening arrestors for elevated structures  
- Stop all electrical motors with internal combustion.  
- Move the vehicles from dangerous...
<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>TYPE OF HAZARD</th>
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<tbody>
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<td></td>
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<td>Remove the load hanging from the crane booms.</td>
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<td></td>
<td>Remain out of the danger areas.</td>
</tr>
<tr>
<td>✓ Improper selection of Fire Extinguisher</td>
<td>It may not extinguish the fire</td>
<td>Ensure usage of correct fire extinguisher meant for the specified fire (for details refer Appendix-C)</td>
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</tr>
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<td></td>
<td>Do not attempt to extinguish Oil and electric fires with water. Use foam cylinders/CO2/sand or earth.</td>
</tr>
<tr>
<td>✓ Improper storage of highly inflammable substances</td>
<td>Same as above</td>
<td>Maintain safe distance of flammable substances from source of ignition</td>
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<td>Restrict the distribution of flammable materials to only min. necessary amount</td>
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<td></td>
<td>Construct specifically designed fuel storage facilities</td>
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<td>Keep chemicals in cool and dry place away from heat. Ensure adequate ventilation</td>
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<td>Before welding operation, remove or shield the flammable material properly</td>
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<td>Store flammable materials in stable racks, correctly labeled preferably with catchments trays.</td>
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<td></td>
<td>Wipe off the spills immediately</td>
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<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
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<tr>
<td></td>
<td>➢ Short circuiting of electrical system</td>
<td>➢ Same as above</td>
<td>➢ Don’t lay wires under carpets, mats or door ways</td>
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<td></td>
<td></td>
<td>➢ Can cause Electrocuton</td>
<td>➢ Use one socket for one appliance</td>
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<td></td>
<td>➢ Use only fully insulated wires or cables</td>
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<td>➢ Do not allow open/bare connections</td>
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<td>➢ Provide all connections through ELCB</td>
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<td></td>
<td>➢ Ensure earthing of machineries and equipments</td>
</tr>
<tr>
<td>(H) VEHICULAR MOVEMENT</td>
<td>➢ Crossing the Speed Limits (Rash driving)</td>
<td>➢ Personal injury</td>
<td>➢ Obey speed limits and traffic rules strictly</td>
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<td>➢ Always expect the unexpected and be a defensive drive</td>
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<td>➢ Use sat belts/helmets</td>
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<td></td>
<td>➢ Blow horn at intersections and during overtaking operations.</td>
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<td></td>
<td>➢ Maintain the vehicle in good condition</td>
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<td></td>
<td>➢ Do not overtake on curves, bridges and slopes</td>
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<td>➢ Adverse weather condition</td>
<td>➢ Same as above</td>
<td>➢ Read the road ahead and ride to the left</td>
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<td></td>
<td></td>
<td>➢ Keep the wind screen and lights clean</td>
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<td>➢ Do not turn at speed</td>
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<td></td>
<td>➢ Recognize the hazard, understand the defense and act correctly in time.</td>
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<td></td>
<td>➢ Consuming alcohol before and during</td>
<td>➢ Same as above</td>
<td>➢ Alcohol and driving do not mix well. Either choose</td>
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<tr>
<td></td>
<td>driving operation</td>
<td></td>
<td>alcohol or driving.</td>
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<td>➢ If you have a choice between hitting a fixed object or an oncoming vehicle, hit the fixed object</td>
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<td>➢ Quit the steering at once and become a passenger.</td>
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<td>➢ Otherwise take sufficient rest and then drive.</td>
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<td>➢ Do not force the driver to drive fast and round the clock.</td>
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<td>➢ Do not day dram while driving</td>
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<td>Falling objects / Mechanical failure</td>
<td>May prove fatal</td>
<td>Ensure effective braking system, adequate visibility for the drives, reverse warning alarm.</td>
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<td>➢ Proper maintenance of the vehicle as per manufacturer instructions</td>
</tr>
<tr>
<td>(I) PROOF TESTING (HYDROSTATIC/ PNEUMATIC TESTING)</td>
<td>Bursting of piping</td>
<td>May cause injury and prove fatal</td>
<td>Prepare test procedure &amp; obtain CONSULTANT/ Owner’s approval</td>
</tr>
<tr>
<td></td>
<td>Collapse of tanks</td>
<td></td>
<td>➢ Provide separate gauge for pressurizing pump and piping/equipment</td>
</tr>
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<td></td>
<td>Tanks flying off</td>
<td></td>
<td>➢ Check the calibration status of all pressure gauges, dead weight testers and temperature recorders</td>
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<td>➢ Take dial readings at suitable defined intervals and ensure most of them fall between 40-60% of the gauge scale range</td>
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<td>➢ Provide safety relief valve (set at</td>
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<td>EFFECT OF HAZARD</td>
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<tr>
<td>(J) WORKING AT HEIGHTS</td>
<td>Person can fall down</td>
<td>May sustain severe injuries or</td>
<td>Provide guard rails/barricade at the</td>
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</tbody>
</table>

- Pressure slightly higher than test pressure) while testing with air/nitrogen
- Ensure necessary precautions, stepwise increase in pressure, tightening of bolts/nuts, grouting, etc. before and during testing
- Keep the vents open before opening any valve while draining out of water used for hydro testing of tanks
- Pneumatic testing involves the hazard of released energy shored in compressed gas. Specific care must therefore be taken to minimize the chance of brittle failure during a pneumatic leak test. Test temperature is important in this regard and must be considered when the designer chooses the material of construction
- A pressure relief device shall be provided, having a set pressure not higher than the test pressure plus the lesser of 345 KPa (50 psi) or 10% of the test pressure. The gas used as test fluid, if not air, shall be nonflammable and nontoxic.
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<td></td>
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<td>prove fatal</td>
<td>work place</td>
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<td></td>
<td>➢ Use PPE like safety belts, full body harness, life line, helmets, safety shoes, etc.</td>
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<td>➢ Obtain a permit before starting the work at height above 3 meters</td>
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<td>➢ Fall arrest systems like safety nets, etc. must be installed</td>
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<td>➢ Provide adequate working space (min. 0.6 m)</td>
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<td>➢ Tie/weld working platform with fixed support</td>
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<td>➢ Use roof top walk ladder while working on a slopping roofs</td>
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<td>➢ Avoid movement on beams</td>
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<td></td>
<td>May hit the scrap / material stacked at the ground or in between</td>
<td>Keep the work place neat and clean</td>
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<td></td>
<td></td>
<td>➢ Remove the scrap immediately</td>
</tr>
<tr>
<td></td>
<td>Material can fall down</td>
<td>May hit the workers working at lower levels and prove fatal.</td>
<td>Same as above plus</td>
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<td>➢ Do not throw or drop material or equipment from height</td>
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<td>➢ All tools to be carried in a toolkit bags or on working uniform</td>
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<td>➢ Remove scrap from the planks</td>
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<td></td>
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<td>➢ Ensure wearing of helmet by the workers at low level</td>
</tr>
<tr>
<td>(K) CONFINED SPACES</td>
<td>Suffocation / drowning</td>
<td>Unconsciousness, death</td>
<td>Use respiratory devices, if required</td>
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<td></td>
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<td>➢ Avoid over crowding inside a confined space</td>
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<td>➢ Provide Exhaust Fans for ventilation</td>
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<td></td>
<td></td>
<td></td>
<td>➢ Do not wear loose clothes, neck ties,</td>
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<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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<tr>
<td></td>
<td>Presence of foul smell and toxic substances</td>
<td>Inhalation can pose threat to life.</td>
<td>Same as above plus Check for hydrocarbon and Aromatic compounds before entering a confined space Depute one person outside the confined space for continuous monitoring and for extending help in case of an emergency</td>
</tr>
<tr>
<td></td>
<td>Ignition / flame can cause fire</td>
<td>Person may sustain burn injuries or explosion may occur</td>
<td>Keep fire extinguishers at a hand distance Remove surplus material and scrap immediately Do not smoke inside a confined space Do not allow gas cylinders inside a confined space Use low voltage (24V) lamps for lighting Use tools with air motors or electric tools with max.</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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</table>
| (L) HANDLING AND LIFTING EQUIPMENTS | Failure of load lifting and moving equipments    | Can cause accident and prove fatal    | ➢ Avoid standing under the lifted load and within the operating radius of cranes  
➢ Check periodically oil, brakes, gears, horns and tyre pressure of all moving machinery  
➢ Check quality, size and condition of all chain pulley blocks, slings, U-clamps, D-shackles, wire ropes, etc.  
➢ Allow crane to move only on hard, firm and leveled ground  
➢ Allow lifting slings as short as possible and check gunny packings at the friction points  
➢ Do not allow crane to tilt its boom while moving  
➢ Install Safe Load Indicator  
➢ Ensure certification by applicable authority. |
|                                  | Overloading of lifting equipments                  | Can cause electrocution and fire       | ➢ Safe lifting capacity of derricks and winches written on them shall be got verified.  
➢ The max safe working load shall be marked on all lifting equipments  
➢ Check the weight of columns and other heavy items painted on them and accordingly decide about the crane |
<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>TYPE OF HAZARD</th>
<th>EFFECT OF HAZARD</th>
<th>PREVENTIVE MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overhead electrical wires</td>
<td>Can cause electrocution and fire</td>
<td>➢ Do not allow boom or other parts of crane to come within 3 m reach of overhead HT cables. &lt;br&gt; ➢ Hook and load being lifted shall preferably remain in full visibility of crane operator.</td>
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<tr>
<td>(M) SCAFFOLDING, FORMWORK AND LADDERS</td>
<td>Person can fall down</td>
<td>Person may sustain severe injuries and prove fatal</td>
<td>➢ Provide guard rails for working at height. &lt;br&gt; ➢ Face ladder while climbing and use both hands. &lt;br&gt; ➢ Ladders shall extend about 1m above landing for easy access and tying up purpose. &lt;br&gt; ➢ Do not place ladders against movable objects and maintain base at ¼ unit of the working length of the ladder. &lt;br&gt; ➢ Suspended scaffolds shall not be less than 500 mm wide and tied properly with ropes. &lt;br&gt; ➢ No loose planks shall be allowed. &lt;br&gt; ➢ Use PPE, like helmets, safety shoes, etc.</td>
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<tr>
<td></td>
<td>Failure of scaffolding material</td>
<td>Same as above</td>
<td>➢ Inspect visually all scaffolding materials for stability and anchoring with permanent structures. &lt;br&gt; ➢ Design scaffolding</td>
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<tr>
<td></td>
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<td></td>
<td>Capacity, boom and angle of erection. &lt;br&gt; ➢ Allow only trained operators and riggers during crane operation.</td>
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<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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<td></td>
<td>for max. load carrying capacity</td>
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<td>Scaffolding planks shall not be less than 50x250 mm full thickness lumber or equivalent. These shall be cleared or secured and must extend over the end supports by at least 150mm and not more than 300 mm</td>
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<td></td>
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<td>Don’t overload the scaffolds</td>
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<td>Do not splice short ladders to make a longer one. Vertical ladders shall not exceed 6m.</td>
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<tr>
<td></td>
<td>Material can fall down</td>
<td>Persons working at lower level gets injured.</td>
<td>Remove excess material and scrap immediately</td>
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<td>Carry the tools in a tool-kit bag only</td>
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<td>Provide safety nets</td>
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<tr>
<td>(N) STRUCTURAL WORKS</td>
<td>Personal negligence</td>
<td>Can cause injury or casualty</td>
<td>Do not take rest inside rooms built for welding machines or electrical distribution system</td>
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<td></td>
<td>and danger of fall</td>
<td></td>
<td>Avoid walking on beams at height</td>
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<td></td>
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<td></td>
<td>Wear helmet with chin strap and safety belts when working at height</td>
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<td>Use hand gloves and goggles during grinding operations</td>
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<td>Cover or mark the sharp and projected edges</td>
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<td>Do not stand within the operating radius of cranes</td>
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<td></td>
<td>Lifting / slipping of</td>
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<td>Do not stand under the lifted load</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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</tbody>
</table>
| (O) PIPELINE WORKS | Erection / lowering failure | Can cause injury | Do not stand under the lifted Load  
Do not allow any person to come within the radii of the side boom handling pipes  
Check the load carrying capacity of the lifting tools and tackles  
Use safe Load Indicators  
Use appropriate PPEs |
|        | Other | Same as above | Wear gum boots in marshy areas  
Allow only one person to perform signaling operations while lowering of pipes  
Provide night caps on pipes  
Provide end covers on pipes for stoppage of pigs while testing/cleaning operations. |
## HSE CHECKLIST CUM COMPLIANCE REPORT (1/6)

Project: _________________________  Contractor :_______________________  
Date:   _________________________  Owner     :________________________  
Inspection By:___________________  Report No. :________________________  
Frequency : Fortnightly    Job No  :_______________________  

Note: write ‘NA’ wherever the item is not applicable

<table>
<thead>
<tr>
<th>SL. NO.</th>
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<th>ACTION</th>
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<td>Waste containers provided and used</td>
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<td>Sanitary facilities adequate and clean</td>
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<tr>
<td>c)</td>
<td>Passageways and Walkways clear</td>
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<td>d)</td>
<td>General neatness of working areas</td>
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<td>Hand protection</td>
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<td>f)</td>
<td>Respiratory Masks etc.</td>
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<td>h)</td>
<td>Safety Helmet/Hard Hat</td>
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<td>i)</td>
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<td>Openings properly covered or barricaded</td>
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<td>b)</td>
<td>Excavations shored</td>
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<td>c)</td>
<td>Excavations barricaded</td>
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<td>d)</td>
<td>Overnight lighting provided</td>
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<td>WELDING &amp; GAS CUTTING</td>
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<tr>
<td>a)</td>
<td>Gas cylinders chained upright</td>
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<tr>
<td>b)</td>
<td>Cables and hoses not obstructing</td>
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<td>c)</td>
<td>Screens or shields used</td>
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<td>d)</td>
<td>Flammable materials protected</td>
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<td>e)</td>
<td>Fire extinguisher(s) accessible</td>
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<td>f)</td>
<td>Others</td>
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<td>SCAFFOLDING</td>
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<td>Fully decked platforms</td>
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<td>b)</td>
<td>Guard and intermediate rails in place</td>
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<tr>
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<td>YES</td>
<td>NO</td>
<td>REMARKS</td>
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<td>c)</td>
<td>Toe boards in place</td>
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<td>d)</td>
<td>Adequate shoring</td>
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<tr>
<td>e)</td>
<td>Adequate access</td>
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<td>f)</td>
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<td><strong>6</strong> LADDERS</td>
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<tr>
<td>a)</td>
<td>Extension side rails 1m above</td>
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<td>b)</td>
<td>Top of landing</td>
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<tr>
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<td>Properly secured</td>
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<td>d)</td>
<td>Angle + 70 from horizontal</td>
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<td><strong>7</strong> HOISTS, CRANES AND DERRICKS</td>
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<td>Condition of slings, chains, hooks and eyes OK</td>
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<td>d)</td>
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<td>Signs/barricades provided</td>
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<td>f)</td>
<td>Signals observed and understood</td>
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<td><strong>8</strong> MACHINERY, TOOLS AND EQUIPMENT</td>
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<td>Inspection and maintenance</td>
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<td>Others</td>
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<tr>
<td>c)</td>
<td>Fire-aid equipment available</td>
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<td><strong>11</strong> FIRE PREVENTION</td>
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<td>No smoking in Prohibited Areas</td>
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<td>Use of 3-core armoured cables</td>
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<td>b)</td>
<td>Usage of 'All insulated' or 'double insulated' electrical tools</td>
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<tr>
<td>c)</td>
<td>All electrical connection are routed through ELCB</td>
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<tr>
<td>d)</td>
<td>Natural Earthing at the source of power (main DB)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e)</td>
<td>Continuity and tightness of earth conductor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f)</td>
<td>Covering of junction boxes, panels and other energized wiring places</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>g)</td>
<td>Ground fault circuit interrupters provided</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>h)</td>
<td>Prevention of tripping hazards</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>HANDLING AND STORAGE OF MATERIALS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>Properly stored or stacked</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>b)</td>
<td>Passageways clear</td>
<td></td>
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</tr>
<tr>
<td>c)</td>
<td>Others</td>
<td></td>
<td></td>
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<tr>
<td>14</td>
<td>FLAMMABLE GASES AND LIQUIDS</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>a)</td>
<td>Containers clearly identified</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>Proper storage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td>Fire extinguishers nearby</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d)</td>
<td>Others</td>
<td></td>
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<tr>
<td>15</td>
<td>WORKING AT HEIGHT</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>a)</td>
<td>Erection plan and work permit obtained</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>Safety nets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td>Full body harness and lanyards; chute lines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d)</td>
<td>Health Check record available for workers going up?</td>
<td></td>
<td></td>
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<tr>
<td>e)</td>
<td>Others</td>
<td></td>
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<tr>
<td>16</td>
<td>CONFINED SPACE</td>
<td></td>
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</tr>
<tr>
<td>a)</td>
<td>Work permit obtained</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>Test for toxic gas and sufficient availability of oxygen conducted</td>
<td></td>
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<tr>
<td>c)</td>
<td>At least one person outside the confined space for monitoring deputed</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>d)</td>
<td>Availability of sufficient means of entry, exit and ventilation</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>e)</td>
<td>Fire extinguishers and first-aid facility ensured</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>f)</td>
<td>Lighting provision made by using 24V lamps</td>
<td></td>
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<tr>
<td>g)</td>
<td>Proper usage of PPEs ensured</td>
<td></td>
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<tr>
<td>17</td>
<td>RADIOGRAPHY</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>Proper storage and handling of source as per BARC / AREB guidelines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>Working permit obtained</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td>Cordonning of the area done</td>
<td></td>
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</table>
## SL. NO. ITEM

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
<th>REMARKS</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>d)</td>
<td>Use of appropriate PPE’s ensured</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e)</td>
<td>Proper training to workers/supervisors imparted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f)</td>
<td>Minimum occupancy of workplace ensured</td>
<td></td>
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</table>

### HEALTH CHECKS

<p>| | | | | |</p>
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</thead>
<tbody>
<tr>
<td>a)</td>
<td>Workers medically examined and found to fit for working:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) At heights</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>ii) In confined space.</td>
<td></td>
<td></td>
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<tr>
<td>b)</td>
<td>Availability of First-aid facilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td>Proper sanitation at site, office and labour camps</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>d)</td>
<td>Arrangement of medical facilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e)</td>
<td>Measures for dealing with illness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f)</td>
<td>Availability of Portable drinking water for workmen &amp; staff</td>
<td></td>
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<tr>
<td>g)</td>
<td>Provision of crèches for children</td>
<td></td>
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<tr>
<td>h)</td>
<td>Stand by vehicle available for evacuation of injured.</td>
<td></td>
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</table>

### ENVIRONMENT

<p>| | | | | |</p>
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</thead>
<tbody>
<tr>
<td>a)</td>
<td>Chemical and other effluents properly disposed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>Cleaning liquid of pipes disposed off properly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td>Seawater used for hydro-testing disposed off as per agreed procedure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d)</td>
<td>Lubricant Waste/Engine oils properly disposed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e)</td>
<td>Waste from Canteen, offices, sanitation etc. disposed properly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f)</td>
<td>Disposal of surplus earth, stripping materials, oily rags and combustible materials done properly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g)</td>
<td>Green belt protection</td>
<td></td>
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</tr>
</tbody>
</table>

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Signature of Resident Engineer with Seal
ACCIDENT / INCIDENT REPORT
(To be submitted by Contractor after every Accident / Incident within 24 hours)

Report No: ______________________
Date: ______________________

Name of Site:- ____________________________
CONTRACTOR ____________________________

Type of Accident / Incident : ☐ Fatal ☐ Other Lost Time ☐ Non Loss Time ☐ First-Aid case

NAME OF THE INJURED………………………………………………………………………………
AGE ………………………………………………………………………………………………………
FATHER’S NAME………………………………………………………………………………………
SUB-CONTRACTOR M/S……………………………………………………………………………….
DATE & TIME OF ACCIDENT………………………………………………………………………….
LOCATION……………………………………………………………………………………………
BRIEF DESCRIPTION OF ACCIDENT

CAUSE OF ACCIDENT

NATURE OF INJURY/DAMAGE

MEDICAL AID PROVIDED/ACTIONS TAKEN

INTIMATION TO LOCAL AUTHORITIES (IF APPLICABLE)

DATE: ______________________
SIGNATURE OF CONTRACTOR
WITH SEAL

To : OWNER…………………………….. 1 COPY
: RCM/SITE-IN-CHARGE, MECON 3 COPIES

Divisional Head (Constrn.) through RCM
Project Manager MECON, through RCM
SUPPLEMENTARY ACCIDENT / INCIDENT INVESTIGATION REPORT

Supplementary to Report No: ____________ (Copy enclosed)

Project: ____________________________ Site: ____________________________
Name of Work : ______________________ Date: _________________________
Contractor: _________________________ Work Order / LOI No. : ____________

NAME OF THE INJURED ……………………………………………………………………………
AGE : …………………………………………………………………………………...
SUB-CONTRACTOR M/S……………………………………………………………………………
DATE & TIME OF ACCIDENT / INCIDENT ……………………………………………………………
LOCATION…………………………………………………………………………………………

BRIEF DESCRIPTION & CAUSE OF A ACCIDENT/ INCIDENT

NATURAL OF INJURY/DAMAGE

COMMENTS FROM MEDICAL PRACTITIONER WHO ATTENDED THE VICTIM/INJURED

SUGGESTED IMPROVEMENT IN THE WORKING CONDITION IF ANY

LOSS OF MANHOURS AND IMPACT ON SITE WORKS

ANY OTHER COMMENT BY SAFETY OFFICER.

DATE: 

SIGNATURE OF CONTRACTOR WITH SEAL

To : OWNER………………………….. 1 COPY
     : RCM/SITE-IN-CHARGE, MECON  3 COPIES

Divisional Head (Constrn.) through RCM
Project Manager MECON, through RCM
### NEAR MISS INCIDENT – SUGGESTED PROFORMA

<table>
<thead>
<tr>
<th>Report No: ____________________</th>
<th>Incident Reported By: ____________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of Site: __________________</td>
<td>Date: ____________________</td>
</tr>
<tr>
<td>Name of Work: __________________</td>
<td>Contractor: ____________________</td>
</tr>
<tr>
<td>Date &amp; Time of Incident: ________</td>
<td>Location: ____________________</td>
</tr>
<tr>
<td>Brief Description of Incident: ____________________</td>
<td>Probable Cause of Incident: ____________________</td>
</tr>
<tr>
<td>Suggested Corrective Action: ____________________</td>
<td>Steps Taken to Avoid Recurrence: YES ☐ NO ☐</td>
</tr>
<tr>
<td>Date: ____________________</td>
<td>Signature of Contractor with Seal: ____________________</td>
</tr>
<tr>
<td>To: OWNER…………………………………</td>
<td>1 COPY</td>
</tr>
<tr>
<td>: RCM/SITE-IN-CHARGE, MECON</td>
<td>3 COPIES</td>
</tr>
<tr>
<td>Divisional Head (Constrn.) through RCM</td>
<td>Project Manager MECON, through RCM</td>
</tr>
</tbody>
</table>
MONTHLY HEALTH, SAFETY & ENVIRONMENT (HSE) REPORT
(To be submitted by each Contractor)

Actual work start Date: ___________________ For the Month of: ___________________
Project: ___________________ Report No: ___________________
Name of the Contractor: ___________________ Status as on: ___________________
Name of Work: ___________________ Name of Safety officer: ___________________

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UPTO PREVIOUS MONTH</th>
<th>THIS MONTH</th>
<th>CUMULATIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Average number of Staff &amp; Workmen (average daily headcount, not man days)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>Manhours Worked</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td>Number of HSE meeting organized at site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d)</td>
<td>Number of HSE awareness programmes conducted at site</td>
<td></td>
<td></td>
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<tr>
<td>e)</td>
<td>Number of Lost Time Accidents (LTA) Fatal Other LTA</td>
<td></td>
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</tr>
<tr>
<td>f)</td>
<td>Number of Loss time Injuries (LTI) Fatalities Other LTI</td>
<td></td>
<td></td>
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<tr>
<td>g)</td>
<td>Number of Loss Time Accidents</td>
<td></td>
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<tr>
<td>h)</td>
<td>Number of First Aid Cases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>Number of Near Miss Incidents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>j)</td>
<td>Man-days lost due to accidents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>k)</td>
<td>LTA Free Manhours i.e. Number of LTA free manhours from the Lst LTA</td>
<td></td>
<td></td>
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<tr>
<td>l)</td>
<td>Compensation cases raised with Insurance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>m)</td>
<td>Compensation case resolved and paid to workmen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n)</td>
<td>Whether workmen compensation policy taken Y/N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o)</td>
<td>Whether workmen compensation policy valid Y/N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>p)</td>
<td>Whether workmen registered under ESI Act Y/N</td>
<td></td>
<td></td>
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</tbody>
</table>

Remark

DATE: ___________________
Safety Officer /Resident Engineer
(Signature and Name)

To: OWNER
RCM/, MECON (2 COPIES)
PERMIT FOR WORKING AT HEIGHT (ABOVE 2 METER)

Project Site : ………………………………………   Sr. No.: …………………
Name of the work: ………………………………… Date: ………………………
Name of Contractor : …………………………….. Nature of Work : …………
Total No.of Workers: …………………………….. Exact location of work : ……

Duration of work: from ………………… to …………

The following items have been checked and compliance shall be ensured during the currency of the permit:

<table>
<thead>
<tr>
<th>Sl.</th>
<th>ITEM</th>
<th>DONE</th>
<th>NOT REQD.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Equipment/Work Area inspected</td>
<td></td>
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<tr>
<td>2.</td>
<td>Considered hazard from other routine/non-routine operations and concerned person alerted</td>
<td></td>
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<tr>
<td>3.</td>
<td>ELCB provided</td>
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<tr>
<td>4.</td>
<td>Proper lighting provided</td>
<td></td>
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<tr>
<td>5.</td>
<td>Area cordoned off.</td>
<td></td>
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<tr>
<td>6.</td>
<td>Precautions against public traffic taken</td>
<td></td>
<td></td>
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<tr>
<td>7.</td>
<td>Sound Scaffolding provided</td>
<td></td>
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<tr>
<td>8.</td>
<td>Adequate protected Platform provided</td>
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<td>9.</td>
<td>Acces and Exit to the area (Ladder properly fixed)</td>
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<tr>
<td>10.</td>
<td>Floor Openings covered</td>
<td></td>
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<tr>
<td>11.</td>
<td>Safety Net provided</td>
<td></td>
<td></td>
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<tr>
<td>12.</td>
<td>Heath check of personnel</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A. Following personal protective equipment are provided ( mark) and used as relevant Safety helmet/Gloves/Goggles/Shoes/Face Shield/Life Line/Safety Belt/Safety Harness.

B. This permit shall be available at the work site at all times.
C. Permit shall be issued for maximum one week only (Monday to Sunday).

D. This permit shall be applicable in non-operational areas.

E. After completion of the work, used permits shall be preserved for record purposes.

F. Additional precautions, if any …………………………………………………………

Permission is granted to work (See overleaf) = Yes/No

Name of Contractor’s Supervisor
(Initiator)

Name of Contractor’s Safety Officer
(Issuing Authority)

GRANT OF PERMIT AND EXTENSIONS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Validity Period From ……… To ………</th>
<th>Work time From …….Hrs. To ………Hrs.</th>
<th>Initiator (Supervisor of Contractor)</th>
<th>Issuing Authority (Safety Officer) of Contractor</th>
<th>Verification by CONSULTANT with date</th>
</tr>
</thead>
<tbody>
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</table>

Additional safety instructions, if any.
## CONFINED SPACE ENTRY PERMIT

**Project Site:** ...........................................  **Sr. No.:** .........................

**Name of the work:** ........................................  **Date:** .........................

**Name of Contractor:** ........................................  **Nature of Work:** ...............  

**Exact location of work:** ........................................

### Safety Requirements: POSITIVE ISOLATION OF THE VESSEL IS MANDATORY

### (A) Has the equipment been?

<table>
<thead>
<tr>
<th>Y</th>
<th>NR</th>
<th>isolated from power / steam / air</th>
<th>Y</th>
<th>NR</th>
<th>water flushed &amp;/or steamed Manways open &amp; ventilated cont. inset gas flow arranged adequately cooled</th>
<th>Y</th>
<th>NR</th>
<th>radiation sources removed Proper lighting provided</th>
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<tbody>
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</tbody>
</table>

### (B) Expected Residual Hazards

<table>
<thead>
<tr>
<th>Y</th>
<th>NR</th>
<th>lack of O₂</th>
<th>Y</th>
<th>NR</th>
<th>combustible gas / liquid pyrophoric iron / scales high humidity</th>
<th>Y</th>
<th>NR</th>
<th>H₂S / toxic gases electricity / static ionizing radiation</th>
</tr>
</thead>
<tbody>
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</table>

### (C) Protective Measures

<table>
<thead>
<tr>
<th>Y</th>
<th>NR</th>
<th>gloves</th>
<th>Y</th>
<th>NR</th>
<th>ear plug / muff</th>
<th>Y</th>
<th>NR</th>
<th>goggles / face shield personal gas alarm</th>
</tr>
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<tbody>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Y</th>
<th>NR</th>
<th>protective clothing</th>
<th>Y</th>
<th>NR</th>
<th>dust / gas / air line mask attendant with SCBA / air mask</th>
<th>Y</th>
<th>NR</th>
<th>rescue equipment / team</th>
</tr>
</thead>
<tbody>
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</table>

<table>
<thead>
<tr>
<th>Y</th>
<th>NR</th>
<th>Grounded air educater / blower / AC Fire fighting arrangements</th>
<th>Y</th>
<th>NR</th>
<th>safety harness &amp; lifeline</th>
<th>Y</th>
<th>NR</th>
<th>communication equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Authorization / Renewal (It is safe to enter the confirmed space)**

<table>
<thead>
<tr>
<th>Date</th>
<th>No. of Persons Allowed</th>
<th>Name of Persons allowed</th>
<th>Signature</th>
<th>Time</th>
<th>Signature</th>
<th>Time</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Contractor’s Supervisor</td>
<td>Contractor’s Safety Officer</td>
<td>From</td>
<td>To</td>
<td>Workman</td>
</tr>
</tbody>
</table>

**Permit Closure :**

(A) **Entry**
- [ ] was closed
- [ ] stopped
- [ ] will continue on

(B) [ ] Site left in a safe condition
[ ] Housekeeping done

(C) **Multi lock**
- [ ] removed
- [ ] key transferred
- [ ] Ensured all men have come out
- [ ] Manways barricaded

**Remarks, if any :**
RADIATION WORK PERMIT

Project : Sr. No.:
Name of the work : Date:
Name of Contractor : Job No. :

Location of work :
Source Strength :
Cordoned distance (m) :

Name of Radiographing agency : Approved by Owner / MECON

The following items have been checked & compliance shall be ensured during currency of the permit :

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Item Description</th>
<th>Done</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Safety regulations as per BARC/AERB ensured while source in use/ in transit &amp; during storage.</td>
<td>☐</td>
</tr>
<tr>
<td>2.</td>
<td>Area cordoned off.</td>
<td>☐</td>
</tr>
<tr>
<td>3.</td>
<td>Lighting arrangements for working during nights ensured.</td>
<td>☐</td>
</tr>
<tr>
<td>4.</td>
<td>Warning signs / flash lights installed.</td>
<td>☐</td>
</tr>
<tr>
<td>5.</td>
<td>Cold work permit taken (if applicable)</td>
<td>☐</td>
</tr>
<tr>
<td>6.</td>
<td>PPEs like film badges, dosimeters used.</td>
<td>☐</td>
</tr>
</tbody>
</table>

Additional precautions, if any ______________________________________________________

(Radiography Agency's BARC / AREB authorized Supervisor) (Contractor's Safety Officer)

Permission is granted.

Permit is valid from ________ AM/PM ____________ Date to ________ AM/PM ____________ Date

(Signature of permit issuing authority)

Name : Designation : Date :
**Permit renewal:**

<table>
<thead>
<tr>
<th>Permit extended upto</th>
<th>Additional precautions required, if any.</th>
<th>Sign of issuing authority with date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Time</td>
<td></td>
</tr>
</tbody>
</table>

Work completed / stopped / area cleared at ____________ Hrs. of Date _______________

(Sign of permit issuing authority)  
Name:
## RADIATION WORK PERMIT

Project: Sr. No.:  
Name of the work: Date:  
Name of Contractor: Job No.:  

Name of Contractor:  
Line No. / Equipment No. /Structure to be dismantled:  

Location details of dismantling / demolition with sketch: (Clearly indicate the area)

The following items have been checked & compliance shall be ensured during currency of the permit:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Item Description</th>
<th>Done</th>
<th>Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Services like power, gas supply, water, etc. disconnected.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>2.</td>
<td>Dismantling / Demolishing method reviewed &amp; approved.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>3.</td>
<td>Usage of appropriate PPEs ensured.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>4.</td>
<td>Precautions taken for neighboring structures</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>5.</td>
<td>First-Aid arrangements made</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>6.</td>
<td>Fire fighting arrangements ensured</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>7.</td>
<td>Precautions taken for blasting</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

(Contractor's Supervisor) 
(Contractor's Safety Officer) 

Permission is granted. 

(Permit issuing authority) 
Name:  
Date:  

8000006103 185 of 506
### Completion Report:

Dismantling / Demolishing is completed on __________ Date at __________ Hrs.

- Materials / debris transported to identified location [ ]
- Tagging completed (as applicable) [ ]
- Services like power, gas supply, water, etc. restored [ ]

(Permit issuing authority)
SPECIFICATION
FOR
QUALITY ASSURANCE SYSTEMS
REQUIREMENTS

SPECIFICATION NO.: MEC/S/05/21/66

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
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Sl.No. Description

1.0 INTRODUCTION

2.0 DEFINITIONS

3.0 CONTRACTORS SCOPE OF WORK

4.0 QUALITY ASSURANCE REQUIREMENTS

FORMAT FOR QUALITY PLAN FORMAT 00001

FORMAT FOR OBSERVATION ON FORMAT 00002

PREPARED BY: (Shalini Singh)

CHECKED BY: (Sunil Kumar)

APPROVED BY: (A.K. Johri)

ISSUE DATE: Nov. 2009
1.0 INTRODUCTION

This specification establishes the Quality Assurance Requirements to be met by the sub-contractors (including turnkey Contractors) and their sub-vendors.

In case of any conflict between this specification and other provisions of the contract/purchase order, the same shall be brought to the notice of MECON, at the stage of bidding and shall be resolved with MECON, prior to the placement of order.

2.0 DEFINITION

Bidder

For the purpose of this specification, the word “Bidder” means the person(s), firm, company or organisation who is under the process of being contracted by MECON/Owner for delivery of some products (including service). The word is considered synonymous to supplier, contractor or vendor.

Correction

Action taken to eliminate the detected non-conformity.

Refers to repair, rework or adjustment and relates to the disposition of an existing non-conformity.

Corrective Action

Action taken to eliminate the causes of an existing non-conformity, defect or other undesirable situation in order to prevent recurrence.

Preventive Action

Action taken to eliminate the causes of a potential non-conformity, defect or other undesirable situation in order to prevent its recurrence.

Process

Set of inter-related resources and activities which transform inputs into outputs.

Special Process

Processes requiring pre-qualification of their process capability.
3.0 CONTRACTORS SCOPE OF WORK

3.1 Prior to award of contract

The bidder shall understand scope of work, drawings, specifications and standards etc., attached to the tender/enquiry document, before he makes an offer.

The bidder shall submit milestone chart showing the time required for each milestone activity and linkages between different milestone activities along with overall time period required to complete the entire scope of work.

The bidder shall develop and submit manpower and resource deployment chart.

The bidder shall submit, along with the bid, a manual or equivalent document describing/indicating/addressing various control/check points for the purpose of quality assurance and the responsibilities of various functions responsible for quality assurance.

3.2 After the award of contract

The bidder shall submit the schedule for submission of following documents in the kick-off meeting or within two weeks of the placement of order, whichever is earlier.

- Detailed Bar Chart
- Quality plan for all activities, required to be done by the bidder, to accomplish offered scope of work.
- Inspection and test plans, covering various control aspects.
- Job procedures as required by MECON/Owner.
- Procurement schedule for items to be supplied by contractor covering inspection of the same.

Various documents submitted by the bidder shall be finalised in consultation with MECON. Here it shall be presumed that ones a bidder has made an offer, he has understood the requirements given in this specification and agrees to comply with them in totality unless otherwise categorically so indicated during pre-award stage through agreed deviation/exception request. All Quality Assurance Plan (QAP) documents shall be reviewed by concerned functional groups of MECON and the bidder shall be required to incorporate all comments within the framework of this specification at this stage of the contract. It is also obligatory on the part of the bidder that obtains approval on every Quality Assurance Plan (QAP) documents, before he starts using a particular document for delivery of contracted scope of work. Participation of MECON/Owner in review/approval of quality plan/QAP documents does not absolve the contractor of his contractual obligations towards specified and intended use of the product (or service) provided/to be provided by him under the contract.
3.3 **During job execution**

During job execution, the bidder shall fully comply with all quality document submitted and finalised/agreed against the requirements of this specification. Approval of MECON on all these documents shall be sought before start of work.

Bidder shall produce sufficient quality records on controlled/agreed forms such that requirements given in this specification are objectively/demonstrable.

Bidder shall facilitate MECON/Owner during quality/technical audits at his works/sites.

Bidder shall discharge all responsibilities towards enforcement of this specification on all his sub-contractors for any part of the scope which is sub-contracted.

4.0 **QUALITY ASSURANCE SYSTEM REQUIREMENTS**

4.1 The bidder shall nominate an overall incharge of the contract titled as “Project Manager” for the scope of work of agreed contract. The name of this person shall be duly intimated to MECON including all subsequent changes, if any. MECON shall correspond only with the project manager of the bidder on all matters of the project. The project manager of the bidder shall be responsible for co-ordination and management of activities with bidder’s organisation and all sub-vendors appointed by the bidder.

After award of work, the bidder may review augmentation of manpower and resources deployment chart (submitted earlier), detail it out, if so consented by MECON/Owner and resubmit the same as “issued for effective implementation of the project”.

4.2 The bidder shall plan the contract scope of work on quality plan format such that no major variation is expected during delivery of contract scope of work. These quality plan shall be made on enclosed format complete in all respect. The quality plan shall be assumed to be detailing bidder’s understanding and planning for the contract/offered scope of work. The bidder shall plan the type of resources including various work methodology which he agrees to utilize for delivery of contract scope of work.

4.3 The bidder is required to review the contract at all appropriate stages to evaluate his capabilities with respect to timely and quality completion of all activities pertaining to contracted scope of work and shall report for constraints, if any to MECON/Owner.

4.4 The design activities, if any, performed during delivery of contract scope of work shall be so controlled that the outputs is reliable enough. It is expected that during development of design, the bidder shall take recourse to detailed checking, inter departmental reviews and documented verification methods.
4.5 For all documents which the bidder is likely to utilise for delivery of contract scope of work, a system must exist which assures that latest/ required version(s) of the document(s) is available at all location/ point of use.

4.6 In case the bidder decides to sub-contract any part/ full of the contract scope of work (without prejudice to main Contractual condition), the bidder shall:

- Evaluate the technical and financial capabilities and past performance of the sub-contractor(s) and their products and/or services before awarding them with the subcontracted scope of work. Selection of a sub-contractor should meet MECON approval in documented form.

- Requirement of this specification shall be enforced on sub-contracted agency also. The bidder shall choose sub-contractor based on their capability to meet requirements of this specification also.

Note: It may so happen that, in a given situation, a sub-contractor may not have a system meeting the requirements of this specification. In all such eventualities, bidder may lend his system to sub-contractor for the contract such that sub-contractor effectively meets the requirements of this specification. In all such cases MECON shall be duly informed.

4.7 Bidder shall establish adequate methodology such that the materials supplied by the Owner/MECON shall be adequately preserved, handled and made use of for the purpose for which they are provided.

4.8 All output delivered against contract scope of work shall be suitably identified in such a manner that either through identification or some other means, sufficient traceability is maintained which permits effective resolution of any problem reported in the outputs.

4.9 Critical activities shall be identified and the bidder is required to have documented methodologies which he is going to utilize for carrying out such activities under the contract scope of work. Wherever it is difficult to fully inspect or verify the output (special process), bidder shall pre-qualify, the performers and methodologies.

4.10 All inspections carried out by the bidder's surveillance/inspection staff shall be conformity to quality plans and/or inspection and test plans. All inspection results shall be duly documented on controlled/agreed forms such that results can be co-related to specific product, that was inspected/tested.

4.11 All inspection, measuring & test equipments (IMTEs) shall be duly calibrated as per National/International standards/codes and only calibrated and certified IMTEs shall be utilized for delivery of contract scope of work.
4.12 All outputs/products delivered against contract scope of work shall be duly marked such that their inspection status is clearly evident during all stages/period of the contract.

4.13 All non-conformities (NCs) found by the contractor’s inspection/surveillance staff shall be duly recorded, including their disposal action. The deficiencies observed during stage of the product, shall be recorded and resolved suitably. Effective corrective and preventive action shall be implemented by the bidder for all repetitive NCs, including deficiencies.

4.14 All deficiencies noticed by MECON/Owner representative(s) shall be recorded on a controlled form (Format No. 00002). Such deficiencies shall be analysed by the bidder and effective and appropriate correction, corrective and preventive actions shall be implemented. Bidder shall intimate MECON/Owner of all such corrective and preventive action implemented by him.

4.15 Bidder shall establish appropriate methodologies for safe and effective handling, storage, preservation of various materials/inputs encountered during delivery of contract scope of work.

4.16 Bidder shall prepare sufficient records for various processes carried out by him for delivery of contract scope of work such that requirements of this specification are objectively demonstrable. In case MECON/Owner finds that enough objective evidence/recording is not available for any particular process, bidder shall be obliged to make additional records so as to provide sufficient objective evidence. The decision of MECON/Owner shall be final and binding on such issues.

4.17 The bidder shall arrange internal quality audits at quarterly intervals, to independently assess the conformance by various performers to the requirements of this specification. The findings of such assessment shall be duly recorded and a copy shall be sent to MECON/Owner for review.

4.18 For all special processes, bidder shall deploy only qualified performers. Wherever MECON/Owner observes any deficiency, the bidder shall arrange the adequate training to the performer(s) before any further delivery of work.
<table>
<thead>
<tr>
<th>Activity Description</th>
<th>Procedure Number</th>
<th>Code of Conformance</th>
<th>Performer</th>
<th>Checker</th>
<th>Reviewer/Approver</th>
<th>Sampling Plan</th>
<th>Testing and Inspection Code</th>
<th>Type of (Approval) Surveillance</th>
<th>Audit Scope</th>
<th>Owner’s/MECON Review/Audit Requirement</th>
</tr>
</thead>
</table>

Note: 1) The bidder ensures that the filled up format conforms to minimum requirements on Quality Plan/Quality Assurance, specified by MECON on drawings/standards/specifications/write-up.

2) The bidder confirms that document is issued for information/approval of Owner/MECON for the project implementation.
## OBSERVATION OF QUALITY ASPECTS

**FORMAT – 00002**

<table>
<thead>
<tr>
<th>Details of Observation(Deficiency)</th>
<th>Recommended Course of Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Allowed for Correction :</td>
<td></td>
</tr>
</tbody>
</table>

Issued by: ________________________  
Name of Signature of RCM, MECON Site

Corrective Action taken report by Contractor/ Vendor:

Date: ________________  
Name and Signature

**Distribution (before resolution):**

<table>
<thead>
<tr>
<th>Project Manager Owner</th>
<th>Chief Executive MECON</th>
<th>Business</th>
<th>MECON Inspection New Delhi</th>
<th>Resident Construction Manager, MECON Site</th>
</tr>
</thead>
</table>

**Verification of Resolution by MECON:**

Date: ________________  
Name of Signature

**Distribution (before resolution):**

<table>
<thead>
<tr>
<th>Project Manager Owner</th>
<th>Chief Executive MECON</th>
<th>Business</th>
<th>MECON Inspection New Delhi</th>
<th>Resident Construction Manager, MECON Site</th>
</tr>
</thead>
</table>
TECHNICAL SPECIFICATIONS FOR CIVIL/STRUCTURAL WORKS
SPECIFICATION FOR CIVIL WORKS - TERMINALS

SPECIFICATION NO. MEC/S/05/11/01

(CIVIL ENGINEERING SECTION)
MECON LIMITED
DELHI - 110 092
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</thead>
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<td>- WORKMANSHIP</td>
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<td>PART - III</td>
<td>- NORMS OF CEMENT CONSUMPTION</td>
</tr>
<tr>
<td>PART - IV</td>
<td>- DIMENSIONAL TOLERANCES</td>
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</tbody>
</table>
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1.0 GENERAL

1.1 Scope

This part deals with the requirements of materials for use in permanent work with regard to quality, testing, approval and storage, before they are used on work. This part is supplementary to Part-II: Workmanship and Other Parts of the Technical Specifications for civil works.

1.2 Standard

A high standard of quality is required for all materials used in permanent work. They shall be the best of the kind obtainable indigenously in each case and shall be procured from manufacturers of repute in order to ensure uniformity of quality and assurance of timely supply.

1.3 Approval and Tests

1.3.1 All materials to be used in permanent construction shall be subject to approval of the Engineer. The Contractor shall apply sufficiently in advance with samples of the materials including the supporting test results from the approved laboratory and other documentary evidence from the manufacturer wherever applicable and indicating the types of materials and their respective sources. The delivery of materials at site shall commence only after the approval of the quality, grading and sources of the materials.

1.3.2 The quality of all materials once approved shall be maintained throughout the period of construction and periodical tests shall be carried out to ensure that it is maintained. Such routine tests shall be listed under the different materials and/or as may be ordered by the Engineer from time to time.

1.3.3 Where a particulars "Brand" or "Make" of material is specified in the Schedule of Items or Technical Specifications, such "Brand" or Make" of material alone shall be used on the work. Should it become necessary for any reason such as non-availability, to use any material other than the specified "Brand" or "Make", the Contractor shall submit sample of the same to the Engineer for approval together with test certificates and other documents necessary for examining and giving approval thereof. Should such change or substitution of material subsequently approved result in use of material of price lower than that of the material specified in the Schedule of Items or Technical Specifications, the rates for the appropriate items of work affected by the substitution shall be proportionately reduced. In case the substitution results in use of material of price higher than that specified in the Schedule of Items or Technical Specifications, no upward revision of the rates will be allowed.

1.4 Codes

1.4.1 Unless mentioned otherwise, current versions of all codes, specifications and standards issued by the Indian Standards Institution and Indian Roads Congress shall be fully applicable to these specifications. In the absence of appropriate publication by ISI or IRC, adaptable specification of the International Organization for Standardization shall apply.

1.4.2 In case of any conflict in meaning between these specifications and those of ISI or IRC, the provisions of these specifications shall prevail.
1.5 Rejection of Materials

1.5.1 Any material brought to site which, in the opinion of the Engineer is damaged, contaminated, deteriorated or does not comply with the requirement of this specification, shall be rejected.

1.5.2 If the routine site tests or random site tests show that any of the materials, brought to site, do not comply in any way with the requirements of this specification, then that material shall be rejected.

1.5.3 The Contractor shall remove from site any and all such rejected material within the time specified by the Engineer.

2.0 MATERIALS FOR CONCRETE

2.1 Aggregates

2.1.1 Aggregates shall comply with the requirements of IS: 383, "Coarse and Fine Aggregates for Concrete". They shall be hard, strong, dense, durable, clean and free from veins and adherent coating, vegetable matter and other deleterious substances; and shall be obtained from approved sources. Aggregates shall not contain any harmful material such as pyrites, coal, lignite, shale or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of concrete. Aggregates which are chemically reactive with alkalis of cement shall not be used. Aggregates which are not sufficiently clean shall be washed in clean fresh water to the satisfaction of the Engineer.

2.1.2 Testing

All aggregates shall be subject to inspection and testing. The Contractor shall submit samples for testing as may be required by the Engineer. Sampling and testing shall be carried out in accordance with IS: 2386, "Methods of Test for Aggregates for concrete".

2.1.3 Grading

The Contractor shall ensure that the full range of aggregate used for making concrete is graded in such a way as to ensure a dense workable mix. The delivery of aggregates will commence only when the Engineer has approved the samples and the quality and grade shall be maintained consistent and equal to the approved sample. Before construction commences, the Contractor shall carryout a series of tests on the aggregates and on the concrete made therefrom to determine the most suitable grading of the available aggregates. Once the most suitable grading has been found, the grading shall be adopted for the construction of the works and periodic tests shall be carried out to ensure that it is maintained.

2.1.3.1 Size and grading of fine aggregates

The grading shall conform to IS: 383 and shall be within the limits of Grading Zone-III. The maximum size of particle shall be 4.75mm and shall be graded down. Sand containing more than 10% of fine grains passing through 76 mesh sieve or having the fineness modulus less than 2 shall not be used for concrete work.
2.1.3.2 Size and grading of coarse aggregates

The nominal maximum size of the aggregates for each mark of concrete or for each type of work shall depend upon the description of the particular item in the Schedule of Items and/or according to relevant clauses of IS: 456. The aggregates shall be well-graded and the grading shall conform to relevant requirements of IS: 383 depending upon the maximum nominal size as specified or as required.

2.1.3.3 Fine aggregate for mortar and grout

The grading of fine aggregate for mortar and grout shall be within the limits of grading zone III and IV as defined in IS: 383.

2.1.4 Storage & stacking

Care shall be taken in the storage to avoid intrusion of any foreign materials into the aggregates and where two types of aggregates are stored close to each other, they shall be separated by a wall or plate. When stock piling care shall be taken to avoid forming pyramids resulting in segregation of different sized materials. The height of the stacks shall be generally limited to 150 cm.

2.2 Coarse Aggregates

2.2.1 Types

The type of coarse aggregate viz., stone chips, gravel or broken brick shall be as described in the Schedule of Items. Unless otherwise specified in the Schedule of Items, stone chips shall be used as coarse aggregate.

2.2.2 Stone chips

It shall be crushed or broken from hard stone obtained from approved quarries of igneous or metamorphic origin. The stone chips shall be hard, strong, dense, durable and angular in shape. It shall be free from soft, flyable, thin, flat, elongated or laminated and flaky pieces and free from dirt clay lumps, and other deleterious materials like coal, lignites, silt, soft fragments, and other foreign materials which may affect adversely the strength & durability of concrete. The total amount of deleterious /foreign materials shall not exceed 5% by weight according to relevant clause of IS: 383. If found necessary the stone chips shall be screened and washed before use.

2.2.3 Gravel

It can be either river bed shingle or pit gravel. It shall be sound, hard, clean, irregular in shape and suitably graded in size with or without some broken fragments. It shall be free from flat particles, powdered clay, silt, loam and other impurities. Before using, the gravel shall be screened and washed to the satisfaction of the Engineer. However, the foreign/deleterious materials shall not exceed 5% by weight.

2.2.4 Broken bricks

These shall be obtained by breaking well burnt or over burnt dense brick bats. They shall be homogenous in texture, well graded in size, roughly cubical in shape, clean and free from dirt, clay, silt or any other deleterious matter. Before use, these shall be screened.
2.3  Fine Aggregates

2.3.1  Unless specified otherwise it shall either natural river sand or pit sand.

2.3.2  Sand shall be clean, sharp, strong, angular and composed of hard siliceous material. It shall not contain harmful organic impurities in such form or quantities as to affect adversely the strength and durability of concrete. Sand for reinforced concrete shall not contain any acidic or other material which is likely to attach steel reinforcement. The percentage of all deleterious materials including silt, clay etc., shall not exceed 5% by weight. If directed, sand shall be screed or washed before use to the satisfaction of Engineer.

2.3.3  Crusher dust

Crusher stone dust that is retained on 300 micron sieve may be used as replacement for certain quantum of sand aiming to improve the fineness modulus of fine aggregate. The quantum of replacement for sand shall be arrived at by suitable trial mixes. The Engineer will decide the final usage of crusher dust having regard to the circumstances.

2.4  Lime

Lime for mortars and concrete shall conform to IS: 712. The total of CaO and Mgo content in quick lime shall not be less than 85% (Mgo shall not exceed 5%). Quicklime, after slaking, shall leave a residue of not more than 5% by weight on IS sieve 85.

2.5  Surkhi

Surkhi used in lime concrete for flooring, terracing etc., shall conform to IS: 1344.

2.6  Cement

Ordinary Portland cement complying with the requirements of IS:8112 shall be used for making plain and reinforced concrete, cement grout and mortar.

Other types of cement may be used depending upon the requirements of certain jobs with the approval of the Engineer. These shall conform to the following standards:

- Portland Pozzolana Cement  IS:1489
- Rapid Hardening Portland Cement  IS:8041
- 53 Grade Ordinary Portland Cement  IS:12269
- Hydrophobic Portland Cement  IS:8043
- Sulphate Resisting Portland Cement  IS:12330

2.6.1  Testing of samples

The Contractor shall supply a copy of the manufacturer's test certificate for each consignment of cement supplied by him and consignments shall be used on work in the
order of delivery. The Contractor shall supply samples of cement to the Engineer as frequently as he may require for testing. The sampling of cement for testing shall be according to IS: 3535. All tests shall be in accordance with the relevant clauses of IS: 4031 & IS: 4032.

2.6.2 Contractor’s responsibility

From the time that a consignment of cement is delivered at site and tested and approved by the Engineer until such time as the cement is used on the works, the Contractor shall be responsible for keeping the same in sound and acceptable condition. Any cement which deteriorates while in the Contractor’s charge and is rejected as unsuitable by the Engineer, shall be removed from the site and outside the limits of work within two days of ordering such removal by the Engineer.

2.6.3 Stock of cement

In order to ensure due progress, the Contractor shall at all times maintain on the site at least such stock of cement as the Engineer may from time to time consider necessary. No cement shall be used upon the works until it has been accepted as satisfactory by the Engineer.

2.6.4 Storage of cement

The cement shall be stored in such manner as to permit easy access for proper inspection and in a suitable weather tight, well ventilated building to protect it from dampness caused by ingress of moisture from any source. Different types of cement shall be stored separately. Cement bags shall be stacked at least 15 to 20 cm clear of the floor bearing a space of 60 cm around the exterior walls. The cement shall not be stacked more than 10 bags high. Each consignment of cement shall be stacked separately to permit easy access for inspection.

2.7 Water

Water used for mixing concrete and mortar and for curing shall be clean and free from injurious amounts of oil, acid, alkali, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The pH value of water shall generally be not less than ‘6’. Water has to meet the requirements mentioned in clause 4.3 of IS: 456. Water shall be obtained from an approved source. Where it is obtained from a source other than a supply main, it shall be tested to establish its suitability.

2.8 Admixture for Concrete

2.8.1 Approval

Admixtures to concrete shall not be used without the written consent of the Engineer. When permitted, the Contractor shall furnish full details from the manufacturer and shall carry out such test as the Engineer may require before any admixture is used in the work.

2.8.2 Usage

2.8.2.1 Admixtures may be used to modify one or more of the following properties of FRESH CONCRETE.
a) To increase workability without increasing water content or to decrease the water content at the same workability.
b) To retard or accelerate both initial and final setting times.
c) To reduce or prevent settlement.
d) To create slight expansion in concrete and mortar.
e) To modify the rate or capacity for bleeding or both.
f) To reduce segregation of concrete, mortars and grouts.
g) To improve penetration and or pumpability of concrete, mortars and grouts.
h) To reduce rate of slump loss.

2.8.2.2 Admixtures may also be used to modify one or more of the following properties of HARDENED CONCRETE.

a) To retard or reduce heat generation during early hardening.
b) To accelerate the rate of strength development.
c) To increase the strength of concrete or mortar (Compressive, tensile or flexural).
d) To increase the durability or resistance to severe conditions of exposure including the application de-icing salts.
e) To decrease the capillary flow of water.
f) To decrease the permeability to liquids.
g) To control the expansion caused by the reaction of alkalis with certain aggregate constituents.
h) To produce cellular concrete.
i) To increase the bond of concrete to steel reinforcement.
j) To increase the bond between old and new concrete.
k) To improve impact resistance and abrasion resistance.
l) To inhibit the corrosion of embedded metal.
m) To produce coloured concrete or mortar.

While modifying any particular property, care shall be taken to ensure that other properties are not affected adversely.
2.8.3 Types

2.8.3.1 Integral water proofer

Admixtures used as integral water proofer shall be free of chlorides and sulphates and shall conform to IS: 2645. The application and dozes shall be as per manufacturer's specification.

2.8.3.2 Finely Divided mineral admixtures

1) CEMENTITIOUS - Natural cements like hydraulic lime, slag cements (mixtures of blast furnace slag and lime) and granulated blast furnace slag.

2) POZZOLANIC - A siliceous or siliceous and aluminium material which in itself possesses little or no cementitious value, but will in finely divided form and in presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties, e.g. Fly ashes, volcanic glass, diatomaceous earth and certain shales and clays either heat treated or natural.

3) OTHER - Finely divided quartz, silica sands dolomite and calcite limestone, marble, granite and other rocks, asbestos waste hydrated lime.

These being extremely fine powders, their mineral admixtures will influence the fresh paste in a manner similar to cement. They can be used to augment the cement in mixtures deficient in fines. Many concrete contain large amount of portland cement than necessary for strength requirements to provide workability or pumpability. A portion or all of this excess cement may be replaced with a suitable mineral admixture. They are usually used in the proportion of 15-35% by weight of the cement and in proportioning the concrete should be considered as part of the cementing medium, provided they are uniformly blended with cement.

The placeability of concrete containing blast furnace slag is generally greater than indicated by static slump test or water/cement ratio. In medium or rich concrete, the increase in water requirements caused by their use may reduce strength. Pozzolanic admixtures usually increases the strength of concrete especially at later ages. The addition of fly-ash, natural pozzolana and granulated slag in sufficient quantities will increase the sulphate resistance of concrete.

2.8.3.3 Accelerating admixtures

1) Calcium Chlorides will also affect the following properties;

   a) may increase drying, shrinkage and creep. The longer the concrete is allowed to cure, the less will be the effect on shrinkage and creep.

   b) may lower the resistance of concrete to freezing and thawing and to attack by sulphates and other injurious solutions.

   c) may increase the rate of temperature residue to the heat of hydration and in large sections may therefore increase the stresses caused by thermal contraction.
d) can cause corrosion of adequately embedded reinforcing steel in the concrete. Where large concentrations of stray currents are present, such as in concrete used in structures for electric railroads, power houses or electrolytic reduction plants.

e) galvanized metal embedded in concrete containing calcium chloride may be expected to corrode at an accelerated rate.

f) combinations of metals such as aluminium alloy, conduit and steel reinforcing should not be used in concrete containing calcium chloride as electrolytic corrosion may take place.

For allowable limits of calcium chloride refer ACI Committee 201.

Calcium Chloride will not increase the flexural strength of concrete to the same degree as the compressive strength and decreases in the flexural strength are generally obtained at or after 28 days. The total chloride content in the concrete should be limited as specified in IS: 456.

2) Calcium aluminate cement blended with portland cement:

Strength will be reduced significantly, shrinkage and swelling on immersion will increase drastically and durability will be poor.

2.8.3.4 Air-entraining admixture

a) The water reduction is possible due to entrained air. The volume of this water reduction is less than the volume of entrained air, therefore to compensate for the volume of entrained air, the fine aggregate volume must also be reduced.

b) Despite reduction in the water/cement ratio usually obtained by the use of air-entrainers, it may reduce strength, particularly, in concretes of high or moderate cement content.

2.8.3.5 Water reducing and set controlling admixtures

a) Admixtures of the hydroxylated carboxylic acid type may tend to increase the bleeding rate and segregation in concrete deficient in fines (aggregate fines of cement).

b) When prolonged retardation is employed care must be taken to prevent the drying of the concrete.

c) The water reducing admixture should be added at the same time in the mixing cycle, in order to obtain a uniform setting time among the batches.

d) Then admixtures in many cases will increase the slump loss.

e) Increases in the flexural strength of concrete containing water reducing admixtures are usually attained but they are not proportionately as great as the increase in the compressive strength.
2.8.4 General

2.8.4.1 Suitable remedial measures as recommended by the manufacturers and approved by the Engineer shall be taken to eliminate any disadvantages arising from the mix of admixtures.

2.8.4.2 While using the admixtures the maximum amount of chloride and sulphate expressed either in percentage of cement or concrete shall not exceed the limit as specified in the relevant I.S. codes.

2.9 Interval of Routine Test

2.9.1 The routine tests of materials, delivered at site, shall be at the following intervals:

- Aggregates: fortnightly or for every 200 m³ for each aggregate whichever is earlier.
- Cement: fortnightly or for each consignment, within 4 days of delivery.
- Water: once in two months for each source of supply.
- Reinforcement: for each consignment within 4 days of delivery.

3.0 STEEL

3.1 For Reinforcement

Reinforcing bars for concrete shall be round steel bars of the following types as may be shown on the drawing:

i) Plain mild steel bars conforming to Grade-I of IS:432 "Mild Steel and Medium Tensile Steel and Hard Drawn Steel wire for Concrete Reinforcement".

ii) Deformed mild steel bars conforming to IS:1139 "Hot Rolled Mild Steel, Medium Tensile Steel and High Yield Strength Steel Deformed Bars for Concrete Reinforcement".

iii) High Yield strength deformed bars conforming to IS:1786 "Cold Worked Steel High Strength Deformed Bars for Concrete Reinforcement".

iv) Reinforcement fabrics conforming to IS: 1566 "Hard Drawn Steel Wire Fabric for Concrete Reinforcement.

All reinforcement bars shall be of uniform cross-sectional area and be free from loose mill scales, dust, loose rust, coats of paint, oil or other coatings which may destroy or reduce bond. Unit weight of reinforcement bars shall be according to IS:1786-1985.

3.2 For binding works

Binding wire for reinforcement shall be annealed steel wire 18-20 BWG or not less than 0.9 mm diameter conforming to IS:280 - "Specification for Mild Steel Wire".
3.3  For light structural work and inserts

Steel for light structural work and for preparation of inserts and embedments shall conform to IS: 2062-1992 - "Steel for general structural purposes - Specifications".

3.4  Steel Tubes

Steel tubes for use in light structural work and inserts shall be of light or medium class (as may be specified on drawings or the schedule of items) and of grade YST 25 conforming to IS:1161 - "Specification for Steel Tubes for Structural Purposes".

3.5  Foundation Bolts

3.5.1  Bolts to be embedded in concrete shall, unless otherwise detailed in drawings, conform to IS:5624 - "Specification for Foundation Bolts". Material for bolts, shall, unless otherwise mentioned on drawings or the schedule of items, be of mild steel conforming to IS: 2062.

3.5.2  Nuts and locknuts shall conform to IS: 1363 - "Specification for Black Hexagon Bolts, Nuts and Lock Nuts (diameter 6-39 mm) and Black Hexagon Screws (diameter 6 - 24 mm)" and to IS: 3138 - "Specification for Hexagon Bolts and Nuts (M-42 to M-150)".

3.5.3  Plain washers shall conform to IS: 2016 - "Specification for Plain Washers and spring washers shall conform to IS: 3063 "Spring washers for Bolts, Nuts and Screws".

3.6  Steel Tubes for Non-structural Use

3.6.1  Steel tubes for non-structural use shall conform to IS: 1239 (Part-I) "Specification for Mild Steel Tubes, Tubular and Other Wrought Steel fittings, Part-I : Mild Steel Tubes".

3.6.2  Fittings for steel tubes used for non structural purposes shall conform to IS: 1239 (Part-II) "Specification for Mild Steel Tubular and Other Wrought Steel Pipe Fittings".

3.7  Threaded Fasteners

Bolts and nuts for fastening shall conform to IS: 1367 - "Technical Supply Conditions for Threaded Fasteners".

3.8  Testing

Test certificates from manufacturer shall be submitted for each consignment. Any additional test which the Engineer may require shall be done according to the relevant IS.

3.9  Cast Steel

3.9.1  Quality

Cast steel shall conform to IS: 1030 "Cast Steel for General Engineering Purpose". Unless otherwise specified, it shall conform to Grade-2.
3.10 Conduits

3.10.1 Steel for electrical wiring

Rigid steel conduits for electrical use shall conform to IS: 1653 for rigid pipes and to IS: 3480 for flexible conduits. Fittings for conduits shall conform to IS: 2667.

All conduit pipes shall be finished with galvanized or stove-enameled surface. All accessories shall be of threaded type and pipes shall be jointed by means of screwed couplers only. Bend in conduits shall be made to the dimension shown in drawing, but a minimum of 12 times the diameter. Where shown in drawing they shall be treated with anticorrosive preservative as specified.

3.10.2 Non-metallic for electrical wiring

Non-metallic conduits for electrical use shall conform to IS:2509 for rigid pipes and to IS: 6946 for flexible pipes. Fittings shall conform to IS: 3419.

Bends shall be achieved by bending the pipe by inserting suitable solid or inspection type normal bends, elbows or similar fittings.

4.0 ASBESTOS CEMENT PRODUCTS

4.1 General

Asbestos cement products shall be free from visible defects, uniform in colour, of required density, length, thickness and diameter within the allowable tolerance. They shall be obtained from an approved source of manufacture and stored safely. Methods of test shall be according to IS: 5913 - "Method of Test for Asbestos Cement Products".

4.2 Building Boards

Building boards shall conform to IS:2098 - "Asbestos Cement Building Boards". They shall, when tested in two perpendicular directions, take a lead of not less than 15 kg for Class-A and 10 kg for Class-B boards. The boards shall show water absorption of not more than 40% of their dry weight.

4.3 Flat Sheets

Flat sheets shall conform to IS: 2096 - "Asbestos Cement Flat Sheets". They shall have a bending stress of not less than 225 kg/cm2 and a density of 1.6 kg/cm3 for compressed sheets and a bending stress of not less than 160 kg/cm2 and a density of 1.2 kg/cm3 for uncompressed sheets.

4.4 Pipes and fittings

Pressure pipes shall conform to IS: 1592 - "Asbestos Cement Pressure Pipes and to IS: 9627 - "Asbestos Cement Pressure Pipes (Light Duty)". Pipes for sewerage and drainage shall conform to IS: 6908 - "Asbestos Cement Pipes and Fittings for Sewerage and Drainage". Building pipes gutters and fittings shall conform to IS: 1626 - "Asbestos Cement Building Pipes and Pipe Fittings".

Pressure pipes shall satisfy hydraulic testing test and transverse crushing test as per IS.
4.5 Corrugated and Semi-Corrugated Sheets and Specials

These shall conform to IS: 459 - "Unreinforced Corrugated and Semi-Corrugated Asbestos Cement Sheets". Unless otherwise stated the sheets shall be corrugated and not less than 6mm thick. The sheets shall have a lead bearing capacity of not less than 5 N/mm width of specimen and shall not absorb more water than 28% of its dry weight.

5.0 BRICKS

5.1 Bricks

Bricks for masonry in foundations, walls and other locations shall be common burnt clay building bricks having minimum crushing strength of 50 kg/cm², or such other strength as may be described in the Schedule of Items, when tested in accordance with IS: 1077 - "Common Burnt Clay Building Bricks". They shall be sound, hard and thoroughly well burnt, but not over-burnt, with uniform size having rectangular, faces with parallel sides and sharp straight right angled edges and be of uniform colour with fine compact uniform texture. Bricks shall be of uniform deep red cherry or copper colour. They shall be free from flaws, cracks and nodules of free lime. Water absorption after 24 hours immersion in cold water shall be not more than 20% by weight. They shall not absorb more than 10% by weight of water after immersion for six hours. They shall emit a clear metallic ringing sound when struck by a mallet and shall not break when dropped on their face, from a height of 60 cm. Fractured surface shall show homogenous, fine grained uniform texture, free from cracks, air holes, laminations, grits, lumps of lime, efflorescence or any other defect which may impair their strength, durability, appearance and usefulness for the purpose intended. Under-burnt or vitrified bricks shall not be used. Samples of bricks brought to the site shall be tested periodically for compression and other tests according to IS: 3495, Parts-I, II & III - "Method of Test for Burnt Clay Building Bricks". Where the size of bricks is not specifically mentioned, it shall be taken to mean conventional sizes as is commonly available in the area. The bricks shall be classified on the basis of average compressive strength as given in table – I of IS:1077-1992.

5.2 Handling

Bricks shall be unloaded by hand and carefully stacked and all broken bricks shall be removed from the site.

5.3 Samples and Inspection

Representative samples shall be submitted by the Contractor and approved samples retained by the Engineer for comparison and future reference. Bricks shall be obtained from approved manufacturer. All bricks shall be subject to inspection on the site and approval of the Engineer who may reject such consignments as are considered by him to be inferior to the quality specified. The Contractor shall provide all labour and plant required for the inspection and conduct such test as shall be required by the Engineer with out additional charges.

5.4 Brick Bats

Brick bats shall be obtained from well burnt bricks.
5.5 Exposed Bricks

5.5.1 Facing Bricks
The facing bricks made from suitable soils shall be free from cracks, flaws, nodules of free lime warpage and organic matter. These shall be thoroughly burnt and shall have plane rectangular faces with parallel sides and sharp straight right angled edges. Facing bricks shall have uniform colour and even texture. Unless otherwise specified, facing bricks shall be machine moulded. Selected hand moulded bricks may also be used as facing bricks where specified. As far as possible, total requirement of facing bricks for a work shall be arranged from the same kiln. Bricks with chipped edges and broken corners shall not be used.

5.5.2 Dimensions and Tolerances
The standard sizes of machine moulded facing bricks shall be as specified.

5.5.3 The permissible tolerances shall be as under:

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Tolerance (For Machine moulded bricks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>± 3</td>
</tr>
<tr>
<td>Width</td>
<td>± 1.5</td>
</tr>
<tr>
<td>Thickness</td>
<td>± 1.5</td>
</tr>
</tbody>
</table>

*Note:* Tolerance and Dimensions for selected hand moulded bricks ± 4mm in length and ±3mm in width and thickness.

5.6 Laterite Stone Blocks
These shall conform to IS: 3620 - "Laterite Stone Blocks for Masonry". The laterite stone blocks shall have a minimum crushing strength of 20 kg/cm². The blocks shall be minimum 15 cm thick and not exceeding 30 cm thick. They shall be dressed to the desired sizes and shapes with an axe. Laterite stones shall be well seasoned by exposure to air before dressing and using on work.

5.7 Stones

5.7.1 Stones used shall be strong, durable, dense, compact, close grained, homogeneous, fire resistant and shall be obtained from sources approved by Engineer. Stones shall additionally be hard, sound, free from cracks, decay and other flaws or weathering and shall be easily workable. Stones with round surfaces shall not be made use of.

5.7.2 Stones shall have a crushing strength of not less than 200 kg/cm². Stones with lesser crushing strength may be used in works with prior approval of the Engineer. Stones shall be non-porous and when tested in accordance with IS: 1124 - "Method of Test for Determination of Water Absorption Etc.," shall show water absorption of less than 5% of its dry weight when soaked in water for 24 hours. Tests for durability and weathering shall be done in accordance with IS: 1126 and IS: 1125 respectively. The working of stones to required sizes and their dressing shall be as per IS: 1127 Recommendations for dimensions and workmanship of natural building stones for Masonry work and IS: 1129. Dressing of Natural Building Stones*. Stones especially limestone and sand stones shall be well seasoned by exposure to air before use in construction works.
### 5.7.3 Size
Normally stones shall be of size that could be lifted and placed by hand, between 20 to 30 kg per piece. The length of stones shall not exceed 3 times the height and the breadth on base shall not be greater than 3/4 of the thickness of wall nor less than 15 cm. The height of stone may be upto 30 cm.

### 5.7.4 Dressing

#### 5.7.4.1 Random rubble
Stones shall be hammer dressed on the face, the sides, and the beds to enable it to come into close proximity with the neighbouring stone. The bushings in the face shall not project more than 4 cm on all exposed faces and 1 cm on a face to be plastered.

#### 5.7.4.2 Coursed rubble - First sort
Face stones shall be hammer dressed on all beds, and joints, so as to give them approximately rectangular block shape. These shall be squared on all joints and beds. The bed joint shall be rough chisel dressed for atleast 8 cm back from the face, and side joints for at least 4 cm such that no portion of the dressed surface is more than 6 mm from a straight edge placed on it. The bushing on the face shall not project more than 4 cm as an exposed face and one cm on a face to be plastered. The hammer dressed stone shall also have a rough tooling for a minimum width of 2.5 cm along the four edges of the face of the stone, when stone work is exposed.

#### 5.7.4.3 Coursed rubble - Second sort
Dressing shall be as specified in 5.7.4.2 except that no portion of dressed surface shall exceed 10 mm from a straight edge placed on it.

#### 5.7.4.4 Stone for veneering
Stone lining upto 8 cm shall be treated as veneering work. The stone shall be cut into slabs or required thickness along the planes parallel to the natural bed. Every stone shall be cut to the required size and shape so as to be free from any waviness and to give truly vertical and horizontal joints. Adjoining faces shall be fine chisel dressed to a depth of a 6 mm, so that when checked with a 60 cm straight edge, no point varies from it by more than 1 mm. All edges shall be chisel dressed to be true, square and free from chippings. Top and bottom faces shall be dressed to within 3 mm tolerance and vertical faces to within 6 mm tolerance, when checked with a 60 cm straight edge. Dressing at the back shall not be done.

### 5.8 Hollow and Solid Concrete Blocks

#### 5.8.1
Cement concrete blocks used in the construction of concrete masonry load bearing as well as non-load bearing walls shall conform to the requirements of IS : 2185. Physical properties such as density, compressive strength, water absorption etc., shall be determined in accordance with the procedure laid down in IS : 2185 and shall conform to the requirement laid therein. When inspected visually all blocks shall be sound, free from cracks, broken edges, honey combing and other defects which would interfere with the proper placing of blocks or impair strength or permanence of construction.

#### 5.8.2 Dimensions and tolerances
The blocks shall be made in sizes and shapes to suit the particular job and shall include stretcher, corner, double corner or pier, jamb, header, bullnose and floor units.
5.8.2.1 The nominal dimensions of concrete block shall be as follows:-
- Length : 400, 500 or 600 mm
- Height : 200 or 100 mm
- Width  : 50, 75, 100, 150, 200, 250 or 300 mm

In addition, blocks shall be manufactured in half lengths.

5.8.2.2 The maximum dimensional tolerances shall plus or minus 5 mm in length and plus or minus 3 mm in height and width.

5.8.3 Hollow blocks (open and closed cavity)

5.8.3.1 Grade-A blocks used as load bearing units shall have a minimum block density of 1500 kg/m³ and shall have minimum average compressive strength of 3.5, 4.5, 5.5 or 7.0 N/mm² at 28 days as specified.

5.8.3.2 Grade-B blocks used as load bearing units shall have block density less than 1500 kg/m³, but not less than 1000 kg/m³ and shall have compressive strength of 2.0, 3.0, or 5.0 N/M³ or as specified.

5.8.3.3 Grade-C blocks used as non load bearing units shall have block density less than 1500 kg/m³, but not less than 1000 kg/m³ and compressive strength of 1.5 N/mm² at 28 days.

5.8.4 Solid blocks

Solid blocks Grade-D used as load bearing units shall have a block density of not less than 1800 kg/m³ and compressive strength of 4.0 or 5.0 N/mm² as specified.

5.8.5 Mix proportion

The concrete mix used for blocks shall not be richer than one part by volume of concrete six parts by volume of combined aggregates.

5.8.6 Surface texture and finish

Surface texture, that is, very fine close texture or coarse open texture and finish, whether coloured or not shall be according to the drawing, description in the Schedule of Items or Instructions of the Engineer.

5.8.7 Marking and certificate

The blocks shall be marked permanently with the Grade of each. Manufacturers test certificate shall be supplied with the delivery of each lot.

5.9 Cement, Lime and Water

Cement, lime and water shall conform to the specification in this series under the Section - 'Concrete'.

5.10 Sand for Masonry Mortar

Sand for masonry mortars shall be natural sand, crushed stone sand or crushed gravel and shall comply with IS : 2116 - "Sand for Masonry Mortars". The maximum size of sand particle for brick work shall be 2.5 mm and for rubble masonry 4.75 mm.

6.0 SAND FOR PLASTERING
Sand for use in mortars for internal wall, ceiling and external plastering and rendering shall conform to 'A' grade of IS : 1542 - "Sand for Plastering". The maximum size of sand particle shall be 1.2 mm.

7.0 MATERIALS FOR FLOORING & PAVING

7.1 Cement and Binders

7.1.1 Cement

Cement, fine aggregates, reinforcement and water used shall comply with the requirements of concrete in series.

7.1.2 Lime

Lime wherever specified for mortar shall conform to IS: 712.

7.1.3 Surkhi

Surkhi used for lime concrete flooring shall conform to IS 1344.

7.1.4 Water

Water for construction shall be clean, soft, free from loam, salt and organic materials. Hard water shall not be used.

7.2 Aggregates

7.2.1 Brick Aggregate

Brick aggregates for lime concrete shall be obtained from well burnt or slightly over burnt brick bats. It shall be homogenous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter. Aggregate size shall be 40 mm to 10 mm graded.

7.2.2 Coarse Aggregate

Coarse aggregate shall conform to the requirements of this series.

7.2.2.2 For granolithic floor the screed bed shall comprise of aggregates size 15 mm and down graded and topping shall comprise of clean fine stone chippings, size 4 mm and down. For concrete floor with hardener treatment the topping shall comprise of stone chippings, size 6 mm and down and for in-situ terrazzo flooring, chippings shall be within sizes 12 mm to 6 mm graded. The marble chips for topping of terrazzo floor shall be of 3 - 6 mm size and shall conform to Grade-I of IS : 2114 "CP for laying in-situ terrazzo floor finish".

7.2.3 Common burnt clay bricks

Common burnt clay bricks shall conform to IS: 1077 and comply with requirements of specification - Masonry of this series.

7.2.4 Rubble

Rubble of approved quality shall be used and shall be clean and free from dirt. The loose
and weathered sections shall be removed before use. Rubble used as hard core shall have a least lateral dimension (thickness) between 100mm and 225 mm, depending on the thickness of hardcore.

### 7.3 Tiles

#### 7.3.1 Terrazzo Tiles

Terrazzo tiles shall be machine made under a minimum pressure of 140 kg/cm². It shall have a minimum total thickness of 20 mm including a minimum of 6 mm thick topping. It shall be of size, texture, colour, shade and pattern as specified in schedule of item and as approved by the Engineer.

#### 7.3.2 White Glazed Tile

White glazed tiles shall be of approved manufacture and quality and shall conform to IS: 777 - "Glazed Earthenware Tiles. They shall be true in shape, free from haircracks, crazing spot chipped edges and corners and surface shall be perfectly flat without warps and of uniform colour. The top surface shall be glazed either gloss or matt as specified. The tiles shall be 150 mm x 150 mm or 100 mm x 100 mm size and shall not be less than 6 mm thick or as specified. The tolerance on facial dimension value shall be plus or minus 1.0 and plus or minus 0.5 mm on thickness. The specials such as coves, internal and external angles, beads, cornices and their corner pieces shall be of specified sizes and of thickness not less than the thickness of tiles.

#### 7.3.3 Coloured tiles

Only Glaze shall be coloured as specified. The size and specification of tiles shall be same as for the white glazed tiles.

### 7.4 Natural stone

#### 7.4.1 Natural stone slabs and tiles

The natural stone slabs shall be from selected quarry/ stock as specified in schedule of items which are hard, sound, dense and of homogenous texture free from cracks, decay, weathering and flaws. They should be hand or machine cut to the requisite thickness, size and be of colour indicated in schedule of items/drawing. Unless otherwise specified the slabs shall be minimum 300 mm x 300 mm and 20 mm thickness and tolerance of plus and minus 5 mm in dimensions and plus or minus 2 mm in thickness will be allowed. The stone slabs shall be brought from specific region as mentioned and of specific quality with top surfaces mentioned and specific quality with top surfaces finished smooth. All sides shall be fine chisel dressed to the full depth to allow finest possible joint.

The slabs shall be delivered to the site well protected against damage and stored in dry place under cover.

### 7.5 Adhesives

The adhesives used for laying linoleum, shall conform to IS: 1198 and for runner & PVC flooring it shall be as per manufacturer's recommendations of tiles for respective types of floors on which tiles are to be laid.
### 7.6 Pigments

Pigments incorporated in mortar or used for grouting shall be subject to approval of Engineer and as per table I of IS:2114.

### 7.7 Hardening Agents

Hardening agents such as ironite used for "Cement Concrete Flooring with Hardener Treatment", shall be of quality approved by the Engineer for every work.

### 7.8 Dividing Strips

Dividing strips shall be of aluminium, glass or similar materials and of quality approved by the Engineer. Aluminium or other metal strips shall be 1.5 mm thick and glass 4 mm thick penetrating to the full depth of the flooring.

### 7.9 Marble Chips

It shall be in sizes varying from 1mm to 25mm and in different colours as per requirement. Marble chips shall be hard, sound, dense and homogeneous in texture with crystalline and coarse grains.

### 8.0 TIMBER

#### 8.1 General

All timber used for permanent works shall be new. It shall be well seasoned by a suitable process conforming to IS: 1141 before being planed to the required sizes. It shall be sound, straight, free from sap, radial cracks, decay, fungal growth, boxed heart, pitch pockets, borer holes, splits, loose knots, flaws or any other defects and shall show a clean surface when cut. Timber shall conform to the requirements of IS:1003. The finished components shall be given suitable preservative treatment wherever necessary.

#### 8.2 Hollock (Terminalia Myriocarpa)

Hollock is not a durable wood unless properly treated. It can be readily treated with wood preservatives. It can be finished to fairly good surface, but needs careful filling before it is polished.

#### 8.3 Country Wood

Country wood shall be belonging to the species or trade names as described in the Schedule of Items or drawing or otherwise directed by the Engineer. It shall be the best procurable.

#### 8.4 Teak Wood

Teak wood shall be superior, first class or second class as specified and the best procurable, having uniform grains and free from any defect likely to impair the appearance of finished work.

#### 8.4.1 Superior teak shall be Malabar, Dandeli or Balarshah teak in which no knot shall be larger than 1 cm diameter and the total area of knots not more than one percent. There
shall be not less than six growth rings per 2.5 cm width.

8.4.2 First class teak shall be Balarshah or M.P. teak in which no knot shall be larger than 2.5 cm diameter and the total area of knot not more than one percent. There shall be not less than five growth rings per 2.5 cm width.

8.4.3 Second class teak shall be similar to first class teak except that knots upto 4 cm diameter and total area of knots not exceeding one and a half percent will be permitted. The number of growth rings per 2.5 cm width shall be not less than four.

8.5 Storage and Inspection

Timber shall be carefully stored and subject to inspection on site, piece by piece. The Engineer may reject such pieces as are considered by him not of the quality or meeting the requirements specified herein.

8.6 Moisture Content

Timber shall be accepted as well seasoned if its moisture content does not exceed the permissible limit as per IS:287.

8.7 Allowance for Bulk Timber

For bulk timber an allowance on the scantling specified 2% above or below the specified dimensions will be allowed.

8.8 Flush Door Shutters, Shelves

Flush door shutters, shall be wooden, solid core or cellular and hollow core type, as may be shown in drawing or described in the Schedule of Items or directed by Engineer. They shall be obtained from an approved source of manufacture covered on face with commercial ply, wood veneer or other finish as may be necessary. Solid core shutters shall conform to IS: 2202 and cellular or hollow core shutters to IS: 2191. The resin used shall be phenol formaldehyde. A full size sample door shall be offered for inspection and approval.

Shelves and vertical partitions of cupboards shall be of timber planks fibre board, particle board, block board or veneered particle board as specified. Thickness and type of planks or boards shall be as specified. Each shelf shall be a single piece and vertical partitions between two consecutive shelves shall be without any joint. Exposed edges of boards having particle board core shall be sealed with 3 mm thick single piece hardwood strips of width equal to the thickness of board with headless pins. The arrangement of shelves and vertical partitions shall be as per drawings or as directed by the Engineer-in-charge.

8.9 Unveneered Particle Board

Unveneered particle board shall conform to IS: 3087 for medium density and to IS: 3478 for high density.

8.10 Veneered Particle Board

Veneered particle board shall conform to IS: 3097.
8.11 Plywood

Plywood for permanent work such as in partitions etc., shall conform to IS: 303 having commercial, teak, rose wood or other desired finish.

8.12 Block Board

8.12.1 Block boards have a solid core made up of uniform strip of wood each not exceeding 25mm in width, laid separately, or spot glued, or otherwise joined to form a slab which is glued, between two or more outer veneers, with the direction of the grain of the core block running at right angles to that of adjacent veneers. In any one blocks boards, the core strips shall be of one species of timber only. Face veneers may be decorative or commercial on both faces or decorative on one face and commercial on the other block boards shall be Grade-I (Exterior Grade) as per IS:1659-1990.

Both surfaces of the boards shall be sanded to a smooth finish.

8.12.2 Adhesives

The adhesives used for bonding shall be BWP type synthetic resin conforming to IS:848-4974 for Grade-I block boards.

8.12.3 Thickness and Tolerance

Block boards are available in thickness ranging from 12 to 50mm. Tolerance in thickness shall be ± 5% for boards upto and including 25mm thick and ± 2.5% for boards above 25mm thickness. Each board shall be of uniform thickness.

8.12.4 Testing

One sample for every 100 sqm or part thereof shall be taken and testing done as per IS:1659-1990. However, testing may not be done if the total requirement of block boards in a work is less than 30 sqm. All the samples tested shall meet the requirements of physical and mechanical properties of block boards specified in the relevant B.I.S. code.

8.12.5 Type of face veneers, thickness and grade of block boards shall be as specified. Unless otherwise stated, grade-I (exterior grade) block board bonded with BWP grade be used.

8.13 Wire Mesh Shutters

8.13.1 Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planned smooth and accurate to the full dimensions, rebates, roundings and mouldings as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted except as provided.

8.13.2 Stile and Rails

The specifications shall be as described. The stiles and rails shall be given a rebate to receive the wire gauze which shall from the panels.
8.13.3 Wire Gauze

This shall be unless specified otherwise conform. The wire gauze shall be bent at right angles in the rebates of stiles and rails, turned back and fixed tight with blue tacks at about 75mm centre, fixed alternately in the two faces of the rebates. Over this, wooden heading shall be fixed with brads or small screws at about 75mm centres.

The space between the beading and rebates, where the wire gauze is bent, shall be nearly finished with putty, so that the end of the wire gauze may not be visible.

8.13.4 Fixing fittings, wooden cleats, blocks and measurement shall be as specified.

8.13.5 Rate

This includes the cost of materials and labour involved in all the operations described above.

9.0 FITTINGS FOR DOORS, WINDOWS ETC.

9.1 General

Fittings shall be of iron, brass, aluminium or as specified. These shall be well made, reasonably smooth and free from sharp edges, corners, flaws and other defects. Screw holes shall be countersunk to suit the head of specified wood screws. All hinge pins shall be of steel and their riveted heads shall be well formed.

Iron fittings shall be finished bright or black enameled or copper oxidized or painted as specified. Brass fittings shall be finished bright, oxidized or chromium plated and aluminium fittings shall be finished bright or anodized as specified. Fittings shall be got approved by the Engineer before fixing. Screws used for fittings shall be of the same metal and finish as the fittings. However, anodized cadmium/chromium plated MS screws of approved quality shall be used for fixing aluminium fittings.

9.2 Hinges

9.2.1 Butt hinges

These shall be mild steel butt hinges (medium), brass butt hinge (light/ ordinary), brass butt hinge (heavy), brass oxidized butt hinges (light/ ordinary), brass oxidized butt hinges (heavy) extruded aluminium alloy butt hinges as specified. Brass and MS butt hinges shall conform generally to Indian Standard Specification for butt hinges IS: 205 and IS: 1341 respectively.

9.2.2 Parliament hinges

These shall be of mild steel or cast brass or as specified and shall generally conform to IS: 362.

9.2.3 Spring hinges

These shall be made of iron or brass casing with steel spring and shall conform generally to IS: 453. Hinges shall work smoothly and hold the door shutters truly vertical in closed position. The size of spring hinge shall be taken as length of its plate.
### Piano hinges

These shall conform to IS: 3818 and shall be made of mild steel or aluminium alloy sheets. Mild steel hinges shall be finished with anticorrosive treatment or plating of brass of nickel as specified. Piano hinges shall be fixed in the entire length of the cupboard shutters.

### Tee hinges

These shall be made of MS sheets and finished bright. They shall conform to IS: 206.

### Sliding Door Bolts

These shall be of aluminium and conform to IS: 2681. They shall be capable of smooth sliding action. Alternative materials may be adopted on the approval of the Engineer for specific locations.

### Door Latch

This shall be mild steel, brass or as specified and shall be capable of smooth sliding action.

### Tower Bolts

Tower bolts may be of one of the following types:

- **i)** Brass barrel tower bolt with cast brass barrel and rolled or drawn brass bolt.
- **ii)** Brass barrel tower bolts with brass sheet barrel and rolled or drawn brass bolt.
- **iii)** Anodized aluminium barrel tower bolt with barrel and bolt of extruded sections of aluminium alloy (12 mm dia shoot).

These shall generally conform to IS: 204 steel spring and ball shall be provided between the bolt and the barrel.

### Door Handles

These shall be cast brass or of aluminium of specified size and of the shape and pattern as approved by the Engineer. These shall generally conform to IS: 208. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size and window handles of 75 mm size unless otherwise specified. These shall be fixed with 25 mm long wood screws.

### Mortice Lock

Mortice lock with latch and pair of lever handles shall have steel casing and brass bolts and shall be right or left handed as shown in the drawing or as directed by the Engineer. It shall be of the best Indian make of approved quality and shall conform to IS: 2209. The shape and pattern shall be approved by the Engineer. The size of the lock shall be determined by its length. The lock for single leaf door shall have plain face and that for double leaf door a rebated face lever handles with springs shall be mounted on plates.
and shall weigh not less than 0.5 kg per pair. These shall be of brass, finished bright chromium plated or oxidized.

9.8 Floor Door Stopper

This shall be made of cast brass and shall have a rubber cushion. The type and pattern will be as approved by the Engineer.

9.9 Hooks and Eyes

These shall be of hard drawn brass and shall generally conform to IS: 207.

9.10 Casement Window Fasteners

These shall be made of cast brass. Casement fasteners for single leaf window shutter shall be left or right handed as specified. These shall not weigh less than 0.20 kg per fastener.

9.11 Casement Brass Stays

These shall be made of cast brass. The stay shall be made from a channel section and shall not weigh less than that indicated below:

- 200 mm ...... 0.24 kg each
- 250 mm ...... 0.28 kg each
- 300 mm ...... 0.33 kg each

The shape and pattern of stays shall be approved by the Engineer.

9.12 Quadrant Stays

These shall be made of cast brass. The shape and pattern shall be approved by the Engineer. It shall not weigh less than 0.20 kg each.

9.13 Fan Light Pivots

These shall be made of cast brass and shall generally conform to IS: 1837. The base and socket plate shall be made from minimum 3.15 mm thick brass plate and projected pivot shall not be less than 12 mm diameter and 12 mm length cast in single pieces with the base plate.

9.14 Fan light catch

These shall be made of cast brass and shall generally conform to IS : 364. Steel springs of the catch shall be 0.90 mm dia 6 coils 12 mm internal diameter and 20 mm long. The pattern and the shape of the catch shall be as approved by the Engineer.

9.15 Chain with Hook for Fan Light

This shall be made of hard drawn brass or cast brass welded or twisted as specified and shall conform generally to IS: 3828. One end of the chain shall be provided with an eye and the other end with a staple. The minimum thickness of plates shall be 2.24 mm and the chain shall be 300mm long made from minimum 4 mm hard drawn wire.
### Hasp and Staple

Hasp and staple (safety type) shall be made of cast brass and generally conform to IS: 363. The hinge pin which in all cases shall be of mild steel, shall be firm and its riveted head well formed. The movement of the hasp shall be free, easy and square and shall not have any play or shake. The hasp shall fit the staple correctly. The size shall be determined by the length of the bigger leaf of the hasp.

### Cupboard Lock

These shall be made of cast brass conforming to IS:729 and shall be of the best Indian make. The lock shall be easy in working, having duplicate keys.

### Hydraulic Door Closer

These shall conform to IS: 3564 and be of brand approved by the Engineer for both left and right hand openings.

### Steel Frames

Steel sections used for door frames, windows and ventilators shall conform to the IS Specification.

### METAL DOORS, WINDOWS, VENTILATORS, COLLAPSIBLE GATES & ROLLING SHUTTERS

#### General

Materials used in the fabrication of doors, windows, and ventilators shall be the best procurable and conforming to relevant Indian Standards.

#### Steel Doors, Windows, Ventilators & Collapsible Gates

Steel sections used for fabrication of doors, windows ventilators & collapsible gates shall be standard rolled steel sections specified in IS: 1038, IS: 1977, IS: 1361 or IS: 7452 as appropriate or as specified in drawing and Schedule of Items. Rivets shall conform to IS: 1148.

#### Aluminium Doors, Windows & Ventilators

Aluminium sections used for fabrication of doors, windows ventilators partitions etc. shall be extruded sections specified in IS: 1948-1961 & 1949-1961 or as manufactured by Indian Aluminium Company Limited or approved equivalent. The alloy used shall conform to designation HE9 – WP of IS:733-1983.

#### Steel Rolling Shutters, Rolling Grills

These shall conform to IS:6248-1979.

#### MS Bolts etc.,

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MS bolts, nuts, screws, washers, peg stays and other mild steel fittings shall be treated
for corrosion as recommended by the relevant Indian Standards. Putty for glazing shall
conform to IS: 419. Glass panes and glazing shall conform to the specification detailed
under this series.

10.6 Hardware and fixtures shall be as specified in the drawings or Schedule of Items. All
hardware and fixtures shall be able to withstand repeated use. Door closers shall be
suitable for doors weighing 61 - 80 kg, unless otherwise stated. Each closer shall be
guaranteed against manufacturing defect for one year and any defect found within this
period shall be rectified or the closer replaced free of charge. Concealed door closers
shall be either floor mounted or transom mounted, suitable for installation with metal
doors. It shall conform to the performance requirements and endurance test stated in IS:
3564 - Appendix-A.

10.7 The mastic for caulking shall be of best quality from a manufacturer approved by the
Engineer. In general, the mastic for fixing of metal frames shall conform to IS: 1081
and/or as approved by the Engineer.

11.0 GLASS

11.1 General

Plain, ground, frosted or rough cast wired glass shall be used as shown on the drawing
or as specified in the Schedule of Items. It shall be procured from a reputed source of
manufacture such as Hindustan Pilkington Glass Works Limited and be of the best
quality. All glass panes shall be free from flaws, specks, bubbles etc., All the panes
shall weigh not less than 7.5 kg per sqm. The tolerance of glass panes in length and
width shall be plus or minus 2 mm.

11.2 Plain Transparent Glass

Plain transparent glass for glazing and framing shall conform to IS: 1761. It shall be free
from flaws, specks, bubbles or distortions.

11.3 Ground and Frosted Glass

Glare reducing or heat absorbing glass shall be "Calorex" of Hindustan Pilkington or
approved equivalent and special care shall be taken to grind smooth and round off the
edges before fixing.

11.4 Wired Glass

Wired glass shall be thick rolled glass with centrally embedded 24 g. Wire mesh of
Georgian type. This may be clear or coloured, as shown in drawings or specified in
Schedule of Items.

11.5 Thickness

Glass shall have the following thickness, unless otherwise stated in the Schedule of
Items or drawings:

<table>
<thead>
<tr>
<th>Size</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 60 cms x 60 cms</td>
<td>3 mm</td>
</tr>
<tr>
<td>do- of larger size</td>
<td>4 mm</td>
</tr>
</tbody>
</table>
11.6 Inspection

All glass shall be subject to inspection on the site. Glass found to suffer from defects shall be rejected. Samples submitted for inspection shall be selected so as to be representative of the consignment.

12.0 PAINTS

12.1 General

All paints, varnishes, distemper or other surface coating materials shall be of approved quality conforming to the appropriate Indian Standard, wherever such standard is available, and be obtained from a manufacturer of repute.

12.2 Sampling and Testing

The Engineer may, at his discretion, require samples of paint to be tested. In such cases testing will be according to IS: 101.

12.3 Storage

Paints, primers, distempers and varnishes shall be delivered in sealed containers. They shall be stored in cool dry condition to the satisfaction of the Engineer.

12.4 Paints for Priming

Ready mixed paints for priming coats of steel and iron work shall comply with IS: 2074 - "Ready Mixed Paint", "Red Oxide Zinc Chrome Priming".

12.5 Paints For Finishing

Ready mixed oil gloss paint where specified shall comply with IS: 129 "Ready Mixed Paint, Brushing, Finishing Semi- gloss, for General Purpose to IS Colours". Aluminium paints where specified on the drawings or ordered by Engineer shall comply with IS: 2339 - "Aluminium Paint for General Purposes in Duel Containers". Plastic Emulsion paint where specified for plastered surfaces of masonry and concrete work shall comply with IS: 5411 (Part _ I) and (Part _ II) for interior use and exterior use respectively.

12.6 White wash

White was shall be prepared from lime slaked on spot, mixed and stirred with sufficient water to make a thin cream.

12.7 Colour wash

Colour was shall be prepared by adding mineral colours, not affected by lime, to white wash.
12.8  Cement Paint

Cement paints shall comply with IS: 5410 and shall be of approved brand and manufacture. The shade shall be approved by the Engineer before its application.

12.9  Distemper

Dry/oil bound distemper of approved brand and manufacture shall be used. The shade shall be approved by the Engineer before application of the distemper.

12.10 Varnish

Varnish for the finishing coat shall be copal finish or super quality spar varnish of approved brand. Varnish for the under coat shall be flatting varnish of the same make as the top coats and shall be to the approval of the Engineer.

12.11 Polish

French spirit polish shall be of an approved make conforming to IS: 348. If it has to be prepared on site, the polish shall be made by dissolving 0.7 kg of best, shellac in 4.5 litres of methylated spirit without heating. To obtain required shade pigment may be added and mixed.

12.11.1 Where wax polishing is specified, it shall be prepared by heating two parts of "Bee Wax" and two parts of boiled linseed oil over a slow fire. When dissolved but still warm, one part of turpentine is to be added.

12.12 Plastic (Acrylic) emulsion Paint

Plastic emulsion paint of approved manufacturers like Jenson & Nicholson, Goodlass Nerolac, Shalimar, Berger, Asian and Garware paints only shall be used unless otherwise specified and shall comply with IS:5411(Part 1) – 1974 & (Part 2) – 1972 as applicable. Cement primer used for priming work both for oil bound distemper and plastic emulsion paint shall be of the same manufacture as that of distemper or plastic emulsion paint used. For dry distemper priming, whiting of approved quality shall be used.

12.13 Floor Polish – Paste

The polish shall consist mainly of waxes and organic solvents with or without water. The paste of floor polish shall be of smooth consistency, homogeneous, semi solid mass and free from gritty material. It shall not flow at ordinary temperature. It shall be so constituted and prepared that on application by means of a clean cloth, it shall spread easily and evenly and shall give with minimum buffing a firm and glossy surface free from greasiness or tackiness. The polish film after spreading with a cloth shall not take more than 10 minutes to dry. The polished floor shall be neither slippery nor show any resistance to easy walking. Floor polish paste shall conform to IS:8591-1977.

13.0 WATER PROOFING MATERIALS

13.1 Integral Cement Waterproofing Compounds
Integral cement waterproofing compounds, i.e. admixture for waterproofing purposes shall fully comply with the requirements of IS: 2645. Properties like permeability, setting time, compressive strength shall be in accordance with the requirements of this code when tested as per procedure laid therein. Calcium chloride content of the product used shall be made known to Engineer before use.

13.2 Bitumen

The bitumen bonding material for waterproofing shall conform to the requirements laid down in IS: 702, or IS: 73 or IS: 217 or IS: 454 depending upon whether industrial bitumen, paving bitumen or cutback bitumen is used. For selecting the particular type and grade of bitumen to be used the relevant item in Schedule of Items shall be referred to.

13.3 Bitumen Primer

Bitumen primer used for application to concrete and masonry surfaces and bitumen for the purpose of waterproofing shall conform to requirements given in IS: 3384 and pass tests in accordance with the procedure laid down in appropriate IS mentioned in Table-I of IS: 3384. Bitumen primer should be free from water and shall preferably be made from the same grade of bitumen as used in bonding.

13.4 Bitumen Felt

Bitumen felts used for water proofing purposes shall be as specified in IS: 1322. Physical properties shall conform to the requirements and tests shall be carried out as per procedure laid down in IS: 1322. Base, (whether fibre or Hessian), type and grade of felt shall be as mentioned in the relevant items under Schedule of Items. Unless otherwise stated, hessian base felt Type-3, Grade-2 shall be used.

13.5 Bitumen Mastic

Bitumen mastic used for water proofing of roofs shall have the physical properties as mentioned in IS: 3037 when tested with the procedure laid down in appropriate IS mentioned in IS: 3037.

13.6 Bitumen Compounds

Bituminous compounds when used for waterproofing of porous masonry, concrete floors, walls and roofs shall conform to the requirements of IS: 1580. Physical properties shall be governed by the requirements of this code when tested in accordance with the procedure laid therein.

13.7 Surface Application Materials

Waterproofing material for application on mortar or concrete surface shall conform to IS: 9862. The primer shall be suitable for spray or brush application. It shall have properties enabling it to penetrate through pores or cracks and fill them up, making the surface impervious.

13.8 High Polymer, based Admixtures & Epoxy Based Emulsion & Paints
The materials used shall be high polymer based chloride and sulphide free cement and waterproofing additions and epoxy based waterproofing paints as per manufacturer's specification and approved by Engineer.

14.0 WATER BAR

14.1 General

Water bar for use in construction/expansion joints in concrete and reinforced concrete structures shall be of copper sheet, galvanized steel sheet, rubber or PVC as shown in drawing or described in the Schedule of Items. It shall be subject to approval of Engineer.

14.2 Jointing

The water bar shall have dimensions as shown in drawing. Where water bars are required to be lengthened or otherwise jointed the joining shall be done in such a way as to achieve a perfectly water-tight joint.

15.0 LEAD

15.1 General

Lead for joints in cast iron spigot and socket pipes shall be melted from pure soft pig lead conforming to Type-I of IS: 782. "Caulking Lead" where lead wool is allowed for caulking, it shall be equal to or better than Type-II of IS: 782. Lead flashing shall conform to IS: 405, "Lead Sheet".

16.0 BUILDING PAPER

Building paper shall be bitumen impregnated paper conforming to IS: 5134, or such other as may be approved by the Engineer.

16.1 Gypsum Building Materials

i) Non load Bearing Gypsum Partition Block (Solid or hollow type)

The materials to be used for non load bearing construction (solid or hollow type) in the interior of building, protection of columns, elevated shafts etc. against fire shall conform to IS : 2489

ii) Gypsum Plaster Boards

These are intended to be used as vertical or horizontal lining in buildings. The boards manufactured conforming IS : 2095 and suitable to receive either direct surface decoration or gypsum plaster finishes shall be used for above work. Boards subjected to secondary manufacturing operation shall not be used for this work.

iii) Fibrous Gypsum Plaster Boards

These boards are manufactured as a composition of gypsum plaster and sisal or coconut or any other suitable fibre body of regular dimensions. These are used
for covering walls, ceilings, partitions in normal dry environments in buildings. These have high fire-resisting properties. These boards shall conform to IS:8273.

17.0 FILLING MATERIAL

17.1 General

Filling material shall conform to what is shown in drawing, described in the Schedule of Items or otherwise directed by the Engineer. Earth or sand for filling under floors shall correspond to those described elsewhere in these specifications.

17.2 Mastic Bitumen

Mastic Bitumen shall conform to IS: 3037 or IS: 5871 as appropriate.

17.3 Flexible Boards

Flexible boards for use in expansion joints shall correspond to the description given in drawing or the Schedule of Items or instructions of the Engineer.

18.0 DRAINAGE & SANITATION (INTERNAL)

18.1 General

All materials, pipes, specials, fittings, fixtures etc., to be used in the works shall be of best quality and class specified in relevant IS Code. Where specified these shall be of specific manufacture and quality and shall be procured from manufacturer or their accredited stockists and be marked with manufacturers’ names and trade mark. Contractor shall submit to the Engineer samples of all materials, pipes, specials, fittings fixtures for approval before use in the works. Such approved samples shall be retained by the Engineer until completion of works. Pipes and specials may be any or combination of following types:-

i) PVC Pipes
ii) Stone Ware Pipes
iii) HCI Pipes for soil waste & Ventilation
iv) CI Pipes for rain water
v) AC Pipes for rain water
vi) R.C.C Pipes

18.2 PVC Waste Pipe

This shall conform to relevant IS unless otherwise specified.

18.3 Stoneware Pipes & Fittings

All stoneware pipes, bends, gully traps and sewer traps shall be of the best salt glazed variety inside and outside, hard burnt dark grey colour, perfectly sound, free from fire cracks and imperfection of glaze, truly circular in cross section, perfectly straight, of standard nominal length and depth of socket and barrel. These shall be of approved manufacture and shall comply with the requirement of IS: 651.
18.4 HCI Pipe

All soil waste and vent pipes and fittings used in the work shall be cast iron and shall conform to IS: 1729. The pipes shall have spigot and socket ends, with bead on spigot end and shall be with or without ears. The pipes shall be free from cracks and other flaws. The interior of the pipe and fittings shall be clean, smooth painted inside and outside with PR Angus smith’s solution or other anti-corrosive paint. The standard weights and thickness of pipe shall comply with the requirements of IS: 1729. The tolerance on wall thickness and weight shall be minus 15 percent and minus 10 percent respectively. Pipes weighing more than the nominal weight given below may be accepted provided they comply in every other respect.

<table>
<thead>
<tr>
<th>Nominal size</th>
<th>Weight per piece in Kg. excl. ears</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall length</td>
</tr>
<tr>
<td></td>
<td>1500 mm</td>
</tr>
<tr>
<td>50</td>
<td>9.56</td>
</tr>
<tr>
<td>75</td>
<td>13.83</td>
</tr>
<tr>
<td>100</td>
<td>18.14</td>
</tr>
<tr>
<td>150</td>
<td>26.70</td>
</tr>
</tbody>
</table>

Specials and Fittings shall include bends, offsets, branches of various types, junctions etc., as required for the work which shall be provided according to drawings and directions of the Engineer. The specials and fittings shall be provided with access doors where so specified or directed by the Engineer. The access door fittings shall be of proper design so as not to form cavities in which the filth may accumulate. Doors shall be provided with 3 mm thick rubber insertion packing, and when closed and bolted they shall be water tight. The access doors shall have MS studs and bolts or screws or bolts and nuts.

18.5 Cast Iron Pipes: Rainwater pipe

Pipes shall be of approved manufacture, true, smooth and cylindrical, their inner and outer surfaces being as nearly as practicable concentric. These shall be sound and uniform casting, free from laps, pin holes or other imperfections and shall be neatly finished and carefully fitted with inside and outside. The ends of pipes shall be reasonably square to their axis.

**Dimensions**

CI rain water pipes shall be of the dia specified in the description of the item and shall be in full lengths of 1.8 meters including socket ends of the pipes, unless shorter lengths are required at junctions with fittings. The pipe lengths shall in each case be with sockets. The pipes shall be supplied without ears unless otherwise specifically mentioned.

The pipes supplied shall be factory painted with a tar based composition both inside and outside which shall be smooth and tenacious.

Every pipe shall ring clearly when struck all over with a light hand hammer.
shorter pipes are cut from full lengths they shall be cut with a hacksaw.

Where the pipes are to be embedded in masonry they shall be of Class of pipes as are used for soil and vent pipes. For the weights of different sizes of these pipes, the specifications under SCI and vent pipes may be referred to.

18.6 Water Closets

18.6.1 European Pattern W.C.
These shall be of Hindustan Sanitary-ware make A class equivalent or of approved Indian make and quality. Unless otherwise specified, these shall comprise of:-

a) White glazed earthenware wash down closet set with 'S' or 'P' trap.

b) 'Duco' spray painted 12.5 litres mosquito proof low level MS flushing cistern with valveless siphon, 15 mm ball cock, C.P. brass unions and couplings for the 32 mm dia flush pipe, 20 mm dia overflow PVC pipe with mosquito proof cover etc.,

c) 'Duco' spray painted 1 1/4" (32 mm) dia GI telescopic flush pipe with buffer clamp, holder bat clamp and 38mm dia PVC pipe.

d) 'BESTOLITE' or equivalent white solid plastic W.C. seat and cover C.F. brass bar hinges, screws bolt, rubber buffers.

e) 15 mm PVC connection pipe with brass couplings at both ends and 15 mm brass CP cock.

f) Teak wood wooden blocks or other suitable fixing arrangement with screws and detofix for fixing WC in floor and putty joint with flush pipe and soil pipe.

18.6.2 Indian Pattern W.C.
These shall be of Hindustan Sanitary Ware make 'A' class or equivalent approved Indian make and quality. Unless otherwise specified these shall comprise of :-

a) White glazed earthenware WC pan back entry type.

b) White glazed earthenware 'P' or 'S' trap with or without vent.

c) 12.5 litres or approved make mosquito proof MS high level flushing cistern with valveless siphon, 15 mm ball cock, galvanised iron chain with with handle, cast iron brackets with wall plugs, brass unions and couplings for flush pipe, 20 mm dia overflow PVC pipe with mosquito proof cover etc.,

d) 32 mm dia GI telescopic/40 mm C.D high density PVC flush pipe with holder bat clamps.

e) One pair of white glazed earthen ware feet set in one cement mortar 1:3.

f) 15 mm PVC connection pipe with brass couplings and at both ends and 15 mm brass stop cock.

18.7 Wash Hand Basin
These shall be of Hindustan Sanitaryware make ‘A’ class or equivalent approved Indian make and quality. Unless otherwise specified these shall comprise of:-

a) White glazed earthenware basin with 2 nos. Concealed Cast Iron Brackets with wall plugs.

b) 1 no. 15 mm C.P. brass pillar taps.

c) 32 mm C.P. brass waste fittings, C.P. brass chain and rubber plug.

d) 32 mm PVC waste pipe with brass couplings/32 mm CP bottle trap.

e) 15 mm PVC connection pipes with brass couplings and 15 mm brass stop cock.

18.8 Sinks

These shall be of Hindustan Sanitaryware make ‘A’ class or equivalent approved Indian make and quality or grey mosaic sink of approved design with reinforcement etc., complete. Unless otherwise specified these shall comprise of the following:-

a) White glazed fire clay sink/mosaic as specified with outlet water overflow at end with 2 nos. cast iron brackets with wall plugs.

b) 38 mm C.P. brass waste fittings, C.P. brass chain and rubber plug.

c) 38 mm PVC waste pipe, with brass couplings complete/ 32 mm CP bottle trap.

18.9 Flat Back Lipped Urinal

These shall be of Hindustan Sanitaryware’ or equivalent approved Indian make and quality. Unless otherwise specified these shall comprise of:-

a) White glazed earthenware urinal basin (back type).

b) CI/M.S mosquito proof high level automatic flushing cistern of capacity as specified in the Schedule of Quantities with all accessories, cast iron brackets with wall plugs, brass Unions and coupling for flush pipe, 20 mm dia overflow pipe with mosquito proof cover.

c) 25 mm dia GI flush pipe and spreaders with wall clips and brackets.

d) 15 mm PVC connection pipe with brass couplings joint at both ends and 15 mm brass stop cock.

e) 32 mm C.P. brass outlets complete with PVC waste.

18.10 Mirror Frames:

Mirror frame where specified shall be of fibre glass of approved shape, size, colour and make.

18.10.1 Mirror shall be of superior glass with edges rounded off or levelled as specified. It shall be free from flaws, specks or bubble and its thickness shall not be less than 5.5 mm. The glass for the mirror shall be uniformly silver plated at the back and shall be free
from silverying defects. Silverying shall have a protective uniform covering of red lead paint.

18.11 Toilet Shelf

18.11.1 Glass shelf unit shall consist of an assembly of glass shelf, CP brass guard rail and supporting brackets. The shelf shall be of glass of best quality with edges rounded off and shall be free from flaws, specks, bubbles and of thickness not less than 5.5 mm. The shelf shall have guard rail, resting on rubber washers on glass plate.

18.11.2 Ceramics shelf shall be of shape, size and design as specified in the Schedule of Items.

18.12 Towel Rail

Towel rail shall be of CP brass/anodized aluminium with two brackets of same material, diameter and length as specified.

18.13 Toilet Paper Holder

Toilet paper holder shall be of CP brass, PVC with CP brass brackets, of approved made and designs.

18.14 Soap Container

Soap container shall be of CP brass, PVC with CP brass brackets of approved make and design.

18.15 CP Flush Valves 15 Litres for EWC

The CP flush valve (15.0 litres) for EWC shall be of ‘ACCO’ brand of Asia Continental Metallware Fabric or equivalent quality.

18.16 CP Flush Valve 5 Litres for Urinals

CP flush valve for urinal shall be of ‘ACCO’ brand of Asian Continental Metalware fabric or of equivalent quality.

18.17 Gully Trap

Each gully trap shall have one C.I. grating 150 mm x 150 mm and one water tight precast R.C. cover 300 x 300 x 40 mm thick with 1:1 1/2:3 mix concrete (one cement: one and half sand : 3 stone chips 20 mm down) including neat cement finish.

18.18 CI Manhole Cover

Manhole cover shall be CI type 450mm dia (internal) light duty 25 kg weight (cover and frame), heavy duty 128kg weight (cover & frame), 560 mm dia (internal) and shall be either single seal or double seal as specified in the Schedule of Items.

18.19 Polycrcrete Sanitary Fittings

Where specifically mentioned polycrcrete sanitary fittings manufactured by Gujarat Polycrcrete Pvt. Ltd., shall be used. The pipe, fittings and appurtenances shall be of the
description mentioned in for glazed vitreous fitting.

18.20 Fibre Glass Sink

Fibre glass sink where specified shall be of heavy duty (4 ply) of approved manufacturer, shape and size. The pipes and other appurtenances shall be of the description mentioned for the glazed vitreous sinks.

19.0 WATER SUPPLY & PLUMBING (INTERNAL)

19.1 General

This section deals with the specification of material for pipes, fittings, fixtures etc., to be used in water supply works. All materials, pipes, fittings, fixtures to be used in the works shall be of the best quality of the class specified in relevant IS Code. Where specified these shall be of specific manufacture and quality and shall be procured from the manufacturer or their accredited stockist and be marked with manufacturers name and trade marks. The Contractor shall submit to the Engineer samples of all pipes, fittings, and fixtures for approval before being used in the works. Such approved samples shall be retained by the Engineer until completion of works.

Pipes and pipe fittings may be of any or combination of following types:

i) Wrought iron galvanised pipe

ii) PVC pipes

iii) Cast iron pipes

iv) Steel pipes coated with bitumen composition inside and galvanised outside.

v) Reinforced concrete pipes

vi) Asbestos cement pipes

vii) Prestressed concrete pipes

viii) Lead (not to be used for potable water)

19.2 Galvanised Iron Pipes and Fittings

Generally pipes for installations in buildings shall be medium quality malleable steel galvanised pipe 'B' class for cold water supply and 'C' class for hot water supply, having threaded ends with socket at one end.

The details of standard pipes and sockets regarding nominal bore thickness and weight in kg/m are given below:-
### Specimen Table

<table>
<thead>
<tr>
<th>PIPE DIA</th>
<th>DIMENSION OF PIPE</th>
<th>THICKNESS</th>
<th>DIMENSION OF ORDINARY SOCKETS</th>
<th>Wt. OF PIPE END</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>MAXIMUM (OUTSIDE DIA)</td>
<td>MINIMUM</td>
<td>OUTSIDE DIA (APPROX)</td>
<td>MINIMUM LENGTH</td>
</tr>
<tr>
<td>15</td>
<td>21.8</td>
<td>21.0</td>
<td>2.65</td>
<td>26.9</td>
</tr>
<tr>
<td>20</td>
<td>27.3</td>
<td>26.5</td>
<td>2.65</td>
<td>33.7</td>
</tr>
<tr>
<td>25</td>
<td>34.2</td>
<td>33.5</td>
<td>3.25</td>
<td>42.0</td>
</tr>
<tr>
<td>32</td>
<td>42.9</td>
<td>42.0</td>
<td>3.25</td>
<td>51.0</td>
</tr>
<tr>
<td>40</td>
<td>48.8</td>
<td>47.9</td>
<td>3.25</td>
<td>57.0</td>
</tr>
<tr>
<td>50</td>
<td>60.8</td>
<td>59.7</td>
<td>3.65</td>
<td>70.0</td>
</tr>
<tr>
<td>65</td>
<td>76.6</td>
<td>75.3</td>
<td>3.65</td>
<td>88.0</td>
</tr>
<tr>
<td>80</td>
<td>89.5</td>
<td>88.0</td>
<td>4.05</td>
<td>101.6</td>
</tr>
</tbody>
</table>

- **Note:** Manufacturing tolerances shall be permitted on tubes and sockets in addition to above. The galvanised iron pipes shall be of approved make and conform to IS and of tested quality. The GI pipes shall be of threaded ends with a socket at one end only. The fittings for GI pipes shall be either galvanised wrought iron or galvanised malleable iron.

#### 19.3 PVC Pipes
Polythene unplasticised pipes be procured from reputed and approved manufacturer and shall have marking in colour in accordance with relevant Indian Standards.

##### 19.3.1 Fittings for PVC Pipes
These fittings shall be special flange compression fittings such as Alka Fan Fittings manufactured by ICI or other equivalent. Tee's, elbows, cross and reducers shall be provided with male & female joints.

##### 19.3.2 Fittings for unplasticized PVC pipes
The fittings shall be injection mould and/or fabricated type.

#### 19.4 R.C.C Asbestos, Prestressed Pipes and Fittings
These shall be of approved manufacture and quality and shall conform to relevant IS.

#### 19.5 Cast Iron Pipes and Fittings
The cast iron pipes and fittings shall be of approved manufacture and quality and shall conform to IS: 1537 for pipes and IS: 1538 for fittings.

#### 19.6 Steel Pipes
This shall conform to IS: 1239 & 3589. Steel pipes shall be coated with bituminous...
19.7 Bib Tap and Stop Tap
Bib tap and stop tap for water services shall be of brass screw down type and shall conform to IS: 781. Minimum finished weight of bib and stop taps shall be as given below:

<table>
<thead>
<tr>
<th>No. of size (mm)</th>
<th>Bib tap (kg)</th>
<th>Stop tap (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0.30</td>
<td>0.35</td>
</tr>
<tr>
<td>15</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>20</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>25</td>
<td>1.25</td>
<td>1.30</td>
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<tr>
<td>32</td>
<td>-</td>
<td>1.80</td>
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<tr>
<td>40</td>
<td>-</td>
<td>2.25</td>
</tr>
<tr>
<td>50</td>
<td>-</td>
<td>3.85</td>
</tr>
</tbody>
</table>

The taps shall be tested under internal hydraulic pressure of at least 20 kg/cm² and maintained at the pressure for a period of at least two minutes during which period it shall neither leak nor sweat.

19.8 Valves
Unless otherwise mentioned in the Schedule of Quantities these shall be of gun metal fullway valves of medium type and shall be of approved manufacture. These shall conform to relevant Indian Standard Specifications.

19.9 Storage Tank
Storage tank shall be either pressed steel, Galvanised iron, R.C.C or PVC of specified sizes, capacities, make, manufacture as specified in Schedule of Items. It shall have facilities for connecting inlet, outlet overflow and washout pipes and a top cover. Where tanks are to be fabricated by the Contractor the fabrication/R.C.C detailed drawings shall be got approved by Engineer.

20.0 EXTERNAL WATER SUPPLY, SEWERAGE & DRAINAGE

20.1 C.I. Pipes
Unless otherwise specified CI Pipe and specials, caulking lead, SW Pipe, RCC pipe shall conform to the following:-

i) CI pipe shall conform to IS: 1536 to 1537

ii) CI pipe fittings shall conform to IS: 1538.

iii) CI specials shall be of similar specification as specified for fittings in IS: 1538.

iv) Bolts and nuts shall be hexagonal bolts and nuts conforming to IS: 1363.

20.2 Washers
Spring washers conforming to latest edition of IS: 3063 shall be used near the pumps to take care of vibration. In other places plain washers conforming to IS: 2016 shall be used.
20.3 Gaskets
Gaskets shall be reinforced rubber sheet conforming to IS: 638.

20.4 Caulking Lead
All the spigot and socket joints shall be caulked by lead conforming to IS: 782.

20.5 Salt glazed stoneware pipes shall conform to IS: 651 and shall be laid as per IS: 3114.

20.6 CI pipes used for sewerage, under roads and other places shall conform to IS: 1536, and shall be laid as per IS: 31.

20.7 Steel pipes used for encasing shall conform to IS: 1239 and IS: 3589.

20.8 Cast iron manhole covers shall conform to IS: 1726.

20.9 Steel reinforcements shall conform to IS: 432.

20.10 RCC pipes used shall conform to IS: 458 and shall be laid as per IS: 783.

21.0 ROAD

21.1 General
Roads shall be understood to include road bed, the wearing surface, berms, foot-paths, kerbs, culverts and bridges.

21.2 Soling Stones
Material for soling shall be natural stone boulders or crushed blast furnace slab. Stone boulders shall consist of materials of uniform quality in sizes between 150 mm to 230 mm with total length not exceeding 300 mm. No stone shall weigh less than 3.5 kg. Stones shall be tough, angular, durable and generally free from flat, elongated, soft and disintegrated particles. They shall also be free from dirt or other objectionable matter and be obtained from quarries approved by the Engineer.

Crushed slag obtained from air-cooled blast furnace slag shall be angular, of reasonably uniform quality and density and generally be free from any thin, elongated, and soft pieces, dirt or other objectionable matter. The density of slag should not be less than 6.12 gm/cc and glassy material shall not exceed 20%. Water absorption when determined in accordance with IS: 2386 (Part-III), "Methods of Tests for Aggregates for Concrete: Specific Gravity, Density Voids, Absorption and Bulking", shall not exceed 10%.

21.3 Coarse Aggregate for Water Bound Macadam
Coarse aggregate for water bound macadam shall be natural gravel, crushed stone obtained from approved quarries or crushed blast furnace slag. Crushed stone shall be hard, durable, tough and of uniform quality, generally free from flat, elongated, soft and disintegrated particles. It shall have sharp edges and also not have excess of dirt and other objectionable matter. When tested as per IS: 2386 (Part-IV) for Los Angeles Abrasion Value or Aggregate Impact Value, the limiting values shall be 50% and 40% respectively for base course and 40% and 30% respectively for surfacing course. The flakiness index shall not exceed 15% when tested in accordance with IS: 2386 (Part-I)
"Methods of Test for Aggregates for Concrete : Particle size and Shape". Crushed slag aggregates shall meet the requirements given for soling stones from blast furnace slag.

Size and grading requirements of coarse aggregates shall be as specified in Table-2 of IRC 19, "Standard Specification and Code of Practice for Water Bound Macadam". The grading number of the table shall correspond to the following layer thicknesses:

<table>
<thead>
<tr>
<th>Grading Number</th>
<th>Size Range</th>
<th>Layer Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>90 mm to 40 mm</td>
<td>More than 90 mm</td>
</tr>
<tr>
<td>2.</td>
<td>63 mm to 40 mm</td>
<td>90 mm to 75 mm</td>
</tr>
<tr>
<td>3.</td>
<td>50 mm to 20 mm</td>
<td>75 mm to 50 mm</td>
</tr>
</tbody>
</table>

21.4 Screenings

Screenings used for filling voids in coarse aggregates for water bound macadam shall generally be of the same material as the coarse aggregate. Non-plastic materials such as Kankar nodules, moorum or gravel (other than river bore rounded aggregates) may be used, provided that the liquid limit and plasticity index are below 20 and 6 respectively. The fraction passing 75 microns sieve shall not exceed 10%. Size and grading of screenings shall be as specified in Table-3 of IRC-19. Type-A screening shall be used for grade number 1 coarse aggregate. Type-B screenings shall be used for grade number 3. Either Type-A or Type-B screenings may be used for grade number 2.

21.5 Stone Chips for Bituminous Surfacing

Course aggregate shall consist of crushed stone, crushed slag or crushed gravel (Shingle) retained on 2.36 mm sieve. The aggregates shall be clean, strong, durable and fairly cubical fragments free from disintegrated pieces, organic and other objectionable matter. The aggregates shall preferably by hydrophobic and of low porosity. The mechanical properties and grading shall be in accordance with IRC-29 "Tentative Specifications for 4 cm Asphaltic Concrete Surface Course", having aggregate inspect value 30%, Flakiness Index 25% and graded between 20mm and 2.36 mm.

21.6 Sand

Sand for use as fine aggregate in bituminous surfacing shall consist of crushed screenings, natural sand or a mixture of both, passing a 2.36mm sieve and retained on 75 micron sieve. It shall be clean, hard, durable, uncoated and dry, free from injurious, soft or flaky pieces and organic deleterious substances.

21.7 Binder

Binding material for water bound macadam shall consist of fine grained material such as stone dust, kankar modules or moorum. The plasticity index shall be between 4 to 9 when water bound macadam is to be used as surface course and upto 6 when used as sub/base or base course. Binder for bituminous surfacing shall be bitumen conforming to IS: 73, of grade 80/100 for tack coat and grade 30/40 for premixing.

21.8 Materials for Cement Concrete Roads
<table>
<thead>
<tr>
<th>Title: Civil Works – Terminals</th>
<th>Specification No.: MEC/S/05/11/01</th>
<th>Revision: 0</th>
</tr>
</thead>
</table>

Materials for cement concrete in concrete roads shall conform to the relevant specifications under "Concrete" of this series, with the additional requirement that the Los Angeles Abrasion Value of Coarse Aggregates Shall not exceed 35%. The size and grading of aggregates shall conform to the requirements of IRC : 15.

### 21.9 Kerbs

Kerbs may be of stone, concrete or brick as may be shown in drawing or otherwise directed by Engineer.

#### 21.9.1 Stone kerbs

Stones shall conform to the dimensions and shapes given in drawing. Exposed faces shall be dressed two lines.

#### 21.9.2 Concrete kerbs

Shape and dimension shall conform to the drawing. They shall be precast and the roadside top corner shall be given a chamfer.

### 22.0 MATERIALS NOT SPECIFIED

Any materials not fully specified in these specification and which may be offered for use in the works shall be subject to approval of Engineer, without which it shall not be used anywhere in the permanent works.
<table>
<thead>
<tr>
<th>TITLE</th>
<th>CIVIL WORKS – TERMINALS</th>
<th>SPECIFICATION NO.</th>
<th>Page</th>
</tr>
</thead>
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<tr>
<td></td>
<td></td>
<td>MEC/S/05/11/01</td>
<td>48</td>
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<th>Section</th>
<th>Description</th>
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<tbody>
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<td>Scope</td>
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<tr>
<td>8.2</td>
<td>Materials</td>
</tr>
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<td>General</td>
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<td>Sub-base</td>
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<td>8.6</td>
<td>Brick Flooring</td>
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<td>Cement Concrete Flooring with Integral Finish</td>
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<td>8.8</td>
<td>Concrete Flooring with Granolithic Finish (Artificial Stone Flooring)</td>
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<td>8.9</td>
<td>Dado &amp; Skirting Work (Grey Cement Skirting/Dado)</td>
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<td>Terrazzo Flooring &amp; Facing</td>
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1.0  GENERAL

1.1  Standard

A high standard of workmanship in all trades will be required. The Contractor shall ensure that only skilled and experienced workmen are employed.

1.2  Supervision

The Contractor's supervising staff shall be fully qualified and experienced in the types of work being carried out under the supervision and shall be capable of ensuring that they are done well and efficiently.

1.3  Temporary works

Where required, the Contractor shall furnish such details of his temporary works as may be called for by the Engineer and the Contractor shall satisfy the Engineer as to their safety and efficiency. The Engineer may direct that temporary works, which he considers unsafe or insufficient, shall be removed and replaced in a satisfactory manner.

1.4  Codes

Unless mentioned otherwise, current versions of all codes, specifications and standards issued by the Indian Standards Institution and Indian Roads Congress, wherever mentioned, shall be fully applicable to these specifications. Where standards are not yet published by the ISI or IRC, adaptable British Standards or Specifications of the International Organization for standardization shall apply.

In case of any conflict in meaning between these specifications and those of ISI or IRC, the provisions of these specifications shall prevail.

1.5  Base lines and bench marks

The Contractor shall establish and maintain, to the satisfaction of Engineer, the base lines and bench marks, based on which the works are set out. Where such base lines and bench marks are provided by the Engineer, the Contractor shall maintain these throughout the period of construction without causing any disturbance to them.

1.6  Setting out

The Contractor shall set out all the works to be executed by him, in line with the standard base lines, levels, position and bench marks and truly as per drawings within the accepted tolerance limits at no extra cost to Owner. The Contractor shall be solely responsible for the setting out of all the works, to be executed by him and the approval of such setting out by the Engineer shall in no way absolve the Contractor his responsibility for carrying the work to the true lines, levels and positions as per drawings.

1.7  Dewatering

The Contractor shall carryout all the works, in dry and workable condition and maintain the same in dry condition till the final handing over of works at no extra cost to the Owner. For this the Contractor shall make all the necessary provisions of dewatering, wherever necessary, to the entire satisfaction of the Engineer.
1.8 Safety of existing work

Before taking up any construction adjoining other property or existing work, the Contractor shall take all steps necessary for the safety and protection of such property or work.

1.9 Protection of existing services

The Contractor shall take all precautions necessary to prevent damage to or interference with underground or overground services such as cables, drains, piping or piles, whether shown on drawings or not. Equipment etc., mounted in position shall be protected against falling debris etc., by means of tarpaulin or such other material.

1.10 Handing over of work site

On completion of work, the Contractor shall remove all rubbish, debris, surplus materials, temporary work etc., from the site. The site shall be handed over in a tidy and workmanlike manner.

2.0 EARTH WORK

2.1 Scope

This chapter deals with earth work and excavation for civil works in site, formation/oversite leveling, foundations, cutting and grading for roads/pavement and railways, canals, embankments other than water retaining embankments trenching for drainage and other buried services and the like.

2.2 General

The Contractor shall carry out the excavation strictly to the lines and levels, in conformity with the drawings or instructions of the Engineer.

2.3 Setting out

Before commencement of earthwork block levels of existing ground shall be taken by the Contractor jointly with the Engineer plotted and signed in token of acceptance of ground levels. Excavation shall not be commenced until the initial ground levels have recorded and accepted. Reference lines, bench marks and base lines shall be set out by the Contractor for control of earthwork operation. Setting out shall be done with pegs, blocks, bamboo poles or rails marking boundaries or center lines, as the case may be, and the same maintained for reference and future checking Chainage stones at regular intervals shall be set up for embankments. All setting out operations shall be got checked and approved by Engineer. However, such checking and approval by the Engineer shall in no way absolve the Contractor of his responsibilities for carrying out the work to the true lines, levels and positions as per drawing, and in case any error is noticed at any stage in the contractor's work, it shall be corrected/rectified by him without any cost to the Owner.

2.4 Site clearance and demolition

The site shall be cleared of all trees, stumps, roots, brush wood, bushes and other objectionable materials. Useful and saleable material shall be the property of the Owner.
and shall be stacked properly as directed by the Engineer. The areas to be covered with embankments shall be stripped of top soil to required depths to expose acceptable founding strata. Top soil unsuitable for use in embankment construction and other fills shall be disposed off as directed. All combustible materials shall be stacked and burnt in locations sufficiently remote to eliminate all danger of fire hazards. All old concrete, brick works and drains which interfere with construction works shall be dismantled with the approval of the Engineer taking all necessary precautions prescribed in safety specification. Top soil which is suitable for use in construction work shall be stockpiled for later use. Other objectionable materials such as trash, debris, stones, brick, broken concrete, scrap metal etc., shall be disposed off as directed by the Engineer. Payment for cutting and removal of trees, stumps, dismantling existing structures and stripping shall be regulated by the description in the Schedule of Items or Part V of these specifications.

2.5 Classification of soil

The Engineer will decide the classification of any particular soil. Classification of soil shall be as under:

A) Ordinary Soil

Soils which yield to ordinary application of pick and shovel, phawra rake or other ordinary digging implements without offering much resistance, shall be classified as ordinary soil. This includes organic soil, turf, sand, gravel, loam clay, mud, peat, black cotton soil, soft shale and loose morn.

B) Hard Soil

This comprises of all soils that cannot reasonably be excavated by the above mentioned digging implements, but can be excavated with close application of pick axe or scarifiers or jumpers to loosen. This includes compact moorum, stiff clay, hard shale, cobble stone etc.,

C) Soft, Rock/Decomposed Rock

This comprises of rock or boulders which may be quarried or split with crow bars, pavement breakers etc., This include lime stone, sand stone, weathered rocks and hard conglomerates, and existing structures embedded in earth and tarred macadam roads, pavements, met in the excavation. The fact that contractor resorts to blasting for his own reasons shall not mean that the rock is hard and classified as hard rock.

D) Hard Rock

This comprises of rocks which require blasting for excavation, but where blasting is prohibited and excavation has to be carried out by chiseling, wedging or such other agreed methods.
2.6 Method of excavation

The Contractor may carry out excavations, filling and compaction by any method considered most suitable, and befitting the site conditions subject to any stipulations contained in the contract and the specifications. All excavations shall be required to be kept completely free from water, from whatever source it may come, for all during the construction. No foundation work shall be taken up until the surfaces are properly drained.

2.7 Excavation of soils other than hard rock

Excavation shall be carried out in the most expeditious and efficient manner to the lines and levels as indicated in drawings or as directed by Engineer. Prior approval of the Engineer shall be taken for the method to be adopted for excavation including dimensions, side slopes, dewatering, shoring etc., Such approval shall not make the Engineer responsible for any consequent damage or loss caused. All precautions shall be taken to preserve the material below and beyond line of excavation in soundest condition. All damages done beyond limits of excavation shall be made good by the Contractor at his own cost in a manner approved by the Engineer. All excavated materials shall be removed to spoil heaps, dumping yards or transported for filling as may be necessary. When soil heaps are formed for future use, heaps shall be protected from washing away due to rain or surface run off. The sides of excavation shall be maintained in stable condition by adequate steppings and batter. To prevent entry of surface water and accumulation of subsoil water in excavated areas, suitable drainage arrangements as may be needed and directed by Engineer, shall be provided and maintained. Pumped out water shall be drained off properly avoiding damage to other existing works. If any pipelines, cables or service lines are likely to exposed, excavation around these services shall be carried out manually and all such services shall be adequately supported and protected.

Excavation shall be carried out in any material encountered including road surfaces, pavements, buried parts of old foundations, pits or other structures. Excavated materials shall be placed beyond 1.5 meters of the edge of the excavation pit/trench or half the depth of the pit/trench whichever is more or further away as directed by the Engineer. Sumps made for dewatering must be kept clear of the foundations.

2.8 Excavation in hard rock

Where hard rock is met and blasting is considered necessary for its excavation, the Contractor shall intimate the Engineer in writing. Excavation in hard rock shall be done either blasting or chiseling or by such other agreed methods as may be required. Levels of hard rock surface shall be taken and got approved by Engineer before start of excavation. Blasting shall be permitted only when proper precautions are taken for protection of persons, works and property. The Contractor shall obtain the necessary license for procuring, storing and using explosives.

Blasting operations shall be carried out by a licensed Blaster. The quality and quantity of explosives, size and spacing of holes depth of holes etc., shall be such that they will neither open seams nor damage or shatter the rock beyond the specified lines of excavation. A tolerance of 150 mm will however be allowed beyond the excavation lines. As excavation approaches final stages, the depth of holes and the amount of explosives used shall reduced progressively to avoid over breakage or damage to founding strata. Any fissures, cracks and voids below prescribed depth of excavation shall be corrected.
by removing loose pieces, shattered or affected rock and replaced by lean concrete of M-5 grade in the case of foundations. Where excavated surface is to receive structural concrete, the surface shall be cleaned of dust and other objectionable materials.

In cases where blasting, though otherwise required, is prohibited because of any reason, the excavation shall be carried out by chiseling, wedging or such other agreed methods. All materials excavated from blasting, chiseling or any such methods shall be stacked for measurement as directed by Engineer.

2.9 Cutting and filling for site leveling

Excavation and filling operations for site leveling shall be so planned and executed, that transportation and re-handling are minimized. The sides of excavation and fills shall be maintained in stable condition by adequate batters, steppings and dewatering. Materials not desirable shall be disposed off in area indicated by Engineer. When it is required to blend the material, it shall be done by selective excavation and filling operation. Wells, ponds, cesspools and water logged areas shall be emptied of water and de-slushed before filling. Filling shall be done in horizontal layers not exceeding 150 mm in thickness. All clods shall be broken before placing the fill. Earth moving equipment shall be allowed to ply over the fill to permit compaction. Adequate allowance shall be made for subsidence of fill material. Levels shall be taken and excess or shortfall shall be made good by appropriate cutting or filling.

2.10 Excavation for trenches

Excavation for trenches shall be carried out in materials excavated to enable laying of service lines or drainage channels or any other desired purpose. Excavation shall be done to lines and levels shown in drawings and shall be done providing adequate measures for stability. Vertical wooden reapers or light rails shall be erected at uniform levels at places where changes of direction and gradients occur. Center lines shall be marked on horizontal repress or rails, laid across the trenches. Depths of excavation and pipe invert levels shall be checked by means of boning rods of appropriate lengths. Trench beds shall be trimmed and rammed with sprinkling of sand or moorum to required gradients for continuously supporting the pipelines. Trenches shall be locally deepened and widened to receive sockets and permit joints to be inspected.

2.11 Excavations for foundations

Excavation for foundation shall be done to the lines and levels indicated in the drawings. Excavated material shall be transported and stored at convenient spots for reuse in back filling of foundations and other fills. Surplus material shall be spread and levelled at dumping areas. Side slopes of excavation and/or shoring shall be adequate from consideration of stability and working space. When so required and authorized by Engineer, the sides of excavation shall be protected with proper shoring, strutting, sheeting and sand bags etc., These shall be removed only when work in the pit is completed, with the approval of the Engineer. When it is felt that removal of supports may result in side collapse or settlement of adjoining ground or endanger adjoining structures and foundations, they shall be left permanently in position. The last 150 mm of excavation shall be done and the bottom trimmed to the required levels only when concreting is imminent. If at any point the natural ground is disturbed or loosened for any reason, it shall be consolidated by tamping or rolling or made up with concrete of M-5 grade, if so ordered by the Engineer. Where the soil encountered at depths indicated in drawings is loose or weak, it shall be further excavated to levels of firm strata as may be
directed by the Engineer and filled with lean concrete of M-5 grade. If the bottom of excavation has been left exposed not through neglect or fault of the Contractor and it has become deleteriously affected by atmospheric action and water, such portion of deteriorated foundation material shall be removed and made good by lean concrete of grade M-5, such extras will be paid for.

2.11.1 For deep excavation in the proximity of existing buildings, foundations, streets, railway tracks, underground cabling, gas piping, water and drainage lines, and the like, adequate appropriate precautions shall be taken to protect such structures or works from damage, displacement or settlement, either as an immediate result of the excavation or as after effect, discernable with the passage of time. The method of protection of existing structures and services may include sheet piling, shoring, strutting slinging or any other method including dewatering. Payment for such protective work shall be governed by the description given in the Schedule of Items for the particular work.

2.11.2 For excavation adjoining existing piles care shall be taken to ensure that no pile under any circumstances is exposed from the top for a height exceeding 2 meters. No strutting shall be done against exposed piles, nor exposed piles ever used for tying guy ropes or supports either temporarily or permanently.

2.12 Excess excavation

All excavation done beyond the specified limits or directions of Engineer shall be considered as excess excavation. They shall be made good as prescribed below by the Contractor at his cost:

i) Excess excavation in case of site leveling shall be made good by filling and compacting with material same as the surrounding material. Degree of compaction shall be at least the same as the surrounding material.

ii) Excess excavation in case of trenches shall be made good by filling and compacting with selected earth to the same compaction as the surrounding material or as directed by Engineer. This shall be done in layers not exceeding 150 mm thick, moistened and thoroughly compacted by tamping.

iii) Excess excavation in case of foundation beyond required depths shall be made good by filling with lean concrete of M-5 grade.

2.13 Disposal of excavated materials

Excavated materials that are unsuitable for use in construction works or in excess of construction requirements shall be disposed off in dumping yards or in locations indicated by Engineer. Waste piles/heaps shall be located in such places where they will not interfere with natural flow of rain water access or transport or with the access to nearby structures. When required, they shall be levelled and trimmed to such lines and levels as indicated by Engineer.

2.14 Back filling of trenches

Trenches shall be backfilled after pipes or service lines are tested and approved. Filling shall be done with earth in 150 mm thick layers free from unwanted material and well
rammed. Soft material shall be used in bottom of trenches up to a level of 150 mm above the top of pipes before backfilling with other fill materials. All clods and lumps shall be broken before placement. Care shall be taken not to disturb, break or damage the pipes during backfilling and compaction process.

2.15 Backfilling of foundations

Backfilling of foundations shall be done using suitable soils from excavations. Soil shall be free from organic matter and other materials which would affect the stability of the fill and shall be free from boulders, brick bats wood pieces and other injurious materials, lumps and clods. Before commencement of backfilling of foundations, all shoring and formwork, bits of timber, cement bags and all other rubbish shall be removed. Hydro-insulation, Bitumen painting or application of anti-corrosive protective and anti-termite treatments shall have been completed. Backfilling operation shall not commence without approval of Engineer. Backfilling shall be carried out in well compacted layers of 150 mm thickness. Each layers shall have near optimum moisture content. Layers will extend to the entire width of excavation and shall be sprinkled with water during compaction process. Ramming shall be done to achieve firm compaction. Backfill shall be trimmed and finished to lines and levels indicated in the drawings and/or as directed by the Engineer.

2.16 Filling under floors

Material for filling under floors shall be soil free from harmful minerals, vegetable matter etc., and shall not be expansive soils. Filling shall be done in well compaction layers not exceeding 150 mm in thickness. Each layer shall be compacted to 95% Standard Procter Density. Sufficient soaking shall be done before compaction. The entire area to be covered by flooring shall be finally dressed and trimmed to required levels.

2.17 Load bearing fills

Load bearing fills include embankments for roads and railways and such other earth fills above ground levels provided for protection of fuel oil tanks, pads for storage tanks, drain bunds and the like.

Fill materials shall either be selected earth obtained from excavations for site leveling, trenches and foundations or from selected borrow areas as may be required. Soils selected for filling in embankments shall be of uniform quality and free from boulders, organic materials and other objectionable matter. Soils having high silt and clay content and having laboratory maximum dry density less than 1.44 gms per c.c. shall not be used for load bearing fills. For fills greater than 3 m in height soils shall have laboratory density not less than 1.52 gms per c.c. Soils for top 500 mm of fills for roads and railways shall have laboratory density not less than 1.65 gms per c.c. and shall not have marked settling and shrinkage properties.

Foundation preparation for embankments shall be done as prescribed under site clearance. The founding strata shall be compacted as much as possible by rolling or tamping before placement of fill material. The water content of founding strata should be same as that specified for embankment fill. Any pockets of loose material or depressions left in founding strata as a result of clearing operation shall be filled and compacted with the same material as the surrounding founding strata. When an embankment is to be placed on steep sloping ground the surface of the ground shall be trenched in steps or trenched or broken up in such a manner that the new materials bonds well with the
foundating strata.

Fill material shall not be placed until foundation has been inspected and approved by Engineer. Material shall be placed in even, continuous, horizontal layers over full width of embankment in well compacted layers not exceeding 200 mm thickness. Each layer shall be compacted by means of smooth rubber tyred rollers, sheep-foot rollers, tractors, tampers or other mechanical means as may be found suitable for the location. Before rolling the water content shall be checked and corrected by sprinkling with water or adding dry material or aeration as may be required. This shall be followed by mixing and the layer left for soaking before compaction. The water content shall be within plus or minus 2% of Standard Proctor Optimum. Density of compacted layers shall be determined by sand replacement method. Average compacted density shall be at least 95% of Standard Proctor Density. The number of tests to be conducted for determination of moisture content and density shall be as provided by the Engineer.

Side slopes of embankments shall be formed alongwith the main embankment. No side dumping shall be done for the formation of slopes. When required the width of each layer shall be constructed slightly in excess of required width and slopes trimmed to remove loose edge materials and completed to lines shown in drawings or as directed by the Engineer.

Subgrade for road works shall be thoroughly wetted sufficiently in advance of placing of any base course and it shall be ensured that it is firm and moist for at least 50 mm below the surface. Should the subgrade for any reason be loose or have density less than required, it shall be re-compacted and refinished. Excessive loss of moisture in the subgrade shall be prevented by sprinkling and/or scaling. No traffic or hauling equipment shall be permitted to play on finished subgrade and any damage caused to such portion shall be made good by the Contractor at his own cost.

2.18 Turfing

The slopes of embankment shall be dressed to line and slightly roughened to bond and hold a surface dressing consisting of 150 mm humus layer of soil. The entire surface shall then be covered with turf consisting of blocks or strips of grass of approved species. The sod shall include a net of roots and earth at least 75 mm thick. The sod shall be laid on slope in close contact and then tamped in place so as to close and fill the joints between blocks.

Immediately after placing the turfed slope shall be thoroughly wetted and kept wet for a sufficient period to assure plant growth. Watering shall be continued until the grass taken root firmly and the whole area presents a uniform appearance. In the event that the plant growth has not taken place within the period of maintenance such areas or patches shall be redone by the Contractor at his own cost.

3.0 ANTI-TERMITE TREATMENT

3.1 Scope

The scope of work includes setting up a chemical barrier against attack by subterranean
termites while the building is under construction.

3.2 Execution

3.2.1 General

All work shall in general be executed as specified in IS: 6313 Part-II and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

3.2.2 Chemicals and rate of application

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

<table>
<thead>
<tr>
<th>Chemicals</th>
<th>Concentration by weight, percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dieldrin</td>
<td>0.5</td>
</tr>
<tr>
<td>Heptachlor (IS:6439 -1972)</td>
<td>0.5</td>
</tr>
<tr>
<td>Aldrin (IS: 1308 -1964)</td>
<td>0.5</td>
</tr>
<tr>
<td>Chlordane (IS: 2632 -1966)</td>
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</tr>
</tbody>
</table>

3.2.2.1 Treatment of pits, trenches and basement excavations

Foundations, basements etc., may either be fully enveloped by the chemical barrier or the treatment may start 500mm below ground level. The bottom surface and sides of excavation (upto a height of about 300 mm) for column pits, walls, trenches and basements shall be treated with chemicals at the rate of 5 litres per sqm of surface area. Backfill around columns, walls, etc., shall be treated at the rate of 15 litres per sqm of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150mm centres close to the wall surface and spraying the chemicals in the specified dose.

3.2.2.2 Treatment of top surface of plinth filling

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crow-bars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres per sqm of surface shall be applied prior to laying soling or subgrade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

3.2.2.3 Treatment of doors, windows & soil surrounding pipes, Wastes and conduits

Special care shall be taken at the points where pipes and conduits enter the building and
the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building. All the wooden door/window frames on the ground floor of the buildings shall be treated with the insecticide solution.

3.2.2.4 Treatment of expansion joints

These shall receive special attention and shall be treated in a manner approved by the Engineer.

3.3 Acceptance Criteria

The Contractor shall give a 10 year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialized agency for the job to keep the building free of termites for the specified period at no extra cost to the Owner.

4.0 CONCRETE PLAIN & REINFORCED

4.1 Scope

This chapter covers the workmanship, special requirements & regulations with which the contractor must comply to achieve the following two objectives:

(a) The provision, at all locations on the site, of dense workable concrete, having the specified characteristic strength.

(b) The placing of concrete at all elevations, well compacted by vibrations, in well aligned and well fixed formwork ensuring the internal and external dimensions of structures as per drawings and maintaining the size, shape number and locations of reinforcements, inserts etc., as specified in the drawings providing the surface finish after stripping off the formwork to ensure the structural configurations as per drawings as well within the specified tolerance limits, curing and guaranteeing the characteristic strength, all as specified.

4.1.1 The mixing, placing, compacting, curing and finishing of concrete shall be done according to IS: 456 "Code of Practice for Plain and Reinforced Concrete".

4.2 Materials

For materials reference to Part-I (Materials) shall be made.

4.3 Grades of Concrete

The grades of concrete shall be in accordance with the following table. The grade of concrete to be used in each section of work will be shown in the drawings or in the schedule of items:

<table>
<thead>
<tr>
<th>GRADE OF CONCRETE</th>
<th>CHARACTERISTIC STRENGTH i.e. COMPRRESSIVE STRENGTH OF 15 CMS CUBES AT 28 DAYS (N/mm²)</th>
<th>NOMINAL MAX. AGGREGATE SIZE (mm)</th>
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</thead>
<tbody>
<tr>
<td>M-5A (Lean Concrete)</td>
<td>5</td>
<td>63</td>
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<tr>
<td>GRADE OF CONCRETE</td>
<td>CHARACTERISTIC STRENGTH i.e. COMPRESSIVE STRENGTH OF 15 CMS CUBES AT 28 DAYS (N/mm²)</td>
<td>NOMINAL MAX. AGGREGATE SIZE (mm)</td>
</tr>
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<td>-------------------</td>
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<td>----------------------------------</td>
</tr>
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<td>M-7.5A (Lean Concrete)</td>
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</tr>
<tr>
<td>M-7.5B (Lean Concrete)</td>
<td>7.5</td>
<td>40</td>
</tr>
<tr>
<td>M-10 A</td>
<td>10</td>
<td>63</td>
</tr>
<tr>
<td>M-10 B</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>M-10 C</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>M-10 D</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>M-15 A</td>
<td>15</td>
<td>63</td>
</tr>
<tr>
<td>M-15 B</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>M-15 C</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>M-15 D</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>M-20 A</td>
<td>20</td>
<td>63</td>
</tr>
<tr>
<td>M-20 B</td>
<td>20</td>
<td>40</td>
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<tr>
<td>M-20 C</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>M-20 D</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>M-25 C</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>M-25 D</td>
<td>25</td>
<td>12</td>
</tr>
<tr>
<td>M-30 C</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>M-30 D</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>M-35 C</td>
<td>35</td>
<td>20</td>
</tr>
<tr>
<td>M-35 D</td>
<td>35</td>
<td>12</td>
</tr>
</tbody>
</table>

**Notes:**
- A, B, C, D mentioned along with grade of concrete correspond to the maximum size of coarse aggregates being 63mm, 40mm, 20mm and 12mm respectively.
- Unless otherwise specified in the drawings or schedule of items the maximum nominal size of coarse aggregates for different grades of concrete shall be as under:

(a) For concreting in very narrow space or in very small thickness .. 12 mm

(b) For all reinforced concrete work except in massive foundations .. 20 mm
(c) For all ordinary plain concrete and massive reinforced foundations .. 40 mm

4.4 Mix Design

4.4.1 General

At the commencement of the contract the Contractor shall make preliminary tests to determine the proportions by weight of cement, fine aggregates, coarse aggregates and water necessary to produce required grades of concrete. The mix proportions shall be selected to ensure that workability of the fresh concrete is suitable for the conditions of handling and placing and when concrete hardens, it shall have the required strength, durability and surface finish. The Contractor shall get approval of Engineer to such proportions before he starts concreting. However, such approval shall not relieve the Contractor of his responsibility to produce concrete having compressive strengths as laid down in the foregoing Table.

No departure from the approved proportions will be permitted during the works unless and until the Engineer gives written authorization for any change in proportion. The Engineer shall have authority at any time to check whether the mixing of concrete is being carried out according to the approved proportions.

4.4.2 For the all major and important R.C. works and for all special works, the design of mixes shall be made by the Contractor at his own cost, for each grade of concrete as well as for various workability. The design of mixes shall be made according to relevant I.S. codes or to approved standard methods.

4.4.3 The concrete made by designing the mix is termed hereinafter as "Design Mix Concrete".

4.5 Water/Cement Ratio

4.5.1 Where a particular water/cement ratio is stipulated in the design or drawing alongwith the characteristic grade of concrete the design of mix shall be carried out by adjusting the other variable factors to obtain the characteristic strength of concrete with stipulated water/cement ratio.

4.5.2 In the structures where the impermeability and shrinkage of concrete have an important bearing on the durability and serviceability of the structures, such as water retaining structures, basements, underground premises, tunnels, pump houses, exposed structures near sea side or deserts, prestressed structure, thin precast members etc., the water cement ratio shall be kept low and preferably not exceeding 0.45.

4.5.3 The water cement ratio, as achieved in the Mix Design, or as specified in the drawings shall be adhered to strictly and shall not be varied without the permission of the Engineer.

4.6 Workability

4.6.1 The workability of fresh concrete shall be such that the concrete is just suitable for the conditions of handling & placing so that after compaction if becomes completely consistent and homogeneously surrounds all the reinforcement and completely fills the formwork.
4.6.2 The workability of fresh concrete at the place of batching/mixing shall be measured by compacting factor test and at the place of disposition by means of slump test. During the finalization of Trial Mixes, the relationship between compacting factor and slump test shall be established for each grade of concrete as well as for various levels of workability.

4.6.3 Normally, in the condition of low water cement ratio as well as for medium/high workability, the workability shall be achieved by increasing the cement content.

4.6.4 In cases where the cement content is to be limited to reduce the heat of hydration, and the water/cement ratio is also to be kept low to reduce the permeability or due to other requirements the desired workability may be achieved with use of limited doses of plasticiser or air entraining agent. In such cases the method of mixing and dosage of the plasticiser/air entraining agent shall be according to the manufacturer's specification and with the approval of the Engineer.

4.7 Durability

The durability of concrete, depending on the exposure condition, is to be taken into account while designing the mix. For given aggregates, the cement content should be sufficient to make sufficiently low water cement ratio and Appendix A of IS: 456 shall be taken as guideline for durability considerations.

4.8 Trial Mixes

4.8.1 After approval of the Mix Design by the Engineer, the Contractor shall make in presence of Engineer the Trial Mixes for each grade of concrete as well as for required workability.

4.8.2 Before starting the trial mixes, necessary preparatory works like determination of sieve analysis of the aggregates, densities of different ingredients, moisture contents in the aggregates, shall be completed according to the relevant I.S. Codes.

4.8.3 Each trial mix shall be handled and compacted by the method which the Contractor proposes to use for that mix in the works and the mixes shall not show tendency of inadequate compaction by the method proposed.

4.8.4 The compacting factor and the slump of each trial mix shall be determined immediately after mixing and the values shall not exceed the maximum value obtained in the mix design.

4.8.5 Five numbers of 150 mm test cubes shall be made from each trial mix. These shall be cured and tested in accordance with relevant I.S. codes. In order to have the specified characteristic strength in the field, the concrete mix as designed in the Design Mix shall have higher average compressive strength depending on the degree of quality control at site.

4.8.6 Before commencement of the concreting works of particular grade of concrete, the Contractor must complete the work of trial mixes and subsequent testing of the test cubes obtained therefrom and the desire of the Approved Mix for that particular grade of concrete.

4.8.7 The entire cost of all the trial mixes including all the preparatory works for trial mixes, preparation of test cubes and their testing shall be borne by the Contractor.
4.9 Nominal Mix Concrete

4.9.1 Nominal mix concrete may be used for all concrete of Grade M-10 and below. If design mix concrete cannot be used for any reason for Grade M-15 & M-20, nominal mix concrete may be used with the permission of Engineer. Nominal mix concrete shall not be used, in any case for Grade of concrete above M-20.

4.9.2 The proportioning of materials for nominal mix concrete shall be in accordance with Table-3 of clause 8.3 of I.S. 456. The stipulations of Clauses 8.3.1 & 8.3.2 of IS: 456 shall also be taken into consideration.

4.10 Volumetric Mix Concrete

Where concrete is specified in volumetric proportions such as 1:4:8, 1:3:6, 1:2:4, 1:1 1/2:3, 1:1:2 etc., in the schedule of items, coarse and fine aggregates shall be measured by volume and cement by weight. The water cement ratio shall be within 0.45 to 0.70 depending upon the workability.

4.11 Batching of Concrete

4.11.1 Cement

Cement shall always be batched by weight. A separate weighing device shall be provided for weighing cement. Where the weight of cement is determined by accepting the weight per bag, number of bags shall be weighed separately to determine the average net weight of cement per bag and the same shall be checked regularly.

4.11.2 Aggregates

4.11.3 For both Design Mix concrete and Nominal Mix concrete, the aggregates (coarse and fine) shall be batched by weight.

4.11.4 In particular cases, or where weight-batching is not possible proportioning by volume batching may be allowed by the Engineer, provided the Contractor guarantees the uniformity of aggregates through out the period of construction. For this purpose, the Contractor shall submit to the Engineer sufficient data indicating the weight/volume relationship of aggregates for different types of concrete and after such approval, periodic checks on the weight/volume relationship of the aggregates shall be made by the Contractor to the satisfaction of the Engineer. Where aggregates are moist and volume batching is adopted, allowance shall be bulking in accordance with I.S. 2386 (Part-III).

4.11.5 Suitable adjustments shall be made for the variation in the weight of aggregates due to variation in their moisture contents.

4.12 Water

4.12.1 Water may be measured either by weight or by volume. When measured by volume, it shall be by well calibrated conical shaped jar or vessel or from a calibrated tank filled to the mixer.

4.12.2 Adjustment of water due to moisture contents in coarse and fine aggregates
It is very important to maintain the water cement ratio constant at its correct value. For the correct determination of amount of water to be added in the concrete mix, to maintain the water cement ratio constant, the amount of moisture content in both coarse and fine aggregates shall be taken into consideration, be as frequently as possible, the frequency for a given job being determined by the Engineer according to weather conditions.

4.12.3 Determination of moisture content in the aggregates

Determination of moisture content in the aggregates shall be according to I.S. 2386 (Part-III). Where tests are not conducted, the amount of surface water may be estimated from the following table:

<table>
<thead>
<tr>
<th>Aggregates</th>
<th>Surface water carried by Aggregates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% by weight</td>
</tr>
<tr>
<td>Very wet sand</td>
<td>7.5</td>
</tr>
<tr>
<td>Moderately wet sand</td>
<td>5.0</td>
</tr>
<tr>
<td>Moist sand</td>
<td>2.5</td>
</tr>
<tr>
<td>Moist gravel stone chips.</td>
<td>1.25 - 2.5</td>
</tr>
</tbody>
</table>

+Coarser the aggregate, less the water it will carry.

4.12.4 Admixtures

Any solid admixture, to be added, shall be measured by weight, but liquid or semi-liquid admixture may be measured by weight or volume.

4.12.5 Accuracy of batching

The accuracy of batching shall be within the following tolerance:

- Cement within plus or minus 2% by weight.
- Aggregate within plus or minus 5% by weight.
- Water within plus or minus 0.5% by weight.

4.13 Mixing & Transportation of concrete

4.13.1 Mixing of Concrete

4.13.1.1 Machine mixing

Concrete shall always be mixed in mechanical mixer. Water shall not, normally, be charged into the drum of the mixer until all other ingredients are already in the drum and mixed for atleast one minute. Mixing shall be continued until there is uniform distribution of materials and the mass is uniform in colour and consistency. The mixing time from the time of adding water shall in accordance with IS: 1791 but in no case less than 2 minutes or atleast 40 revolutions.
4.13.1.2  Hand mixing

When hand mixing is permitted by the Engineer it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand mixing 10% extra cement shall be added to each batch at no extra cost to the Owner.

4.13.2  Transportation of concrete

4.13.2.1  Concrete shall be transported from the place of mixing to the place of placing concrete as rapidly as practicable by means which will prevent the segregation or loss of any of the ingredients and maintain the required workability. No water shall be mixed with the concrete after it has left the mixer.

4.13.2.2  Where concrete is transported over long distances, the Contractor shall provide suitable means by which different grades of concrete are readily identifiable at the place of final deposit.

4.14  Preparatory Works/Surface Preparation

4.14.1  For concrete directly on earth foundation

4.14.1.1  Earth foundation on which direct placement of concrete is specified, shall be rammed and consolidated as directed by the Engineer such that it does not crumble and get mixed with concrete during or after placement. If the foundation is quite wet, the same shall be kept dry and then sufficiently consolidated, if necessary, a thin top layer of the wet soil shall be removed and replaced by sand or other suitable materials as directed by the Engineer without any cost to the Owner. Care shall also be taken that earth from the sides also does not get mixed with the concrete, during or after placement, before it has sufficiently set and hardened.

4.14.1.2  The earth foundation, over which concrete is to be placed direct, shall not be kept abandoned at the specified level and concrete shall be placed immediately following the final preparation of the formation otherwise suitable measures shall be taken, as directed by the Engineer without any cost to the Owner.

4.14.2  For construction joints

All such joints shall have continuous square bond grooves to produce a substantial and water-tight key. Where the placement of concrete has to be resumed on a surface which has hardened, it shall be roughened, cleaned by wire or bristle brushing, compressed air, water jet etc., and thoroughly wetted. For vertical construction joints a neat cement slurry shall be applied on the surface immediate before the placement of concrete. For horizontal joints the surface shall be covered with a layer of mortar about 10 to 15 mm thick composed of cement and sand in the same proportion as the cement and sand in the concrete mix freshly mixed and applied immediately before placing of the concrete. On this surface (i.e. on the surface of joints) a layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against old work, particular attention being paid to corners and close spots. To ensure water tightness, care shall be taken to punn concrete properly against the old surface.
4.14.3 On vertical surfaces of masonry

When the concrete is placed on the vertical surface of masonry (as in the case of thin concrete fins projected from the vertical masonry surface), a groove of dimension as directed by the Engineer shall be cut in the masonry to ensure a proper bond and the surface shall be cleaned thoroughly. Before the placement of concrete, the surface shall be kept moist by spraying water at least for the period of 2 hours and a thick coat of cement slurry shall be applied immediately before the placement of concrete.

4.14.4 Inside the formwork (cleaning, surface preparation etc.,)

The interior of the form works, where the concrete is to be placed, shall be thoroughly washed by high pressure water jet or air jet to completely clean the entire volume from all sort of dirt, grease/oil, foreign and deleterious materials etc. The reinforcement shall be completely clean and free from all sorts of dirt, grease/oil, rust, foreign/deleterious materials etc., Before placement of concrete, the form works coming in contact with concrete, shall be coated highly with form oil or raw linseed oil material or provided with any approved material to prevent adhesion of concrete to the form work, but utmost care shall be taken so that such oily material do not come in contact with the reinforcement.

4.15 Placing and Compaction of Concrete

4.15.1 The concrete shall be placed and compacted before setting commences and should not be subsequently disturbed. No water shall be mixed with the concrete after it has left the mixer. Method of placing should be such as to preclude segregation. Approved mechanical vibrator shall be used for compacting concrete, and concrete shall not be non-vibrated or under vibrated. No concrete shall be placed until the place of deposit has been thoroughly inspected and approved by the Engineer. all inserts and embedments properly secured in position and checked and forms properly oiled. No concrete shall be placed in the absence of the Engineer.

4.15.2 Concrete shall be placed on clean bed having the designed level. The bed shall be cleaned of all debris and other objectionable materials. Seepage water, if any, shall be controlled or diverted.

4.15.3 Concreting shall not be carried on during rains unless all precautions have been taken by the Contractor and necessary permission has been given by the Engineer. Suitable measures shall be taken to control the temperature of concrete.

4.15.4 Where plums are permitted is massive concrete, they shall be washed and carefully placed. No stone shall be closer than 30 cm to an exposed face, nor nearer than 15 cm to an adjacent stone.

4.15.5 Concrete shall not be dropped from a height of more than 2m except through a chute, the design and type of which shall be subject to approval of the Engineer.

4.15.6 The concrete shall be placed, spread and compacted by approved mechanical vibrator. Vibrators shall not be used for pushing concrete to adjoining areas.

4.15.7 For members involving vertical placing of concrete (e.g. columns, walls etc.), each lift shall be deposited in horizontal layer extending for the full width between shuttering and of such depth that each layer can be easily and effectively vibrated and incorporated with the layer below by means of compaction being employed.
4.15.8 For members involving horizontal placing of concrete (e.g. slabs, beams etc.,) the concrete shall be placed along the line of starting point in such quantities as will allow members to be cast to their full depth along the full width between side shuttering and then gradually brought towards the finishing point along its entire front parallel to the starting line. Vibration and surface finish shall follow behind the placement as closely as possible.

4.15.9 Utmost care shall be taken to avoid the displacement of reinforcements/embodied parts or movement of formwork or damage to faces of the formwork or transmission of any harmful vibration/shocks to the concrete which has not yet hardened sufficiently.

4.15.10 All members shall be concreted at such a rate that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable.

4.15.11 Should any unforeseen occurrence result in a stoppage of concreting for one hour or such other time as might allow the concrete, already placed, to begin to set before the next batches can be placed, the Contractor shall make at his own cost, suitable tongue, and groove construction joint, as approved by the Engineer. Any additional reinforcement required as directed by the Engineer shall also be provided by the Contractor at his own cost. Before placement of new batches of concrete over that construction joint, the surface preparation according to this specification stipulated earlier, shall be done by the Contractor.

4.15.12 The concrete shall be worked well up against whatever surface it adjoins and compacted to such a degree that it reaches its maximum density as a homogeneous mass, free from air and water holes and penetrates to all corners of moulds and shuttering and completely surrounds the reinforcement. All measures shall be taken to make the shape, size, and location of the finished concrete including its embedments, holes, openings etc., well within the accepted tolerance limit.

4.16 Construction Joint & Cold Joints

4.16.1 Construction joints

4.16.1.1 Normally, the construction joints including crank inducing joints shall be constructed as per locations and details indicated on the drawings.

4.16.1.2 Where the location of the joint is not specified in the drawings, it shall be in accordance with the following guide lines:

(a) In Columns

(i) In case of Projection from basement slab

300 mm from the top of base slab or 75 mm from the top of the haunches whichever is higher

(ii) In framing of beam at different elevation, 75 mm below the lowest soffit of the beam and in case of projection from beams and slabs 75 mm from the top surface of the beam/slab or at the top surface of beam/Slab whichever facilities formwork.
(iii) For columns below flat slabs 75 mm below the lowest soffit of the slab.

(b) In walls (horizontal construction joints)

(i) Walls projecting from base slab
300 mm from top of base slab.

(ii) Walls supporting the suspended slab
75 mm from the lowest soffit of the slab.

Note:- In the case of water retaining structures and structures under the influence of ground water, approved water bars of suitable size shall be provided to make the joint completely water-tight.

(c) In beams

Beams shall be cast, as a rule, without a joint. But if provision of a joint is unavoidable, the joint from simply supported beam shall be vertical and at the middle of the span in continuous beam, the same shall be at the point of minimum shear force.

(d) In suspended slabs

(i) In slab of small span, there shall be no construction joints.

(ii) In slabs of large span and continuous slabs, construction joint, if allowed by the Engineer shall be vertical at the middle of span and at the right angles to the principal reinforcement.

(e) In walls (Vertical construction joint)

As a rule, walls shall be cast monolithically without any vertical construction joint, unless specified in the drawing. However, for a long wall, the Engineer may allow vertical construction joint and the same shall be at the place of minimum shear force. In water retaining structures and in structures under the influence of ground water approved water bars of suitable size shall be provided to make the joints completely water tight.

(f) In slabs resting on ground

(i) For Plain concrete
Concreting shall be done in alternate panels not exceeding 10 sqm in area. The largest panel dimension shall be 5 m.

(ii) For nominally reinforced slab
The area of pour shall not exceed 40 sqm and the maximum panel dimension shall not exceed 8m.

(iii) For the basement slabs which act as structural member
There shall be no construction joint.

(g) In ribbed beam

The beams shall be cast monolithically with the slab in one continuous operation.

4.16.1.3 In all construction joints the reinforcements shall pass through as per drawings and the same shall not be disturbed in any way.

4.16.1.4 The vertical construction joints shall be provided by insertion of board keeping provision for passage of reinforcement/fixtures/embedments. All construction joints shall be made to form a tongue and groove joint.

4.16.2 Cold joint

An advancing face of a concrete pour, which could not be covered before expiry of initial setting time for unexpected reasons, is called a cold joint. The Contractor shall remain always vigilant to avoid cold joints. If however, a cold joint is formed due to unavoidable reasons, the following procedures shall be adopted for treating it:

(a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly over the old surface and the fresh concrete alongwith the old concrete shall be vibrated systematically and thoroughly.

(b) In case the concrete has hardened a bit more than (a), but can still be easily removed by a light hand pick, the surface shall be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. Then a rich mortar layer of 12 mm thickness, shall be placed on the cold joint and then the fresh concrete shall be placed on the mortar layer and vibrated thoroughly, penetrating deep in to the layer of concrete.

(c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise inspite of extensive vibration, a tongue and groove joint shall be made by removing some of the older concrete and the joint shall be left to harden at least for 12-24 hours. It will then be treated as regular construction joint and the surface preparation of the same, before placement of concrete, shall be as described in the appropriate clauses of these specifications.

4.17 Requirements for Concreting in Special Cases

4.17.1 Concreting in deep lifts

Placing of concrete in lifts exceeding 3 M in columns & 2 M in walls is in the category of deep lifts.

4.17.1.1 Before commencement of work, the contractor shall submit for the approval of the Engineer, the details of the methods he propose to adopt for concreting.

4.17.1.2 The placement of concrete shall preferably be by tremie chute or any other approved
### 4.17.1.3 In structures of heavy/complicated reinforcement or in complicated form works, the contractor shall provide sufficient number of windows in the form works as directed by the Engineer to check the placement and compaction of concrete in different stages. Such windows shall be closed as soon as the concreting reaches the bottom level of the same.

### 4.17.2 Concreting under water

When it is necessary to deposit concrete under water, the special requirements, over and above those of this specification shall be in accordance with Clause 13.2 of IS: 456.

### 4.17.3 Cold weather concreting

When conditions are such that the ambient temperature may be expected to be 4.5 C degree or below during the placing and curing period, the work shall conform to IS: 7861 (Part-II).

### 4.17.4 Hot weather concreting

When concreting in very hot weather the Contractor shall take all precautions as stipulated in IS: 7861 (Part-I) and stagger the work to cooler parts of the day to ensure that the temperature of wet concrete used, specially in massive structure, does not exceed 38 degree 'C'.

Positive temperature control by methods like pre-cooling, post cooling or cooling of concrete by circulating cold water through small embedded pipe lines inside concrete, if required, shall be specified and shall be undertaken.

### 4.17.5 Concreting in the area exposed directly along sea coast

The special requirements, over and above those of this specification shall be in accordance with clause 13.3 of IS: 456.

### 4.17.6 Concreting in large pours (mass concrete)

#### 4.17.6.1

The aim of controlling the concreting in large pours is to reduce cracking caused by shrinkage due to heat of hydration. The Contractor shall submit detailed proposal to the Engineer for approval about the method of pouring and the measures to reduce heat of hydration, which he proposes to adopt.

#### 4.17.6.2

The maximum height of lifts will depend on the type of cement used. The use of cement having low heat of hydration, could allow greater lifts.

#### 4.17.6.3

The Contractor shall provide all the necessary arrangements like precooling of aggregates, cooling of fresh concreting by passing cold water through pipes placed inside the concrete or such other measures at least 48 hours before the placement of concrete and also provide the facility for recording of temperature at least 24 hours prior to placement of concrete.

#### 4.17.6.4

The minimum interval between concreting of successive lifts, separated by horizontal construction joint, shall be six days or as directed by the Engineer.
4.17.6.5 The minimum interval between the concreting of adjacent pours separated by vertical construction joints shall be three (3) days, or as directed by the Engineer.

4.18 Finishes to Exposed Surfaces of Concrete

The Contractor is to include his quoted rate for concrete, the provision of normal finishes in both formed & unformed surfaces as and where required by the Engineer without any extra cost to the owner. Some common finishes are indicated below:

4.18.1 Surface which do not require plastering

Surface in contact with casings shall be brought to a fair and even surface by working the concrete smooth against casings with a steel trowel while it is being deposited and also by working over the surface with a trowel immediately after the removal of the casings or centerings, removing any irregularities and stopping air holes, etc. Use of mortar plaster is not permissible for correcting levels, removing unevenness etc. However, if, in the opinion of the Engineer, such plastering is unavoidable then the thickness of plaster shall in no case exceeds 5 mm and the plastering shall be in cement mortar (1:3).

4.18.2 Faces of foundations which will be back filled

Neither the smoothness of the surface nor the positions of the joints in the form work are important. Small blemishes caused by entrapped air are permitted. No special surface finish is required.

4.18.3 Exposed surfaces which need plastering

Surfaces of beams/columns flushing with the block work or other structures where is intended to plaster, shall be hacked adequately as soon as the shuttering is stripped off so that proper bond with the plaster can develop.

4.18.4 Surface for non-integral finish

Where a non-integral finish such as floor finish is specified or required, the surface of the concrete shall be struck off at the specified levels shall be finished and finished rough.

4.18.5 For monolithic finish

Where no more finishing course is to be applied as in the case of basement floor, industrial flooring or the screed concrete flooring etc, the concrete shall be completed and struck off at the specified levels and slopes with a screed, board and then floated with a wooden float. Steel trowelling is then started after the concrete has hardened enough to prevent the excess of fines and water to rise to the surface but not hard enough to prevent proper finishing. Trowelling shall be such that the surface is flat, smooth and neatly finished.

4.19 Curing of Concrete

4.19.1 General

The purpose of curing is either to provide sufficient water at optimum temperature or to prevent loss of moisture from the concrete itself so that the cement inside the concrete is
sufficiently hydrated which of course in slow and prolonged process. As soon as the concrete has hardened sufficiently the curing shall be started.

4.19.2 Different methods of curing

Any one of the following may be used for curing as approved by the Engineer.

(a) Curing by direct water.

(b) Curing by covering the concrete with absorbent material and kept damp.

(c) Covering the concrete with an impervious sheet.

(d) Curing by providing protective membrane.

(e) Curing by chemical coating.

4.19.3 Curing by direct water

This is done either by ponding or spraying water.

(a) Ponding

Ponding is widely used for curing slab and pavements. Earth bunds are formed over the slabs and water is pumped or poured into them and the same is replenished at interval to make up for the loss of evaporation. As this type of curing is one of the best methods, 10 days of curing after final setting is sufficient.

(b) By spraying water

Curing is done by spraying water by suitable means at approved time intervals. While spraying it shall be ensured that the complete area is covered. In order to avoid cracking, cold water shall not be applied to massive members immediately after striking the form work, while the concrete is still warm. Alternate wetting and over drying shall be avoided.

Curing by spraying water shall be continued at least for 18 days.

4.19.4 Curing of concrete with absorbent material kept damp

The entire concrete surface is covered either with hessian, burlap, sawdust, sand, canvas or similar material and kept wet continuously for atleast 12 days after final setting.

4.19.5 Curing by covering concrete surface with an impervious sheet

This is achieved by covering the entire concrete surface with water proof paper or plastic sheets specially manufactured for this purpose. The waterproof papers are stuck together by adhesive compound and the plastic sheets can be welded at site.

Such type of covering shall be kept at least for 24 days after the final setting. It is preferable to have sheet as white in appearance since the white colour will reflect hot sunrays and keep the concrete temperature at reasonable level.
4.19.6  Curing by providing protective membrane by applying a curing compound

This is achieved by applying a membrane forming compound (curing compound) over the concrete surface. Generally these are available in emulsion form, liquid. The application of the curing compound should be started immediately after stripping off the shuttering in case of formed surface and after the surface has hardened in case of unformed surface.

The curing compound membrane forming emulsion dry up within 3 to 4 hours after application and forms a continuous coherent adhesive membrane over the concrete surface. Such membrane serves as a physical barrier to prevent the loss of moisture from the concrete itself. Membrane forming emulsions are generally coloured black or white to improve visibility for ensuring uniform application. Black colour shall never be used for curing in very hot weather. In order to prevent glare, a colouring pigment may be added to white compounds.

(a)  Black curing compounds are either Bituminous or Asphaltic emulsions and shall be used to the surface which are to be covered by back filling or on the floor which is to be covered with tiles and linoleum.

(b)  White curing compound shall be used to the surfaces of tall structures under exposure of hot sun where other method of curing cannot be properly ensured.

4.19.7  Curing by chemical coating

For chemical curing sodium silicate or calcium chloride is used. The use of calcium chloride shall be done without the approval of the Engineer. Normally the sodium silicate mixed with water is applied over concrete surface and when it dries up it forms a thin varnish like film which fills up the pores and surface voids and prevents evaporation of water. This also acts like curing compound but only difference is that curing compounds are available in ready mixed emulsion forms while sodium silicate is to be mixed with water at site.

4.19.8  Limitation to use of different methods of curing

(i)  Curing by the processes as indicated in 4.19.3 and 4.19.4 give very good results in normal warm climate for maturity of concrete.

(ii)  In cold weather, the process as indicated in 4.19.4 gives very good result for maturity of concrete.

(iii)  Where water cement ratio is less than 0.5 the methods indicated in 4.19.6 and 4.19.7 shall not be used.

(iv)  In warm climate also, where the methods of curing as indicated in 4.19.3 or 4.19.4 cannot be properly ensured, any suitable method of curing as indicated in 4.19.5 to 4.19.7 as approved/directed by the Engineer shall be adopted.

4.20  Testing of Concrete
4.20.1 General

The Contractor shall carryout, entirely at his own cost, all sampling and testing in accordance with the relevant I.S. standards and as supplemented herein. The Contractor shall get all tests done in approved Laboratory and submit to the Engineer, the test result in triplicate within 3 days after completion of the test.

4.20.2 Consistency test (tests of fresh concrete)

4.20.2.1 At the place of deposition/pouring of the concrete, to control the consistency, slump tests and/or compacting factor tests shall be carried out by the Contractor in accordance with I.S. 199 as directed by the Engineer.

4.20.2.2 The results of the slump tests/compacting factor tests shall be recorded in a register for reference duly signed by both the Contractor and the Engineer. That register shall be considered as the property of the Owner and shall be kept by the Contractor at site in safe custody.

4.20.2.3 The results of the slump tests/compacting factor tests shall tally, within accepted variation of plus or minus 12% with the results in the respective design mix, in case of mix design concrete and with the values indicated in the table under clause 6.1 of IS: 456 in case of nominal mix concrete.

4.20.2.4 For any particular batch of concrete, if the results do not conform to the requirements as specified in 15.2.3 or do not conform to any requirement of this specification, the Engineer has the right to reject that batch and the Contractor shall remove the same immediately from the site, at no cost to the Owner.

4.20.3 Strength test of concrete

4.20.3.1 While placing concrete, the Contractor shall make 6 nos. of 15 cm test cubes from particular batches of concrete as desired by the Engineer. The frequency of taking test cubes shall be either according to clause 14.2 of IS: 456 or as directed by the Engineer.

4.20.3.2 The cubes shall be prepared, cured and tested according to IS: 516. Out of 6 nos. of test cubes 3 shall be tested for compressive strength at 7 days after casting and the remaining 3 at 28 days after casting.

4.20.3.3 A register shall be maintained at site by the Contractor with the following details entered and signed by both the Contractor and the Engineer. That register shall be considered as the property of the Owner.

(a) Reference to the specific structural member
(b) Mark on cubes
(c) The grade of concrete
(d) The mix of concrete
(e) Date and time of casting
(f) Crushing strength at 7 days
(g) Crushing strength at 28 days

(h) Any other information directed by the Engineer.

4.20.4 Acceptance criteria for test cubes

The acceptance criteria of concrete on strength requirement shall be in accordance with the stipulations under clause 15 of IS: 456.

4.20.5 Non-destructive tests on hardened concrete

4.20.5.1 If there is doubt about the strength or quality of a particular work or the test results do not comply with the acceptance criteria as stipulated under clause 15 of IS: 456, non-destructive tests on hardened concrete like core test and/or load tests or other type of non destructive tests like ultrasonic impulse test etc. shall be carried out, as may be directed by the Engineer, by the Contractor at entirely his own cost.

4.20.5.2 The core tests and load tests shall comply with the requirements of clause 16.3 and 16.5 of IS: 456 respectively. In case of other types of special tests like ultrasonic impulse test etc., the stipulation of clause 16.6 of IS: 456 shall be applicable.

4.20.6 Concrete below specified strength

In case of failure of test cubes to meet the specified requirements the Engineer may take one of the following actions:-

1) Reject the work and instruct that section of the works to which the failed cubes relate shall be cut out and replaced at Contractor's expense.

2) Instruct the Contractor to carryout additional test and/or works to ensure the soundness of the structure at Contractor's expense.

3) Accept the work with reduction in the rate in appropriate item.

4.20.7 Concrete failed in non-destruction tests

In case the test results of the core tests or load tests in a particular work do not comply with the requirements of respective clause (16.3 for core test and 16.5 for load tests) of IS: 456 the whole or part of the work concerned shall be dismantled and replaced by the Contractor as may be directed by the Engineer at no extra cost to the Owner and to the satisfaction of the Engineer. No payment for the dismantled concrete including relevant form work, reinforcement, embedded fixtures etc. shall be made. In the course of dismantling if any damage occurs to the adjacent structure or embedded item, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

4.21 Steel Reinforcement

4.21.1 Material

Material shall be as specified in the respective schedule of Items. The specifications of materials shall be as per Part-I.
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### 4.21.2 Storage

Steel reinforcement shall be stored in such a manner that they are not in direct contact with ground. Bars of different classifications and sizes shall be stored separately. In cases of long storage or in coastal areas, reinforcement shall be stacked above ground level by at least 15 cm, and a coat of cement wash shall be given to prevent scaling and rusting.

### 4.21.3 Bending and placing

Bending and placing of bars shall be in conformity with IS: 2502 "Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement" and IS: 456 - "Code of Practice for Plain and Reinforced Concrete".

### 4.21.4 Welding of Reinforcement

Welding of mild steel reinforcement bars conforming to IS:432 (Part-I) shall be done in accordance with IS: 2751 - "Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete construction" with additional precaution that for lap welded joints the throat thickness of weld beads shall be at least 3 mm or 0.6 times the nominal size of weld (which is the radius of bar) whichever is more.

Welding of cold worked high strength deformed bars conforming to IS: 1786 shall be done using electric arc welding process using low hydrogen electrodes (Ferro Weld- I or Ferro Weld-II or equivalent). Oxyacetylene welding shall not be used.

Butt welding of bars up to 32 mm diameter for vertical splices shall be done either by single bevel groove weld or double bevel groove weld, with bevel angle 45 degree. Butt welding of bars up to 32 mm diameter for horizontal splices shall be done either by single Vee-grove weld or double Vee groove weld with chamfered angle of 45 degree to 60 degree. The diameter of welded joint shall be 1.2 times the diameter of bar. Edge preparation for butt welding shall be done by shearing, machining and grinding. Oxyacetylene flame shall not be used for cutting. Chamfered faces shall be smooth finished by hand file if required.

Lap welding of bars up to 20 mm diameter shall have a minimum bead length of 12 times the diameter of bar or 200 mm whichever is more arranged on one or both sides. The throat thickness of weld beads shall be 5 mm or 0.75 times the nominal size of weld (which is the radius of bar) whichever is more. In case of unsymmetrical lap weld with weld bead on one side only, the maximum length of each weld bead shall be 6 times the diameter of bar or 100 mm (whichever is more), separated by an equal length in between weld beads. Splice bars used in symmetrical weld joint shall have same diameter as the parent bars. Lap joint with single splice bars shall have weld beads on both sides.

Lap welding of bars above 20 mm shall be done using splice plate or splice angle. Thickness of splice plate shall not be less than 0.65 times the diameter of bar and width shall not be less than twice the diameter of bar. The size of splice angle shall be such that its area of cross section is at least 1.62 times the area of bar being spliced.

More than one third of the bars shall not be welded at any one section and welded joints shall be staggered at a distance of 50 times the diameter of bars. Welding shall not be done at bends or curved parts of bars and it shall be located at least at a distance of 50 times the diameter of bar from bends.
### Tests

Test pieces of welded bars shall be selected and tested in accordance with the provisions of IS: 2751. The number of tests will be as laid down in IS: 2751 or such larger number as the Engineer may decide having regard to the circumstances.

#### 4.21.5 Cleaning

All steel for reinforcement shall be free from loose scales, rust coatings oil, grease, paint or other harmful matters immediately before placing the concrete. To ensure this reinforcements with rust coatings shall be cleaned thoroughly before bending/placement of the same.

#### 4.21.6 Placing in position

All reinforcements shall be accurately fixed and maintained in positions as shown on the drawings and by adequate means like mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by annealed soft steel wire or by tack welding in case of bars larger than 25 mm dia, as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers.

#### 4.21.7 Clear cover

Clear cover shall be as specified in the drawings. If nothing is specified in the drawing the clear cover shall be in accordance with the relevant clause of IS: 456.

#### 4.21.8 Light structural work and embedded metallic parts, conduits,

##### 4.21.8.1 Fabrication of metallic parts & light structural works

Fabrication of all structural steel work shall be done in accordance with IS: 800 - "Code of Practice for use of Structural Steel in General Building Construction". All workmanship shall be equal to the best practice in modern structural shops. Greatest accuracy shall be observed in the manufacture of every part and all identical parts shall be strictly inter-changeable. Steel work shall be shop fitted and shop assembled as far as practicable to minimize on site work and to meet transport restrictions. All materials shall be straight and if necessary before being worked shall be straightened of flattened by pressure and shall be free from twists. Shearing or flame cutting may be used and the resulting edges shall be clean and straight. Flame cut edges shall be planed/cleaned by chipping or grinding. Sheared members shall be free from distortion at sheared edges. Welding and welded work shall conform to IS: 816 - "Code of Practice for use of metal arc welding for General Construction in Mild Steel". Mild steel electrodes conforming to IS: 814 "Specification for covered electrodes for metal arc welding of mills steel (third revision) shall be used.

##### 4.21.8.2 Transportation and Storage
All pieces shall be properly identified and bundled for transportation to work site. Care shall be exercised in the delivery, handling and storage of material to ensure that material is not damaged in any manner. Materials shall be kept free of dirt, grease and foreign matter and shall be stored properly on skids or any other suitable supports to avoid contact with ground, damage due to twisting, bending etc.

4.21.8.3 Erection of light structural work

Erection of light structural work shall be carried out in accordance with the provisions of IS: 800. No component which is bend or twisted shall be put in place until the defects are corrected. Components seriously damaged during handling shall be replaced. No riveting, permanent bolting or welding shall be done until proper alignment has been completed. Whenever field welding is to be done it shall be in accordance with the requirements of shop fabrication. Shop paints shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

4.21.8.4.1 Erection of embedded metallic parts, inserts, conduits

Bolts and inserts shall be securely fixed in position as shown in the drawings, before commencement of concreting. Bolts shall be checked for accuracy in alignment on both the axes. Limits of tolerance in alignment and level shall be as shown in the drawing or described elsewhere in these specifications.

Where bolts are housed in sleeves, special care shall be taken after concreting is over and has partly set to ensure that the bolts move within the sleeves. The annular space of the sleeve shall be plugged with suitable stoppers to prevent the ingress of water, grit, dust, rubbish or other foreign material into it, both during and after concreting. Opened conduits shall be plugged similarly. Where channels, U-shaped profiles or other similar inserts are required to be placed in concrete, special care shall be taken to keep the grooves of such profiles free from the ingress of concrete, slurry etc., by suitable packing material, if necessary. All threads for bolts and inserts shall be greased at intervals and kept covered to prevent damage.

4.21.8.4.2 Necessary templates, jigs, fixtures, supports shall be used as may be specified or required or directed by the Engineer free of cost to the Owner.

Exposed surfaces of embedded materials shall be painted with one coat of anticorrosive paint or bituminous paint, as desired, without any extra cost to the Owner.

4.22 Shuttering

4.22.1 General

All shuttering, formwork, supports and staging shall be designed by the Contractor and be subject to approval by the Engineer. The Contractor shall submit drawings and calculations to the Engineer for scrutiny when called upon to do so. The shuttering shall be designed for a load of 400 Kg/Cm² in addition to the weight of the green concrete, or such other load as the Engineer may specify. The Contractor shall be responsible for the correctness and strength of the formwork including its supports and centering and approval by the Engineer will not relieve him of his responsibilities.

4.22.2 Material
The staging and supports may be of round or sawn timber or tubular or other shapes in steel. Round timber shall preferably extend over the full height in one piece. These shall be securely jointed or otherwise fastened and spaced at suitable intervals as the design may warrant. They shall be suitably braced at regular intervals horizontally and diagonally.

The form work shall be of steel plate on steel frame, wooden boards with steel sheet lining, or plywood or season timber board. Where ornamental and curved surfaces are required the material shall be very good seasoned timber or plywood which can be shaped correctly.

4.22.3 Fixing

The shuttering shall conform to the shapes, lines, levels and dimensions shown in the drawing. It shall be fixed in perfect alignment and securely braced so as to be able to withstand, without appreciable displacement, deflection of movement of any kind, the weight of all construction, movement of persons and plant. It shall be so constructed as to remain rigid during the placing and compacting of concrete without shifting or yielding and shall be sufficiently water tight to prevent loss of slurry from the concrete.

All props shall be supported on sole plates and double wedges. At the time of removing props these wedges shall be gently eased and not knocked out. The form work shall be so designed that the sides are independent of the soffit and the side forms can be removed easily without any damage or shock to the concrete.

4.22.4 Wrought shuttering

Wrought shuttering shall be such as to produce a first class fair face on the concrete free from board marks or any other disfigurements. This shall be used for exposed surfaces where specified or directed by the Engineer. It may be made of heavy quality plywood or steel sheets having smooth, plain surface.

The joints in shuttering shall be arranged in a regular pattern approved by the Engineer. Wrought shuttering shall be aligned within a tolerance of 3 mm.

4.22.5 Rough shuttering

Rough shuttering shall be used for all surface of concrete walls, footings etc., which are not exposed in the finished work or which are to receive plaster and as directed by the Engineer. It may be made of timber, ordinary plywood or steel sheets.

4.22.6 Slipform shuttering

Slip forms, where used, shall provide a smooth, even surface true to dimensions and alignment. The concrete surface produced by such shuttering shall be free from fines, bulges and unseemly off-sets. Slipforms shall have prior approval of the Engineer and the Contractor shall submit complete information required in this regard.

4.22.7 Special provision

4.22.7.1 Wherever concreting of narrow member is required to be carried out within shutters of considerable depth, temporary openings in the sides of the shutters shall, if so directed by the Engineer, be provided to facilitate cleaning, pouring and consolidation of concrete.
4.22.7.2 In liquid retaining structures and structures below ground water level, through bolts for the purpose of securing and aligning the form work shall not be used.

4.22.7.3 Forms shall be given an upward camber, if so desired by the Engineer, to ensure that long beams do not have any sag. The camber may be 1 in 250 or as the Engineer may direct.

4.22.7.4 The joints in form work shall be sealed by adhesive tapes or by other means, to prevent any leakage of slurry or mortar.

4.22.8 Preparation for concreting

Before any concreting is commenced the shuttering shall be carefully examined for dimensional accuracy and safety of construction. The space to be occupied by concrete shall be thoroughly cleaned out to remove rubbish, debris, shavings and saw dust. The surface in contact with concrete shall be coated with an approved substance such as mould oil or other non-staining mineral oil to prevent adhesion. Where necessary the surface shall be wetted to prevent absorption of moisture from concrete. Care shall be taken to avoid the reinforcements coming in contact with shutter oil.

4.22.9 Removing

4.22.9.1 Removal of forms shall never be started until the concrete has thoroughly set and aged to attain sufficient strength to carry twice its own weight plus the live load that is likely to come over it during construction.

4.22.9.2 Removal of forms shall not entail chipping or disfiguring of the concrete surface. Shuttering shall be removed without shock or vibration and shall be eased off carefully in order to allow the structure to take up its load gradually.

4.22.9.3 Under normal circumstances (generally where temperatures are above 21 degree 'C'), and where ordinary portland cement is used shuttering may be struck after the expiry of the following periods :-

i) Walls, columns and vertical faces .. 24 to 48 hours as may be directed by the Engineer.

ii) Bottom of slab upto 4.5 m span .. 7 days

iii) Bottom of slab above 4.5 m span, bottom of beam and arch, rise upto 6 m span .. 14 days

iv) Bottom of beam and arch rise over 6 m span .. 21 days

These periods may be increased at the discretion of the Engineer. Special care shall be taken while striking the shuttering of cantilevered slabs and beams, portal frames etc.,
4.22.9.4 Before removing the form work, the Contractor must notify the Engineer to enable him to inspect the condition of the finished concrete immediately after the removal of the form works.

4.22.10 Contractor’s responsibility

Any damage resulting from faulty preparation, premature or careless removal of shuttering shall be made good by the Contractor at his own expense.

4.22.11 Irrecoverable shuttering

In cases where the shuttering cannot be removed without damaging the structure itself or where removal of shuttering is rendered impossible due to the nature of construction or where the Engineer may so instruct, such shuttering shall be classified as irrecoverable shuttering. However, such abandoning of shuttering will be permitted only in situations where it will not remain exposed or otherwise cause damage of any kind.

4.22.12 Metal Forms

Where permanently left-in-place metal forms or deck are shown in drawings or otherwise ordered to be provided by the Engineer, they shall satisfy the requirements with regard to load carrying capacity. The metal forms shall be obtained from a reputed manufacturer, whose performance guarantee shall be obtained and submitted to the Engineer. Designs and drawings giving full details shall be submitted to the Engineer in advance for approval.

4.23 Damp Proof Course Concrete

4.23.1 Thickness

It shall be as specified in the drawings/ schedule of items.

4.23.2 Mix

The grade of mix shall be as specified in the drawing or schedule of quantities. If nothing is specified, the mix shall be 1 part of cement : 1 1/2 part of coarse sand : 3 parts of stone chips. The stone chips shall be 12 mm down graded.

Approved water proofing admixture shall be mixed with cement as per manufacturer’s specifications. The water cement ratio shall be as low as possible to increase the impermeability of concrete and in no case more than 0.5.

4.23.3 Preparation of base surface

The base surface shall be well roughened by chipping and brushing with steel brush and shall be cleaned of all dirt, dust, grease, oil and all other foreign & deleterious materials. Then the surface shall be well moistened with water.

4.23.4 Placing and compaction

Just prior to placement of D.P.C. Concrete, a thick coat of cement slurry shall be applied on the base surface. The placement shall be as specified for the concrete in beams.
The concrete shall be well compacted to make it dense.

4.23.5 Finishing

When the concrete has set enough but remains still green, the top surface shall be marked in regular pattern by steel trowel so as to have proper bond with the future work.

4.23.6 Curing

The D.P.C. coarse shall be kept continuously moist at least 10 days.

4.24 Grout

4.24.1 Scope

The scope covers the grouting under base plates, grouting between the joints of precast concrete, grouting the pockets/holes/opening etc.

4.24.2 Grouting under base plates

Grouting under base plates of equipment/structures shall be of cement mortar 1:2 for thickness up to 25 mm. For thickness exceeding 25 mm, concrete of grade specified in the drawing or minimum M-20 grade using 10 mm down graded aggregates shall be used. The grout shall be placed in position well rammed until the whole space is completely filled with concrete. No vibrators shall be used. Quick setting cements shall be used in the preparation of mortar or concrete, where so specified.

The grout shall either be "dry" concrete or mortar or "wet expanding" concrete or mortar as the Engineer may direct. A dry grout shall have a slump not exceeding 6 mm. It shall be rammed under the horizontal surface with the aid of suitable tools. A "wet expanding" grout shall have a slump of at least 125 mm but not exceeding 225 mm. To this shall be added an expanding admixture approved by the Engineer and according to the Manufacturer's instructions.

4.24.3 Grouting the joints of precast members

The requirements are same as that described in 4.24.2 except that the slump shall be much less (the slump in this case shall be within 75 mm to 125 mm as per the requirements) and in the case the thickness of the joint is 30 mm or less the mix shall be 1 part of quick setting cement and 1 1/2 parts of coarse sand. Some times dry mortars i.e. mortar with slump less than 6 mm is used for grouting the joints of precast members.

4.24.4 Grouting pockets/holes in concrete

Depending upon the size of the pockets/holes in the concrete, the mix of the grout shall be either of concrete or of cement sand mortars. Normally the grade of such concrete/mortar shall be M-20 unless specified otherwise. In filling the holes of foundation bolts and expanding admixture of approved type shall be used as per manufacturer's specification.

4.24.5 Workmanship
4.24.5.1 The surface of the concrete over which grouting is to be applied shall be thoroughly prepared to provide a clean rough surface. If necessary, chipping shall be carried out on such surface to make it completely rough. Then the surface shall be wetted. Bolt pockets shall be cleaned immediately before the base plate is placed in position.

4.24.5.2 Before placement of grout, the surfaces (except in the case of bolt holes) shall be wetted with cement slurry. In case of bolt holes/pockets water from such pockets shall be thoroughly removed by some suitable means and no cement slurry shall be applied.

4.24.5.3 Hand mixing is not permitted and the grout shall always be machine mixed. If however in some special cases where the quantity of grout is so small that it cannot be machine mixed, hand mixing may be allowed but the same shall be done under the strict supervision of an experienced supervisor of the Contractor.

4.24.5.4 The grout shall be placed within 30 minutes of being mixed. The grout shall be poured and then worked into position by suitable means until the space is completely filled. The Contractor shall take all possible measures during grouting so that the grout fills the space completely and thoroughly. Where the gap is very small or unapproachable for the placement of concrete, the Contractor shall grout by pressure grouting and in that case the mix may be of cement sand mortar of the appropriate grade but in any case the water cement ratio shall be as low as possible.

4.24.6 Curing

After 10 hours of grouting, the same shall be covered with wet gunny bags and the surface shall be kept continuously moist atleast for 10 days.

4.25 Concreting in Water Retaining Structures

The basic specifications as regards ‘mix’ design, placing, compacting, curing etc. shall conform to the requirements as specified herein before of this Chapter. Over and above the materials and workmanship shall conform to the stipulations of IS: 3370 (Part-I & II) to make dense and impervious concrete. As specified herein before all the construction joints shall be provided with approved water bars. The expansion and construction joints, if any, shall be provided with the requirements as specified in the drawing or as directed by the Engineer.

4.26 Application of Live Load

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

5.0 MASONRY

5.1 General

This specification deals with masonry and allied works in foundation, plinth and superstructure.

5.2 Materials

For specifications of materials Part-I shall be referred.
5.3 Selection of Mortars

Mortar for masonry shall conform generally to IS: 2250, "Code of Practice for Preparation and Use of Masonry Mortars", and proportion shall be as specified in the drawing or in the Schedule of Items.

5.4 Lime Mortar

Field slaking of lime shall be done in accordance with IS: 1635, "Code of Practice for Field Slaking of Lime, and Preparation of Putty".

5.4.1 Hydrated lime mixed with water to form putty shall be stored at least for 24 hours before used well covered and protected against evaporation. For quick lime, sufficient water shall be added for slaking and forming a cream and the same screened through a No. 10 sieve and stored for at least 7 days before use.

5.4.2 Lime putty and sand of proper proportion, with addition of necessary water, shall be mixed on a water-tight platform and then thoroughly ground in a mortar mill. It shall then be stored ready for use, well covered and protected to avoid evaporation and drying of mortar. In case cement is needed to be added to the lime-sand mortar, required quantity of cement shall be added and again mixed for at least three minutes preferably in a mechanical mixer, with addition of minimum quantity of water to achieve workable consistency. Lime mortar shall be used within 72 hours of mixing.

5.5 Cement Mortar

5.5.1 Cement and sand of requisite quantity shall be mixed dry, preferably in a mechanical mixer and further mixed after adding the required quantity of water to achieve workable consistency and uniform colour.

5.5.2 Fresh mixed mortar shall be used for masonry work. Subsequent thinning by addition of water shall not be permitted.

5.5.3 Cement sand and cement lime mortars or lime mortar with hydraulic lime shall be used as soon as possible after addition of water, but in no case later than 2 hours.

5.5.4 Old and stale mortar and mortar picked up from droppings in masonry work shall generally be not used.

5.6 Brick Work

5.6.1 Storage and handling bricks

Bricks shall not be dumped at site. They shall be carefully handled and carefully stacked in regular tiers to avoid breakage and defacement of bricks and prevent contamination by mud or other materials. The supply of bricks shall be so arranged that as far as possible at least two days' requirement of bricks is available at site at any time. Bricks selected for different situations of work shall be stacked separately.

5.6.2 Soaking & Cleaning bricks

Bricks required for masonry shall be cleaned to be free from dirt, dust and sand and fully soaked in clean water by submerging in vats before use, till air bubbling ceases. The
bricks shall not be too wet at the time of use. After soaking they shall be removed from the tank sufficiently early so that at the time of laying they are skin dry and stacked on a clean space.

5.6.3 Setting out

The building lines shall be set out by the Contractor as per clause 7 of IS: 2212 and got checked by the Engineer.

5.6.4 Laying of bricks

5.6.4.1 Bricks shall be laid in English bond, unless otherwise specified, with frogs upward over a full bed of evenly laid mortar, and slightly pressed and tapped into final position to the lines levels and shape as shown in the drawing fully embedded in mortar. All joints including inside faces shall be flushed and packed. No more than 8 courses shall generally be laid in a day. The first course itself shall be made horizontal by providing enough mortar in the bed joint to fill up any undulations. The horizontalness of courses and the verticality of wall shall be checked very often with spirit level and plumb bob respectively.

5.6.4.2 Mortar joints shall be such that the height of four courses of brick laid in mortar shall not increase by more than 25 mm the height of the same bricks laid dry. Horizontal joints shall be truly horizontal and vertical joints shall line up in every alternate course. The joints shall not exceed 10 mm in thickness and shall be well finished and neatly struck. The joints shall be kept uniform throughout the brick work. All the brick joints of the face works shall be neatly raked out to a minimum depth of 15 mm with the help of raking tools and the faces of brick wall cleaned with wire brush to remove any splashes of mortar before the close of the day's work, while the mortar is still green and the last brick layer shall be cleaned with wire brush and the frogs free from mortar.

5.6.4.3 Walls coming in contact with R.C.C. structures shall perfectly be bonded with MS inserts or lugs where shown on drawings and the sides butting against the R.C.C structures neatly and efficiently flashed and packed with rich mortar & cement slurry at no extra cost (cost of MS inserts or lugs used shall be measured and paid separately under relevant items). Where such lugs are not required to be provided, brick work shall be built tightly against columns, slabs or other structural parts, around door and window frames with proper distance to permit caulked joint. Where drawings indicate structural steel column or beam to be partly or wholly covered with brick work, bricks shall be built closely against all flanges and webs, with all spaces between steel and brick work filled solid with mortar not less than 10 mm thick.

5.6.4.4 Damaged or broken brick or brick bats shall not normally be used in brick work. Cut bricks may be used to complete bond or as closures or around irregular openings.

5.6.4.5 Bricks shall not be thrown from heights to the ground, but shall be handled carefully and put gently in position to avoid damaging their edges.

5.6.4.6 Selected bricks of regular shape and dimension shall be used for face work.

5.6.4.7 Making of grooves, sleeves and chases shall be done during the construction to the lines, levels and position as shown in the drawing or as instructed by the Engineer. Such sleeves shall slope outward in external walls so that their surface cannot form channels.
for the easy passage of water inside.

5.6.4.8 Fixtures, plugs, frames etc., if any, shall be built in at the right places to the lines & levels as shown in the drawings while laying the course and not later by disturbing the brick work already laid.

5.6.4.9 Brick walls of one brick thick or less shall have one selected face in true plane and walls more than one brick thick shall have both the faces of wall in true plane.

5.6.4.10 All connected brick work shall be carried out simultaneously with uniform heights throughout the work, and in exceptional cases, with the approval of the Engineer, the brick work built in any part of the work may be lower than another adjoining wall/connected wall by a maximum of 60 cm and the difference in height of adjoining wall/connecting wall shall be raked back according to bond by stepping at an angle not steeper than 45 degree, without sacrificing the necessary bond, horizontalness of layers, verticality of joints and the wall. Toothing shall not be allowed in brick work, for raking back.

The top layer just below the R.C.C slab or beam shall be laid with frogs down over a layer of mortar on full width.

5.6.4.11 Openings in brick work

Openings shall be made in brick work, which may be of any shape, size, at all levels, heights or depths, including round openings, as shown in the drawing or as directed by the Engineer, maintaining the necessary bond using a minimum of cut bricks. Openings in external face walls, the sills, jambs, soffit of opening may be rebated and the sill shall be sloped slightly for drainage of rain water.

5.6.4.12 Architectural features

All projecting architectural features such as in plinth projections, string courses or cornices shall be effectively bonded into the brick work to ensure stability. Such architectural features shall be set straight and true with the finished joints. Where such features are not to be plastered over, they shall be built with bricks of even size, good shape and quality, which have durability, resistance to abrasion and moisture penetration.

5.6.4.13 Sun shades and such projecting features which depend on the weight of brick masonry over them for stability, shall be kept supported till such time as the brick masonry above is built and hardened sufficiently.

5.6.4.14 All exposed brick work shall be rubbed down, thoroughly washed, cleaned and pointed as specified. Where face bricks of specific quality are used the same shall be rubbed with carborundum stone.

5.6.5 Half-brick masonry

5.6.5.1 The work of half-brick work shall be done in the same manner as for brick work except that all courses shall be laid in stretchers. Both faces shall be true to plane and the joints raked on both faces.

Where reinforcement is considered necessary or shown in drawing, MS bars shall be
provided as stipulated in the Schedule of Items. The reinforcement shall be cleaned of rust and loose scale with a wire brush, and shall be laid straight on the mortar and lapped with the dowel bars provided in the column, securely anchoring them at their ends where the half-brick wall butts. The batching of mortar usually shall be in the proportion of 1:4 or as stipulated in the Schedule of Items. Half of the mortar for the joints shall first be laid and the other half laid after the reinforcement is laid in position, so that the reinforcement is fully embedded in position.

5.6.6 Brick on edge masonry

The work brick on edge masonry wall in superstructure shall be done in the same manner as mentioned for brick work except that it shall always be reinforced with a mesh of 18 gauge netting of approved variety and embedded in cement mortar at interval as specified in the Schedule of Items. The wire netting shall be continuously laid and securely anchored with the dowel bars provided & projecting from the walls/RCC structure or steel structures at their ends where the 75 mm thick brick wall butts. The batching of mortar usually shall be in the proportion of 1:3 or as stipulated in the Schedule of Items.

5.6.7 Protection of brick work

The brick wall shall be protected and covered with gunny bags or water proof sheets from the effects of inclement weather, rain, frost, etc., during the construction and until the mortar sets. Care shall be taken during construction that the edges of jambs, sills and soffit of openings are not damaged.

5.6.8 Exposed Brick Work

5.6.8.1 Physical Requirements

Facing bricks shall be of class designation 75 unless otherwise specified. Average compressive strength shall not be less than 7.5 N/mm² water absorption shall not exceed 20 per cent by weight and efflorescence rating shall be nil when tested in accordance with the procedure laid down and tolerance in dimensions shall be checked as per the laid down procedure.

Mortar, Soaking of Bricks and laying shall be as follows :

Mortar

The mortar for the bricks work shall be as specified, and conform to accepted standards. Lime shall not be used where reinforcement is provided in brick work.

Soaking of Bricks

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks. Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. The bricks required for masonry work using mud mortar shall not be soaked. When the bricks are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place where they are not again spoiled by dirt earth etc.
5.6.8.2 Joints in the exposed brick work shall be truly horizontal and vertical and kept uniform with the help of wooden or steel strips. The thickness of joints shall be as follows.

5.6.8.2.1 Joints

The thickness of all types of joints including brick wall joints and cross joints shall be such that four course and three joints taken consecutively shall measures as follows:

i) In case of modular bricks conforming to IS:1077-1986 specification for common burnt clay buildings bricks, equal to 39 cm.

ii) In case of non-modular bricks, it shall be equal to 31 cm.

Note: Specified thickness of joints shall be of 1 cm deviation from the specified thickness of all joints shall not exceed one-fifth of specified thickness.

5.6.8.2.2 Finishing of Joints

The face of brick work may be finished flush or by pointing. In flush finishing either the face joints of the mortar shall be worked out while still green to give a finished surface flush with the face of the brick work or the joints shall be squarely raked out to a depth of 1 cm while the mortar is still green for subsequently plastering. The faces of brick work shall be cleaned with wire brush so as to remove any splashes of mortar during the course of raising the brick work. In pointing, the joints shall be squarely raked out to a depth of 1.5 cm while the mortar is still green and raked joints shall be brushed to remove dust and loose particles and well wetted, and shall be later refilled with mortar to give ruled finish. Some such finishes are `flush', `weathered', ruled. etc.

5.6.9 Curing

All brick works shall be kept moist for 10 days after laying.

5.6.10 Scaffolding

5.6.10.1 Necessary and suitable scaffolding shall be provided at all heights to facilitate the construction of brick wall. Scaffolding shall be sound, strong and all supports and other members shall be sufficiently strong and rigid, stiffened with necessary bracings and shall be firmly connected to the walls securing them against swing or sway. Planks shall be laid over the scaffolding at required levels. Scaffolding shall preferably be of tubular steel, although the Engineer may permit other material, depending upon the circumstances.

5.6.10.2 Scaffolding shall be double, having two sets of vertical supports, particularly for the face wall and all exposed brick work. Single scaffolding may be used for buildings upto two storeys high or at other locations, if permitted by the Engineer. In such case the inner ends of horizontal members shall rest in holes provided in header course only. Such holes shall not be allowed in pillars under one meter in width, or immediately near the skew backs or arches. The holes thus left in masonry shall be filled with bricks set in rich mortar and the surface made good on removal of scaffolding.

5.6.10.3 If for any reason the Contractor is required to erect scaffolding in property other than that belonging to the Owner, including municipal corporation or local bodies, necessary permission shall be obtained by the Contractor from the appropriate authorities and
necessary licensing fees shall have to be borne by him.

5.6.10.4 All scaffoldings once erected shall be allowed to remain in position, efficiently maintained by the Contractor, till all the finishing works required to be done are completed and shall not be removed without the approval of the Engineer.

The Contractor shall allow workmen of other trades to make reasonable use of the scaffolding without any extra cost.

5.6.10.5 Fixing of wooden frames

Unless otherwise specified, wooden door and window frames shall be fixed in the openings generally with MS hold-fasts of adequate size and strength securely embedded in the brick work for sufficient length, during the progress of work, or chases shall be made in the brick work and the frames may be fitted later on and subsequently fixed by filling the opening with cement concrete not less than 1:2:4 by volume.

5.6.11 Cavity walls

Cavity walls shall be made in accordance with Clause 10.12 of IS: 2212. A cavity wall comprises of two leaves, each leaf being built of masonry units and separated by a cavity and tied together with metal ties or bonding units to ensure that the two leaves act as one structural unit, the space between the leaves being either left a continuous cavity or filled with a non-load bearing insulating and water proofing material.

Thickness of each leave of a cavity wall shall not be less than 75 mm. Where the outer leaf is half masonry unit in thickness, the uninterrupted height and length of this leaf shall be limited so as to avoid undue loosening of ties due to differential movements between the two leaves. The outer leaf shall therefore be supported at least at every third storey or at every 10 m of height whichever is less and at every 10 m or less along the length.

5.6.12 Arches

Small arches/flat arches shall be made as shown in the drawings with selected good bricks of approved quality over timber centering or templates generally in rings of half brick length. For face brick work the bricks shall be specially selected and sought to shape to get radial joints uniform. Necessary allowance shall be made for any slight settlement or to correct any apparent sagging. The mortar to be used for arches shall be as specified in the Schedule of Items. The joints shall be raked out and treated as required in general brick work. The centering and shuttering shall be retained in position till the brick work in arch ring is completely set and strength achieved, and shall not be removed without the approval of the Engineer.

5.6.13 Honey-Comb brick work

The work shall be as mentioned for general brick work. Bricks shall be laid in cement mortar 1:4. All edges shall be struck flush to give an even surface on both faces. Joints shall be raked and pointed or plastered as specified in the Schedule of Items. The thickness of the brick honey-comb work shall be usually half brick or as specified in the Schedule of Items. The openings of the hone-comb brick work shall be equal and alternate with half bricks laid with a minimum bearing of 2.5 cm on either side.
5.7 Stone Masonry

5.7.1 General

All aspects of the work shall be in conformity with the "Code of Practice for Construction of Stone Masonry, IS:1597 (Part-I & II) - 1992. Relevant clauses under brick work, such as setting out, making chases, openings, fixing frames and plugs, protection curing, scaffolding etc., shall apply to stone masonry and concrete block masonry.

5.7.2 Mortar

The mortar used shall be as specified in the Schedule of Items or drawing.

5.7.3 Holes and Plugs

Holes in stone walls shall be left for water supply, plumbing, sanitation, electrification, etc., where shown on drawings or ordered by the Engineer as the work proceeds. These holes shall, on completion, be made good to match with the adjoining wall. The Contractor shall provide and fix wooden plugs, water supply piping and electric conduit pipes etc. where so specified.

5.7.4 Random Rubble Masonry

5.7.4.1 Laying

All stones shall be wetted and cleaned of all dust and loose materials before laying. Stones shall be laid on their natural beds, fitted carefully to the adjacent stones to form neat and close joints fully packed with mortar and chips of stone may also be used wherever necessary to avoid thick mortar bed or joints. Walls shall be carried to plumb or to the specified batter. Stones may be brought to level courses at plinth, window sills and roof levels and the leveling shall be done with concrete comprising of 1 part of the mortar as used for the masonry and 2 parts of 20mm down graded hard stone chips at no extra cost. Bond shall be provided by fitting in closely the adjacent stones and by using bond stones running through the thickness of wall in a line from the face to back with at least one bond stone, or a set of bond stones, for every 0.5 sq.mm of the wall surface. Face stones shall extend and bond well into the backing. These shall be arranged to break joints as much as possible, and to avoid long vertical lines of joints.

5.7.4.2 Quoins

Quoins shall be of selected stones, neatly dressed with hammer or chisel to form the required angle and laid header and stretcher alternately. No quoin stone shall be smaller than 0.25 cum (25 dcum in volume and it shall also not be less than 300mm in length, 25% of them being not less than 500mm in length).

5.7.4.3 Joints

The stones shall be so laid that the joints are fully packed with mortar and chips and face joints shall not be more than 20mm thick. When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying, otherwise the joints shall be raked to a minimum depth of 20mm by raking tool during the progress of work, when the mortar is still green.
5.7.5 Coursed Rubble Masonry – First Sort

5.7.5.1 Laying

All stones shall be wetted before use. The walls shall be carried up truly plumb or to specified batter. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. The height of each course shall not be less than 15cm nor more than 30cm.

Face stones shall be laid alternate headers and stretchers. No pinning shall be allowed on the face. No face stone shall be less in breadth than its height and at least one third of the stones shall tail into the work for length not less than twice their height.

The hearting or the interior filling of the wall shall consist of stones carefully laid on their proper beds in mortar, chips and spalls of stone being used where necessary to avoid thick beds of joints of mortar and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The chips shall not be used below the hearting stone to bring these up to the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in heating and these shall not exceed 10% of the quantity of stone masonry. The masonry in a structure shall be carried up regularly but where breaks are unavoidable, the joints shall be raked back at an angle not steeper than 45 degree. Tooothing shall not be allowed.

5.7.5.2 Bond Stones

Bond stone or a set of bond stones shall be inserted 1.5 to 1.8 metres apart, in every course.

5.7.5.3 Quoins

The quoins, shall be of the same height as the course in which these occur. These shall be at least 45 cm long and shall be laid stretches and headers alternately. These shall be laid square on the beds, which shall be rough-chisel dressed to a depth of at least 10cm. In case of exposed work, these stones shall have a minimum of 2.5 cm wide chisel drafts at four edges, all the edges being in the same plane.

5.7.5.4 Joints

All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar, face joints not be more than one cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20mm by raking tool during the progress of work, when the mortar is still green.

5.7.6 Coursed Rubble Masonry – First Sort

5.7.6.1 Laying

Shall be as specified in 5.7.5.1 except that the use of chips shall not exceed 15% of the quantity of stone masonry, and stone in each course need not be of the same height but more than two stones shall not be used in the height of a course.

5.7.5.2 Bond Stones, Quoins
Shall be as specified for first sort respectively.

### 5.7.5.4 Joints

All be joints shall be horizontal and all side joints vertical. All points shall be fully packed with mortar, face joints shall not be more than 2 cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20mm by raking tool during the progress of work, when the mortar is still green.

### 6.0 PILING

#### 6.1 General

This specification deals with the requirements regarding workmanship of bored and driven, cast-in-situ reinforced concrete piles.

The workmanship shall conform with the provisions of the following codes and standard specifications in particular:

- IS: 456 - Code of Practice for Plain Reinforced Concrete.
- IS: 2911 - Code of Practice for Design Construction of Pile Foundations, Part I & IV.

#### 6.2 Materials & Workmanship

##### 6.2.1 Concrete

Concrete shall conform to the specification "Concrete Plain and Reinforced" in this series.

##### 6.2.2 Reinforcement

Reinforcement shall conform to the specification "Concrete" in this series.

##### 6.2.3 Sequence

In case of bored piles, boring shall proceed by alternately driving the casing and extracting the bored material with the boring tools. While boring in soft material liable to cavitation, boring tools shall not be operated at level below the toe of the casing. Care shall be taken to ensure that the volume of water added to the bore is no more than the minimum necessary for the operation of the boring tools. The casing shall be driven down through the soft material to penetrate a hard stratum not subjected to cavitation and shall be sealed in this material as far as possible. Thereafter the boring shall be continued by means of the boring tools until the approved bearing layer is reached. The bearing layer shall consist of sound materials capable of safely sustaining the load imposed by the pile and shall be consistent in quality for a depth of minimum 300 mm in the pile bore.
The piles shall be driven with due consideration for safety of adjacent structure by a method which leaves their strength unimpaired and which develop and retain the required bearing resistance.

Where the soil is such that driving of a pile causes previously installed pipes to heave, load test shall be conducted.

6.2.4 Jetting

When jetting is used, it shall be carried out in such a manner that the carrying capacity of the piles already in position and the safety of the existing structures are not impaired. Jetting shall be stopped not less than one meter above the final expected bottom of the pile and the pile shall be carried down until the required resistance is obtained. If there is evidence that the jetting has disturbed the load carrying capacity of previously installed piles, those piles which have been disturbed shall be rejected.

6.2.5 Jacking

If sufficient overhead space is not available due to the existing structures which cannot be removed, driving of piles by jacking or other similar methods without impact shall be adopted. The carrying capacity of a pile installed by such methods shall taken to be not more than 50% of the load or force used to install the pile.

6.2.6 Spacing

All piles shall have minimum spacing on centres of 2 d for bored piles and 2.5 d for driven piles (where d is the diameter of the pile), subject to a minimum of 100cm.

No pile of uniform section shall have diameter of less than 200 mm upto 12 m long piles & not less than 300 mm for length between 12 m and 15 m. For piles longer than 15 m, the minimum diameter shall be 400 mm. The longitudinal reinforcement shall be a minimum of 0.8% of the pile cross-section or 6 rods of 16 mm dia whichever is more. The transverse reinforcement shall not be less than 0.2% of the gross volume of the pile in the form of helical binders.

6.2.7 Cast-in-situ piles

Immediately before concreting the bore hole shall be cleaned of all the loose material, debris etc. Concrete shall be so placed as to fill the entire volume of the bore hole without the formation of voids caused by the faulty compaction or entrapped air. Great care shall be taken to ensure that the fluid alluvial soil does not penetrate between batches of the concrete.

Concrete shall not normally be placed through water and in unavoidable cases such concreting shall be done with necessary precautions. The ground water shall be balanced by adding fresh water to the bore and the concreting shall be placed by means of an enclosed placer or by tremie pipe. In case of bored piles after the uncased portion of the bottom of the bore has been concreted, further concrete is to be added. The sequence of placing concrete and withdrawing the casing shall be so arranged that the head of concrete above the bottom of casing is never less than 3 meters. Once the concreting of the pile is commenced the work shall proceed without interruption until the pile is completed.

Concreting of the pile shall continue until the pile is fully formed upto a level not less
than 600 mm above the soffit of the pile cap. Extraction of casing shall be done in such a way that no necking or shearing of the concrete in the shaft takes place.

### 6.2.8 Trimming of Piles

Completed piles shall be trimmed to the cut-off levels as shown on the drawings when sound concrete has been formed. In the event of trimming being carried below the cut-off level, the pile shall be made up to the correct cut-off level with concrete of the same quality as used in the piles. Reinforcement shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile cap. The minimum distance of keying of the pile into the pile cap shall be 50 mm. All concrete and cement shall be removed from the bars, which shall also be wire-brushed to remove any loose rust, dirt and scale.

### 6.2.9 Lengthening of piles

Where it is necessary to increase the length of any pile after it has been driven, the head of the pile shall be cut-off to expose the reinforcement for a full bond length of the bars to lap with the new bars. The exposed surface of the concrete shall be hacked to form a key, brushed to remove loose material and covered with 25 mm. thick cement mortar (1:2 mix) immediately before the new concrete is placed.

### 6.2.10 Load test

Atleast 1% of the piles driven shall be tested to an overload of 50% above the working load of the pile and 0.1% of the piles driven shall be tested to an overload of 100% above the working load of the pile.

The longest practicable time shall be allowed to escape between driving and testing to allow the recovery of soil conditions around the pile and it shall not be less than two weeks.

The gross settlement under test load of any pile shall not exceed 12 mm in case of 150% working load tests, and 20 mm in case of 200% working load tests.

### 6.2.11 Standard of acceptance

The piles shall be accepted as satisfactory only when the work has been executed in accordance with this specification and the Standards stated hereinafter.

(a) The head of the pile shall be within 65 mm of the specified position on the drawings.

(b) The pile shall not be out of plumb by more than 1 in 100.

(c) The toe of the pile shall be at the approved bearing level in each case.

(d) The total volume of concrete shall not be less than 10% and not more than 40% greater than the calculated volume. The calculated volume for this purpose shall be the cross-sectional area inside the casting multiplied by the length of the shaft. The concrete shall show the specified strength as indicated by the cube test results.

(e) The results of the load tests carried out in accordance with the contract and with the specifications for load testing shall satisfactory.
6.2.12 Defective piles

If an individual pile fails to meet the requirements specified in clause above such pile may be deemed to be defective.

When any pile is found defective, one or more of the following remedial measures shall be carried out:

(a) Replacement of defective piles
(b) Driving additional piles.
(c) Alteration in design of pile caps.

6.2.13 Recording

For each pile, a record of the following data shall be kept:

(1) The date and time of commence & finishing of the driving operation.
(2) The particulars of the equipment and method of driving.
(3) The location and type of the pile, with a reference to approved drawings.
(4) The diameter of the pile.
(5) The length and cut-off level of the pile.
(6) The quantities of concrete, reinforcement, cement and w/c ratio used.
(7) The sequence of the driving in pile groups.
(8) The final set for the last ten blows.
(9) The test load and settlement for test piles as required under clause of load testing.

7.0 PLASTERING AND POINTING

7.1 Materials

The specification of materials shall conform to the requirements as specified in Part-I.

7.2 Plastering

7.2.1 General

Plastering shall be done in accordance with provisions of IS: 1661. Mix proportions of mortar for plastering and thickness of plaster shall be as given either in the drawing, or as per Schedule of Items or as directed by the Engineer. For special plaster work, necessary admixtures shall be added to mortar in required proportion as per manufacturer's specifications or as specified herein.

7.2.2 Preparation of surface
The surface to be plastered shall be cleaned of all extraneous matter and rubbish. In masonry the joints shall be raked to a minimum depth of 12 mm and cleaned with wire brush. Concrete surfaces to be plastered shall be roughened and hacked to form key for plastering. All plastered surfaces shall be finished smooth with a wooden float in one plane and all internal angles shall be finished slightly rounded. If desired by the Engineer, any unevenness shall be rubbed down by carborundum stones. The surface to be plastered shall be wetted evenly before the application of plastering.

For one coat plastering the plaster shall be laid slightly thicker than the specified thickness and the surface then levelled with flat wooden float to the required thickness. For two coat plaster work, the first coat (usually half of total thickness) shall be applied as detailed above except that the surface shall be left rough and keys formed for the application of second coat. The second coat shall be laid on with a wooden float to the specified thickness and shall be applied a day or two after the first coat has set, but has not dried up.

Cement mortar for plastering work shall be used within 30 minutes after adding water to cement and should be kept agitated at intervals of 20 minutes.

Unless otherwise specified cement punning shall be done over the plastered surface by sprinkling neat cement powder evenly on the surface and rubbed smoothly with a trowel to give a fine coating, at no extra cost. The plaster shall be kept wet for atleast seven days and protected from extremes of temperature and weather during this period.

The arrises of doors and windows shall have richer mortar 1:3 in a width of 75 mm on either side or as required at respective location.

7.3 Cement Pointing

7.3.1 Where shown on drawing, Schedule of Items, or as directed by the Engineer, exposed brick faces shall be cement rule pointed. The mortar shall be raked out of the joints to a depth of 12 mm. The dust shall be brushed out of the joints and the wall well wetted.

Unless otherwise specified the pointing shall be made with cement and sand mixed in proportion 1:3 with water proofing compound. The joints of the pointed work shall be neatly finished truly vertical and horizontal or as directed and the lines shall be kept wet till the cementing material has set and become hard. If required, the whole brick face shall be rubbed and polished with fine grade of carborundum stones. Particular care shall be taken to see that no brick face or brick edge is damaged during this work.

7.3.2 Flush Pointing

The mortar shall be pressed into the joints and shall be finished flush and levelled. The edges shall be neatly trimmed with trowel and straight edges.

7.3.3 Ruled Pointing

The joint shall be initially formed as for flush pointing and then, while mortar is still green, a groove of required shape and size shall be formed by running a forming tool straight along the centre line of the joint till a smooth and hard surface is obtained. The vertical joints shall also be finished in similar way. The pointing line shall be uniform in width and truly horizontal in case of floors and ceilings.
7.4  Rough Cast Concrete Facing

7.4.1 The surface shall be prepared as for Cement plaster and then 2 cm backing coat of cement sand mortar 1:3 shall be applied. Subsequently, a top coat 12 mm average thick cement and stone chips mixture in proportion 1:3 (stone chips 10 mm size and below) shall be applied by throwing the mixture on top with trowel to produce uniform rough texture. The surface shall afterwards be cured for 10 days. After curing, the surface shall be brushed with hard wire brush to remove loose chips from the surface. A coat of cement was shall then be applied.

7.4.2 Rendered sand faced cement plaster

The surface shall be cleaned of all dust and dirt and the brick work thoroughly watered. The backing coat shall be 12 mm thick of cement plaster proportion 1:4 (1 cement and 4 sand) and keys shall be formed on the surface. After curing this coat sufficiently, the finishing coat 6 mm thick consisting of grey cement and screened coarse sand to required gradation (1:3) shall be applied and finished to the desired texture to the satisfaction of the Engineer.

7.4.3 Plaster moulding

Where specified, plaster moulding shall be strictly as per drawings and details, and shall run clean and true from proper templates and moulds, to the entire satisfaction of the Engineer. Rates shall include for brick or concrete cores and for any necessary dubbing in cement mortar or brick or metal lath curing and final finish as desired. Where desired, all angles in internal moulding work shall be covered to a radius of 50 mm or as directed without any extra charges.

7.5  Punning with Lime or Plaster of Paris

7.5.1 Lime Punning

Lime punning shall be carried out with best quality approved lime. Lime shall be properly stirred, tempered with water to form a homogeneous mass and strained through fine cloth. The punning shall be laid and rubbed and trowelled to an uniform smooth even finish using special trowels. Any unevenness shall be rubbed down with fine sand paper. The plaster must be dry before the lime punning is applied.

The lime paste shall be kept wet until use and no more quantity than can be consumed in 10 days shall be prepared at a time.

7.5.2 Plaster of paris punning

This shall be provided by using the best quality of plaster of paris from approved manufacturer. Unless otherwise specified same procedure of lime punning shall be followed for getting uniform smooth finish.

8.0  FLOORING, PAVING & FACING

8.1 Scope

Flooring Paving and facing includes flooring, skirting and dado of various types encountered in plants, buildings, pavements etc. as described under respective heads.
8.2 Materials

Materials shall conform to Part-I of this series.

8.3 General

Flooring, skirting & dado may have to be done in discontinuous strips or areas to suit the needs of erection and commissioning of equipment. Flooring shall be done in close co-ordination with erection of equipment or other services and shall keep pace with the demands in respect of commissioning of individual equipment. No claims for extra shall be tenable for reasons of discontinuity of work or delay in having areas available for work.

Unless otherwise specifically included in the Schedule of Quantities or stated in the description of work, no extra shall be payable for works such as forming coves at internal angles, nosing at plinths, steps, window sills and stair treads, dishing in bath rooms and toilet and cutting to line and fair finish to top edge of skirting and dado. Thickness mentioned shall be the minimum.

8.4 Sub-base

Flooring at ground level having sub-base of sand or earth as specified shall be laid in layers of 15 cm, watered and consolidated by rolling with hand roller or ramming with iron rammer and with butt ends of the crow bars. When filling reaches the required level, the surface shall be flooded with water for 24 hours, allowed to dry and then rammed and consolidated to avoid any settlement later. The thickness of the sub-base shall be as specified either in the drawing or in the Schedule of Items.

8.5 Subgrade

The surface shall be brought to the desired level before subgrade is laid.

8.5.1 Hard core subgrade

Where hardcore subgrade is specified, stone/slag boulders/laterite boulders shall be laid closely stacked together, the longer edge being laid vertically. All interstices shall be filled with smaller particles of the same material or with gravel or red earth. The top surface shall be spread with loose moorum sufficient to cover the gap and to achieve uniform top surface. The surface shall then be adequately watered and rolled by roller.

Hard core shall be laid to form the desired slope in the finished floor.

8.5.2 Brick Khoa subgrade

Over burnt bricks shall be used for getting brick khoa as per sizes described in Schedule of Items. The khoa shall be laid uniformly and rammed in dry and wet conditions so as to get a uniform compact surface.

8.5.3 Concrete subgrade

The concrete subgrade shall be allowed to set for seven days and the flooring shall be laid in the next three days.
The flooring shall be commenced within 48 hours if the subgrade is of lean cement concrete, failing this, the surface of the subgrade shall be lightly brushed with steel wire, wetted and smeared with a coat of cement slurry @ 2 kg/sqm. to get a good bond between subgrade and flooring. The subgrade shall be provided with slope as specified.

8.6 Brick Flooring

Laying and finishing of brick flooring shall, in general conform to IS : 5766. Where dry brick paving is specified, the bricks shall be laid on their long edges on prepared subgrade or on rammed earth formed to desired slope in floor. Bricks shall be laid with gaps of about 6 mm, lightly tamped and brought to proper level and fall as indicated. The joints shall then be filled with sand.

Where bricks are specified to be laid in cement mortar, mortar mix shall be 1:6 (1 cement : 6 sand) unless otherwise shown on the drawings/Schedule of Items. When lime mortar is specified, mix proportions shall be 1:5 (1 lime : 5 surkhi) unless otherwise shown in drawings. Mechanical mixing shall be employed for preparing mortar unless otherwise permitted by Engineer. Cement mortar shall be consumed before initial setting has taken place. Bricks shall be sufficiently soaked in water before use.

Unless otherwise directed, the bricks shall be laid in herring-bone pattern with their long axes at 45°C to the length of the paving.

8.7 Cement Concrete Flooring with Integral Finish

Cement concrete shall be mixed, laid, consolidated and cured as described in Chapter “Concrete”. Laying of concrete shall be done in alternate panels. The size and division of panels shall be as per direction of Engineer. The mix or grade of concrete shall be as specified in Schedule of Items.

The finished surface may be rendered smooth using 2 mm thick neat cement slurry using 2.2 kg of cement per square meter area of flooring or may be trowel finished to provide an appearance of fine and smooth textured surface and in panels or in geometric pattern as specified in Schedule of Items or as directed by Engineer.

8.8 Concrete Flooring with Granolithic Finish (Artificial Stone Flooring)

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete. The subgrade shall be either brick khoa/lime concrete/cement concrete, as specified. Flooring shall be laid & finished according to IS : 5491.

8.8.1 Thickness

Unless otherwise mentioned, the thickness of flooring including topping shall be either 25 mm or 40 mm or 50 mm as shown on drawing. The net thickness of topping shall be 6 mm for 25 mm thick floor, 10 mm for 40 mm and 12 mm for 50mm thick floor.

An additional allowance of 2mm in thickness of topping shall be made for cutting and grinding margin wherever polishing is specified in the item. The rate of item will be inclusive of this.

8.8.2 Mix
For base or under bed course, the mix shall be 1:2:4 concrete, unless specified otherwise. The mix of the topping shall consist of 1 part cement :1 part coarse sand : 2 parts coarse aggregated by volume. The coarse aggregate shall very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

8.8.3 Laying

a) Laying of monolithic topping

The concrete base or under bed shall be laid as per specification "Cement Concrete" and levelled up to the required grade. The surface shall remain sufficiently rough to take the finish.

For large areas the laying shall be in panels of maximum 2.5 sqm. area. The panels shall be laid in chequered board pattern. Within about 3 hours of laying the base while it is still fully 'green' the topping shall be laid evenly to proper thickness and grade. The tapping shall be pressed firmly and rigorously to form full board with the base/under bed.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips. The trowelling of flooring shall be such that a fine smooth textured appearance comes.

(b) Laying of topping separately on hardened base

The base concrete shall be prepared as stated in Clause 2.4 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc., shall be same as for monolithic topping.

8.8.4 General

The junction of the floors with all plaster dado or skirting shall be rounded of with 1:1 cement sand mortar & polished.

8.8.5 Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for atleast 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to use during this period.

8.8.6 Grinding & finishing

Where grinding is specified, it shall start only after the finish has fully set. The grinding shall be done with carborundum stone of No. 60, then No. 80 and then 120 as per the method as specified in in-situ mosaic flooring. After final polishing, the floor shall be rubbed with oxalic acid and then wax polished.
8.9  **Dado & Skirting Work (Grey Cement Skirting/Dado)**

A backing coat of 12 mm thick and 15 mm thick shall be applied on walls after proper dabbing of the surface for a finished thickness of 18 mm and 21 mm thick respectively, with cement plaster of proportion 1:4 (1 cement and 4 approved quality sand). Over this a top coat 6 mm thick consisting of one cement to one stone chips 3 mm nominal size shall be applied. If grinding and polishing specified, the same shall be done as per granolithic flooring with carborundum stones.

8.10  **Terrazzo Flooring & Facing**

**General**

The terrazzo work shall be done by an approved firm or specialists. Marble clips used for facing coat of terrazzo work shall be of best quality (from Dehradun or other approved source and of uniform tint and colour and shall be approved by the Engineer before using in the work. All terrazzo work shall be polished on completion followed by a final wax polish of approved quality.

Terrazzo work shall be done either cast-in-situ or with precast tiles as specified in the Schedule of Quantities Unless otherwise specified thickness for cast-in-situ terrazzo work shall be 25 mm including base course and for tiles 20 mm excluding mortar bed.

The rate for terrazzo work shall include any coving of internal angles, nosing at plinth, steps and sills, set backs, mitres, flashing as per direction of the Engineer.

8.10.1  **Cast-in-situ terrazzo flooring**

It shall consist of an underbed and a tapping laid over an already matured concrete subgrade.

8.10.1.1  **Thickness**

Unless specified otherwise, the total thickness of the finished flooring shall be either 25 mm or 40 mm of which the tapping shall be minimum 6 mm (net) for 25 mm and minimum 10 mm for 40 mm flooring. A minimum allowance of 2 mm in the tapping shall be kept for grinding and polishing so as to achieve the minimum specified thickness of tapping.

All junctions of vertical with horizontal planes shall be rounded neatly to uniform radius of 25 mm.

8.10.1.2  **Mix**

i)  **Underbed course**

The underbed for floors and similar horizontal surface shall consist of a mix of 1 part cement, 2 parts sand and 4 parts stone chips by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only minimum water to be added to give a workable consistency.

ii)  **Topping**
Topping shall consist cement (grey or white) as specified with or without colour pigment, marble powder and marble chips. The proportion of cement and marble powder shall be 3 parts of cement to one part of marble powder by weight.

The proportion of marble chips to 4 parts of cement marble powder mix mixed by volume. For grey chocolate or similar shades ordinary cement with approved colouring pigments may be used instead of coloured cements. Care shall be taken to ensure an even and uniform disposition of the marble chips.

8.10.1.3 Laying

i) Laying of underbed

The underbed shall be laid in alternate lays of chequered pattern. The panels shall not be more than 2 sqm. in area of which no side shall be more than 2.0 m long. For exposed locations the maximum area of a panel shall be 2.0 sqm. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent. Cement slurry @ 2 kg/sqm. shall be applied before laying over cement concrete/RCC surface/plastered surface.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plug topping. In case of in-situ dado work, the sections shall not be more than 60 cm x 60 cm and the aluminium, glass or any other material strips provided similarly. (The cost of these strips shall be held covered by the rate for terrazzo work unless otherwise specified).

ii) Laying of topping

After laying, the underbed shall be levelled compacted and brought to proper grade with screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat 'green' but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly land brushed in just before laying the toppling. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in an even pattern of distribution.

8.10.1.4 Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

8.10.1.5 Grinding & polishing

After 48 hours of laying of floor when floor is hardened, first cutting shall be done with special rapid cutting grit of coarse grade (no. 60) till the marble chips are evenly exposed and floor is smooth. The floor shall then be washed and cleaned to remove mud and grindings, a grout of cement and colouring pigment in same proportion of the topping
shall be applied to cover the pin holes. The surface shall be cured for 5 to 7 days and then ground with machine fitted fine grit blocks (No. 120). The surface shall be again cleaned and repaired as mentioned above and shall be cured for 3 to 5 days. Finally the third grinding shall be done with machine fitted with fine/grade clocks (No. 320) to get even and smooth surface without pin holes. The finished surface should show the marble chips evenly exposed.

Where use of machine for polishing is not feasible/possible rubbing and polishing by hand shall be done in the same manner as specified for machine polishing except that carborundum of coarse grade (No. 60, 80 and 120) for first, second & final polishing. After the floor is polished to the satisfaction of the Engineer, it shall be rubbed with oxalic acid and finally wax polished with 'Mansion' or similar approved floor polish to the entire satisfaction of Engineer.

### 8.10.2 Terrazzo cast-in-situ facing, skirting and dado

The work shall be carried out in the same manner as that for terrazzo cast-in-situ floors except that the base or bedding course shall consist of 1:3 cement mortar (1 cement & 3 medium sand) of 12 mm or 15 mm or 19 mm thickness or total thickness 18 mm or 21 mm or 25 mm respectively. As specified earlier, the bedding course shall be laid in panel (not more than 60 cm x 60 cm) divided by glass/ aluminium strips minimum thickness. The topping shall be of 6 mm thick finished and shall be laid when the backing plaster is still green. Special care shall be taken to see that the surface are properly cured.

### 8.10.3 Terrazzo tile finished flooring/facing

The work will consist of manufa ctured terrazzo tile and an underbed.

#### 8.10.3.1 Thickness

The total (net) thickness including the underbed shall be 40 mm for flooring and other horizontal surface and 32 mm for vertical surfaces like dado/skirting. The necessary allowance for cutting and grinding shall be kept to have the specified finished thickness.

#### 8.10.3.2 Tiles : terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tiles shall be pressed hydraulically to a minimum of 140 kg. per sqcm.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 8 mm (net) for flooring & 6 mm (net) for vertical surface. The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary grey cement and 3 parts of stone chips by weight mixed with water.

The ingredients for topping shall be same as cast-in-situ terrazzo. The thickness of the topping, as specified above, shall be net after grinding & polishing. First grinding shall be given to the tiles at the shop before delivery.
The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles.

8.10.3.3 Mix: underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty: 1 part surkhi: 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surface it shall be about 12 mm thick and composed of 1 part cement 3 parts coarse sand by weight.

8.10.3.4 Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The base surface shall be roughened for better bond. Before laying the underbed, over the base/subgrade a coat of cement slurry shall be applied over the subgrade. Before the underbed has time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect. When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moistened allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Cl may be used for dividing the work into suitable panels.

8.10.3.5 Grinding and polishing

Procedure shall be same as in-situ terrazzo finished flooring. Grinding shall not commence earlier than 14 days after laying of tiles.

8.11 Glazed Tile Finished Flooring & Facing

This finish shall be composed of glazed earthen coarse tiles with an underbed laid over a concrete or masonry base.

8.11.1 Thickness

Unless specified the total thickness shall be 21 mm for flooring & 18 mm for dado/skirting the underbed.

The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.
8.11.2 Tiles : Glazed

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 6 mm thick unless otherwise specified. The tolerance shall be plus or minus 1.5 mm for length and breadth and plus or minus 0.5 mm for thickness. Specials like internal and external angles, beads, covers, cornices, corner pieces etc., shall match. The top surface of the tiles shall be glazed with a gloss or matt unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform, and fractured section shall be fine grained in textures, dense and homogeneous.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

8.11.3 Mix : underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water of any other mix if specified.

8.11.4 Laying & finishing

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. Before laying the underbed, over the base/subgrade of coat of cement slurry shall be applied over the subgrade. Before the underbed has time to set and while it is still fairly moist but firm, cement shall be hand dusted over it and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The joints shall be practically invisible and filled with non-staining white cement/white cement mixed with pigment for coloured tiles. Internal angles shall be provided with 'specials' and a 75 mm high border of approved colour shall be provided at the top of dado. Drains shall be provided with 'specials'. The tiles shall be thoroughly cleaned after completion. The tiles shall be laid to the slope specified in the drawings and truly vertical on walls when used as skirting.

8.11.5 Curing & cleaning

After flushing painting the treatment cured for 7 days by keeping it wet. The surface shall be then cleaned with soap or suitable detergent, washed fully and wiped with soft cloth to prevent scratching before handling over.

8.12 Chemical Resistant Tiles Flooring/Facing

Either of natural stone or prepared tiles

This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry. The Contractor shall get it done by specialised manufacturer & get guarantee of performance.

8.12.1 Tiles

The chemical resistant tiles as detailed in the Schedule of Items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour and textures.
Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have atleast compression strength of 700 kg/cm². The surface shall be abrasion resistant and durable.

8.12.2 Laying

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

8.13 Chemical Resistant in Situ Finished Flooring/Facing

Chemical resistant in situ finish shall be as called for in the Schedule of Items. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The Contractor shall get it done by a specialised manufacturer, get guarantee of performance from the organisation and pass it on to the owner in addition to his own guarantee.

8.14 Mastic Asphalt Flooring

8.14.1 General

The type and thickness of flooring, viz., heavy duty, acid resisting etc., the treatment of the sub-floor and the type of finish shall be as per Schedule of Items or as shown on drawings or otherwise directed by the Engineer. The flooring shall be laid to the levels or slope shown on drawings, skirtings and channels and outlets for drainage shall similarly be provided, and the floor shall be laid and finished in accordance with the Indian Standard Code of Practice for laying Mastic Asphalt Flooring IS : 1196. The work shall be done by a firm of specialists approved by the Engineer.

The flooring shall be done with Asphalt concrete in heated condition at temperature range of 180°C to 205°C and the workmanship should be in such a manner that the finished floor shall be quite hard, resilient, heavy duty abrasion resistant and impervious. The weight of the asphalt concrete shall be approximately 2.2 T/M³ and the hardness number of the mastic asphalt, without coarse aggregates, at 35°C shall remain within 4 to 10.

8.14.2 Material

Binder : It shall be blown grade bitumen conforming to IS : 702 and preferably 85/25 or 95/15 grade bitumen shall be used.

Fine Aggregates : Asphalt concrete when used for flooring, the fine aggregates shall be specifically graded silica powder or any approved inert material graded suitably. If lime stone powder is used the calcium carbonate content shall not be less than 80% by weight. For any floor where no acids or alkalies come in contact the lime stone powder can also be used.
The gradation of the fine aggregates shall conform to Table-II of IS : 1195.

Coarse Aggregate : It shall be either siliceous sand or crushed silicious stone suitably graded and the gradation shall conform to Table-III of IS : 1195.

8.14.3 Composition for asphalt concrete

The percentage of coarse aggregates shall approximately conform to table-IV of IS : 1195.

However, average proportion will be as under by weight.

Bitumen    - 18 to 22%
Cement   - 5%
Fine Aggregates  - 35% to 45%
Coarse Aggregate - 30% to 40%

8.14.4 Preparation of mastic asphalt

(i) Fine aggregates and coarse aggregates to be fried on different container upto a temperature of 170°C to 205°C.

(ii) The bitumen shall be heated to a temperature of 180°C.

(iii) Then the beated bitumen shall be mixed with the fired aggregates (both fine & coarse) and cement and the whole thing shall be cooked in a cooking plant or in any approved form for a period of 5/6 hours until the materials are thoroughly mixed and the temperature at no time shall exceed 205°C.

8.14.5 Laying of asphalt concrete

(i) Cleaning surface to make free from all the foreign materials upto the satisfaction of the Engineer.

(ii) Applying of one coat of primer in form of emulsion consisting of not less than 50% of bitumen in weight.

(iii) Providing one coat of hot bitumen (for vertical face blown grade is essential) for fixing the underlay over it.

(iv) Providing one layer of "underlay" over item (iii) above and that underlay shall be made of hassian saturated in bitumen.

(v) Providing one coat of hot bitumen over the "Underlay" (the bitumen shall conform to either IS : 73 or IS : 702 as desired by the Engineer).

(vi) The prepared asphalt concrete is then put in position and laid with hot trowels (temp. of trowels not less than 200°C) by continuous rubbing with constant pressure.
(vii) The finishing coarse: Applying one coat of hot bitmen of low penetration and high softening point. The surface should be finished by continuous rubbing to give a glazy finished surface up to the full satisfaction of the Engineer.

8.14.6 Sampling and testing

Before commencing the works the Contractor shall make at site sufficient nos. of samples of different compositions as specified in sub-head 20.3 for testing of the mastic asphalt as specified in the relevant IS codes and for approval of the Engineer.

After approval of the sample by the Engineer, the Contractor shall start the work and that will be carried on the basis of the composition of the approved sample. The work shall be checked and tested at regular intervals. The Contractor shall supply at least 10 nos. of properly made samples per 1000 M2 of the works for testing and the test results of the samples must tally with the result of approved sample.

All the costs regarding sampling, testing etc., shall be borne by the Contractor.

8.15 P.V.C. Sheet/Tiles Flooring

8.15.1 Base

It shall be laid on a base that is finished even and smooth such as concrete, metal or timber boarding.

8.15.2 Materials

The P.V.C. flooring material shall conform to IS : 3462-1966. It shall consist of a thoroughly blended composition of thermoplastic binder, filler and pigments.

8.15.3 Adhesive

Rubber based adhesives are suitable for fixing PVC flooring over concrete, wooden and metal sub-floors, PVA based adhesives may be used for concrete and wooden sub-floors. PVA based adhesives are not suitable for metallic surfaces and also for locations where there is constant spillage of water.

8.15.4 General

Sheets can be used for flooring. But for skirting only the tiles shall be used. The colour & texture shall be as approved by the Engineer.

8.15.5 Preparation of base/sub grade

Before laying PVC sheets/tiles, it is essential to ensure that the base is thoroughly dry and damp-proof. In case of new work a period of 4 to 8 weeks shall be allowed for drying the sub-floor under normal conditions.

In concrete sub-floors the same shall be painted with two coats of bitumen (conforming to IS : 1580-1969) applied at the rate of 1.5 kg/sq.m.

Over that a levelling course of specified thickness (if not specified the same may be of
average thickness of 15 mm) with 1:4 cement course sand mortar shall be provided with a finish just suitable to receive the flooring sheets/line. After that, the same shall be cured and then made dry.

8.15.6 Laying and fixing

Before commencing the laying operations, the sub-floor shall be examined for evenness and dryness. The sub-floor shall then be cleaned with a dry cloth.

The adhesive shall be applied by using a notched trowel to the sub-floor and to edge and to the back side of the PVC sheet or tile flooring. When the adhesive is just tack free the PVC flooring sheet/tiles shall be carefully laid in position the air will be completely squeezed out between the sheet and the background surface. After laying in position, it shall be pressed with suitable roller to develop proper contact with the sub-floor. The sheets shall be laid edge to edge so that there is minimum gap between joints. The alignment should be checked after laying of each row of sheet is completed. If the alignment is not perfect, the sheets may be trimmed by using a straight edge.

Any adhesive which may squeeze up between sheets or tiles should be wiped off immediately with a wet cloth before the adhesive hardens. If, by chance, adhesive dries up and hardens on the surface of the sheet or tile, it should be removed with a suitable solvent.

8.15.7 Protection and finish

A minimum period of 24 hours shall be given after laying the flooring for developing proper bond of the adhesive. During this period, the flooring shall not be put to service. It is preferable to lay the PVC flooring after the completion of plastering, painting and other decorative finish works so as to avoid any accidental damage to the flooring.

When the flooring has been securely fixed, it shall be cleaned with a wet cloth soaked in warm soap solution (two spoons of soap in 5 litres of warm water).

8.16 Acceptance Criteria

The Contractors shall satisfy the Engineer specially for the workmanship of the following finished floor:

(a) Level, slope, plumb as the case may be
(b) Alignment of joints, dividing strip etc.
(c) Colour, texture
(d) Surface finish
(e) Thickness of joints including the workmanship in joints.
(f) Details at edges, junctions etc.
(g) Performance
(h) Precautions specified for durability.

9.0 WOOD WORK

9.1 General

Wood work shall be neatly and truly finished to exact dimensions and details as per drawings, without patching or plugging of any kind and rebates, roundings and mouldings as shown in drawings made before assembling. Exposed work shall be finished smooth
with well planed faces.

All assembly of shutters of doors, windows, ventilators and frames thereof shall be exactly at right angles. In the case of frames, the right angle shall be checked from the inside surfaces of the respective members.

All door and window frames shall be clamped together so as to be square and flat at the time of delivery. Door frames without sills shall be fitted with temporary stretchers.

Horns of frames and other parts that go into or butt against the masonry, shall be protected against moisture and decay with two coats of coal tar or other approved protective material.

All surfaces of the door, window and ventilator frames and shutters which are required to be painted ultimately shall be covered evenly by brush painting with a priming coat of a white lead based primer. In the case of doors to be polished or varnished, a priming coat of approved polish or varnish shall be given before delivery. No primer shall be applied to the wood work until it has been inspected and passed by the Engineer.

9.2 Joinery

All heads, posts, transoms and mullions etc., of doors, windows and ventilators shall be made out of single pieces of timber only. The heads and post shall be through- tenoned into the mortices of the jamb posts to the full width of the latter and the thickness of the tenon shall be not less than 1.25 cm. The tenons shall be close fitting into the mortices and pinned with corrosion resisting metal pins not less than 8 mm diameter or with wood dowels not less than 10 mm diameter. The depth of rebate in frames for housing the shutters shall in all cases be 1.25 cm and the rebate in shutters for closing in double shutter doors or windows shall be not less than 2 cm.

Unless otherwise specified, all joints shall be mortice and tenon joints with the ends of the tenons exposed to view. Joints shall fit truly and fully without fillings. The contact surfaces of tenons and mortices shall be treated, before putting together, with an approved adhesive conforming to the relevant IS specifications.

9.3 Shrinkage & Tolerance

The arrangement, joining and fixing of all joinery work shall be such that shrinkage in any part and in any direction shall not impair the strength and appearance of the finished work.

The tolerance on overall dimensions shall be within the limits prescribed in IS:1003.

9.4 Fixing

Door and window frames shall generally be built in at the time the walls are constructed. Alternatively, where permitted by the Engineer, the frames may be subsequently fixed into prepared openings for which purpose holes to accommodate the hold fasts shall be left at the time of construction. The method of fixing shall be as described elsewhere in these. Where the frames are subsequently fixed into prepared openings in the wall such openings should be 25 mm more than the overall width of the door, window or ventilator frame to allow minimum 12.5 mm plaster on each jamb. The height of the unfinished opening shall depend upon whether a threshold is required or not. While
fixing the door care shall be taken to see that at least 6 mm space is left between the door and the finished floor. The MS clamps fixed to the frame shall be inserted in the holes and jammed in cement concrete M-15 with 10 mm down graded stone chips after holding the frame in proper position to the line level and plumb.

9.5 Tarring

Timber in contact with earth, concrete, plaster or masonry shall be treated with one coat of coal tar before fixing in position.

9.6 Fittings

on each side of a door frame, one at the center point, and the other two at 30 cm from the top and the bottom of the door frames. In the case of windows and ventilators, a pair on each side shall be fixed at quarter points of the frames. Unless otherwise specified the hold-fasts shall be of mild steel plate 40 x 3 x 250 mm long, fish tailed at one end and screwed to the frame in the formed rebates.

Generally, each door shutter shall be fixed to the frame with three hinges of approved manufacture, one at the center and the other two approximately 24 cm from the top and bottom of the shutter. Each window shutter shall be fixed to its frame with two hinges at the quarter points.

Locks, handles, door closers, stoppers etc., shall be fitted as shown in drawing or described in the Schedule of Items.

9.7 Doors, Windows and Ventilators

Dimensions of the various components of doors, windows and ventilators shall be in accordance with IS : 1003, Table- III or as shown on the drawings.

9.8 Paneled Shutters

Solid wood panels shall be made of one or more pieces of timber, preferably not less than 12.5 cm nor more than 20 cm in width, as specified in IS : 1033. When made from more than one piece, the piece shall be joined with a continuous tongue and groove joint, glued together and reinforced with metal dowels. Unless otherwise specified, the thickness of the panels for 4 cm thick shutters shall be 2 cm and that for 2.5 cm thick shutters, 1.25 cm.

9.9 Glazed Shutters

The openings for glazed shutters shall be rebated and moulded out of solid timber, and shall be provided with mitered glazing beads, loosely fixed in position. Plain sheet glass for panels shall be of approved quality as specified earlier. Wherever specified, ground glass or frosted glass of approved quality shall be used in place of plain sheet glass.

9.10 Flush Door Shutters

Unless otherwise specified, flush door shutters shall be not less than 4 cm thick, with a solid/cellular core, a teak wood frame, and faced with approved quality of plywood on both faces. The core and stock shall be made from well seasoned approved timber and treated with approved preservatives. The plywood faces shall be glued on to the
solid/cellular core with waterproof glue under pressure. The construction of flush doors shall be such that no difficulty should arise in fixing mortice locks, hydraulic door closers etc. The shutters shall be rebated in the case of the double leaf doors.

9.11 **Wire Mesh Shutters**

The wire gauze shall be bent in angles in the rebates of stiles and rails, turned and fixed tight with blue tacks at about 75mm fixed alternately in the two faces of the rebates. Over this, wooden heading shall be fixed with brads or small screws at about 75mm centres.

9.12 **Hand rails**

Hand rails of width and depth as specified in the item shall be measured in running meters up to two places of decimal.

9.13 **Cupboard Shelves etc.**

Planks for shelves shall be planed on all faces and edges. In case of boards they shall be sawn to the required size truly straight and square. Timber battens 25 x 40 mm unless otherwise specified shall be planed smooth and fixed inside the cupboard with wooden plugs and screws. Shelves shall be fixed to the battens and vertical portions shall be held in position by fixing them to the battens and shelves using screws. hardwood strips for edge sealing of the boards shall be planed smooth and fixed with headless nails. Tolerance in width shall be ±1.5mm and in thickness 1 mm.

9.14 **Hardware Fittings for Doors, Windows & Ventilators**

All mortice or rim locks, latches, cabinet and wardrobe locks, hydraulic door closers, floor springs etc. shall be of Godrej, Everite make or of similar approved make. The rate shall include for all necessary screws, other adjuncts, fixing in position and is for the completed work. The finish shall be as specified in the schedule of quantities. Door, window and ventilator fittings shall be as per specifications already described. The rates for doors, windows and ventilator shutters shall include the cost of fixing the fittings, with the necessary screws to the shutters and the frame. The cost of fittings only shall be paid separately. Where specified in the schedule of quantities, the cost of fittings shall be included in the rates for doors, windows and ventilator shutters. In such case the contractor shall supply and fix the various fittings strictly to the standard laid down in the schedule of hardware fittings and no separate payment for this shall be made.

9.15 **Inspection**

The Contractor shall provide all facilities to the Engineer for the inspection of the goods at his premises. No primer shall be applied to wood work until it has been inspected and passed by the Engineer. The Engineer shall have the option of rejecting any article or asking for replacement of any article found to be defective or not complying with the requirements of this specification and the relevant Indian Standards.

10.0 **METAL DOORS, WINDOWS, VENTILATORS & COLLAPSIBLE GATES**

10.1 **General**

Doors, windows and ventilators etc., shall be truly square and flat, i.e. free from twist and warp. The general fabrication shall conform to IS : 1038 and IS : 1361 as appropriate.

10.1.1 Frames shall be constructed of sections which have been cut to length and mitered.
They shall be morticed, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Flash butt welded construction with mitered corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall be brought to site with floor ties/weather bars installed in place. All frames shall be square and flat. Door thresholds shall be provided as shown on drawing. Doors without threshold shall have bottom tie of approved type.

10.1.2 The Contractor shall obtain doors, windows, ventilators etc., from an approved manufacturer. The Contractor shall first submit for the approval of the Engineer, the name and address of the manufacturer whose metal casements and doors and windows he intends to use, together with typical drawings and specifications, describing the details of construction for each type of door/window/ventilator etc.

10.1.3 All steel doors, windows and ventilators shall be either galvanized or painted. All steel surfaces shall first be thoroughly cleaned free of rust, scale or dirt and mill scale by pickling or similar process and they shall be painted with one coat of an approved primer conforming to IS : 102 before despatch. Alternatively they may be galvanized by the "Hot Dip" zinc spray or electro-galvanizing process as described in IS : 1361.

10.2 Fixing

Doors, windows and ventilators shall not be built in at the time the walls are constructed but shall be subsequently fixed into prepared openings, as laid down in IS : 1081. Holes to accommodate the fixing lugs are to be left or cut, and the casements fixed after all the rough masonry and plaster work have been finalised. The lugs of the casement shall be jammed in cement concrete (15C Mark) after holding the casement in proper position, line and level.

The width of the clear unfinished opening in the wall should be 25 mm more than the overall width of the door frame to allow for 12.5 mm plaster on each jamb. The height of the unfinished opening shall depend upon whether a threshold is required or not. While fixing the door, care shall be taken to see that at least 6 mm space is left between the door and the finished floor.

10.3 Fittings

Hardware shall be fixed as late as possible, preferably just before the final coat of paint is applied. It shall be fitted in a workmanlike manner, so that it may not work loose and in such a way that screws and pins are not marked and mutilated by hammers and screw drivers. It shall be tested for correct operation. Where specified, doors shall be fitted with a three-way bolting device which can be operated from outside as well as inside, and a locking system, which can similarly be operated from either side. Solid steel bolt handles shall be provided, one on the outside and one on the inside of each shutter. In case of doors provided with a service door, the lock shall be fitted on the service door. All materials shall be the best procurable and shall conform to the relevant IS specifications.

10.4 Normal Steel Plate Doors

Steel doors may be of the hinged type or sliding/folding type, single shutter or double shutter, and of single-walled or double walled construction, as specified on the drawings.
or Schedule of Items. All doors shall be provided with a sturdy frame and hold fasts for fixing into the wall. Unless otherwise specified, the frame shall be prepared from mild steel angles of size not less than 65 x 65 x 6 mm electrically welded at the corners and the shutter shall be made from flat steel sheet of 18 gauge thickness with a frame of mild steel angles not less than 50 x 50 x 6 mm all round, suitably braced. The whole shutter shall be of welded construction and shall be hung at the sides by means of three or four hinges as specified.

10.4.1 Double Plate flush door shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of two outer sheets or 18G steel sheets, rigidly connected and reinforced inside with continuous vertical 20G stiffeners, spot welded in position at not more than 150 mm on centres. Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and head, shall have proper level on lock stiles and rails and shall be reinforced at corners to prevent sagging or twisting. Spires or double doors shall have meeting style edges beveled or rebated. Where shown on drawing, or in the Schedule of Items, the doors shall be sound-deadened by filling the inside voids with mineral wool or other suitable approved materials. Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push-plates and other surface hardware where necessary. Any drilling and tapering required for surface hardware shall be done at site. Where shown in drawing, provisions, shall be made for fixing glazing, vision panels, louvers etc. Glazing mouldings shall be of 18 g steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louver blades shall be V or Z shaped sections.

10.4.2 Single sheet door shutters

Single sheet doors shall be made from best quality 18g mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with a semitubular edge and central stiffening rail which shall convey the lock and other fixture. The frames shall be made from best quality steel sections. Wherever required or shown on drawings, provision for fixing glass panes, louvers etc., shall be made.

The manufacturing shall done as specified in "Double Plate Flush Door Shutters".

10.5 Sliding Doors

Shall be either double plate or single plate construction as shown in drawings and Schedule of Items, made out of 18 gauge steel sheets with adequate stiffeners. The Contractor shall specify the weight of the door in his shop drawing and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where shown in drawings or in the Schedule of Items, the Contractor shall make provision for openings in the door for mono-rail beams. Doors when closed shall effectively exclude rain water from seeping in. When called for in schedule, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

10.6 Pressed Steel Doors
All pressed steel doors shall be obtained from an approved manufacturer. The frame and shutters shall be fabricated from cold rolled or pressed steel sections. Unless otherwise specified, the thickness of all sheets used for frames shall be not less than 5 mm. The shutters shall be made of sheet steel of 2 mm thickness for single shutter doors and double shutter doors with or without service door. The plates shall be adequately stiffened with suitably placed stiffeners.

The double-walled door shutter shall consist of two plates each 2.5 mm thick, separated by a gap of 33 mm in between making an overall thickness of 38 mm or as shown in drawing. The plates shall be adequately stiffened by means of suitably spaced horizontal steel stiffeners.

10.7 Steel Windows, Sashes, Ventilators, etc.

These shall conform to IS : 1038 and IS : 1361 as appropriate and as shown in drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc.

10.7.1 Where composite unit openings are shown in drawings, the individual window units shall be joined together with requisite transoms and Mullions. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown in drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

All welds at the corner of casement shall be done by flash butt welding process and dressed flush on all exposed and contact surfaces.

10.8 Collapsible Gate (Steel)

Mild steel collapsible gates shall be obtained from an approved manufacturer. These shall be of mid bar type made out of double channels each 20 x 10 x 2 mm with 20 x 5 mm diagonals and shall be top hung with roller bearings, and fitted with locking arrangement.

Collapsible gates under 3.0 meter height shall generally have 3 sets of lattices and those over 3.0 meter height, 4 sets of lattices. Guide tracks shall be fitted at the top and bottom, of T-iron 40 x 40 x 6 mm with 40 mm dia bearings in every fourth double channel.

10.9 Aluminium Doors, Windows, Frames

10.9.1 Anodised tubular aluminium doors shall be of approved make and shall be of size and design as per relevant drawing. Unless otherwise specified, the door frame shall be of 101.4mm x 44.6mm and shutter of 50mm tubular extrusions, 3mm thick. The opening arrangement shall be single action or double action as shown in drawings with spring hinges in floor. The glazing shall be 5.5mm thick plain glass panes fixed with necessary gaskets and aluminium beading strip. The door shall be provided with one security lock. The shutters shall be provided with 1.6mm thick 300 x 150mm push plates and 1.6mm thick 300mm wide kick plate of anodised aluminium for full width of door inside and outside.
The door frames shall be polished and anodised with approved colour. The average thickness of anodic coating shall not be less than 15 microns as per IS:1868-1982. Door frame shall be provided with approved anchors @ 90cm c/c maximum for fixing.

10.9.2 Aluminium Windows

Aluminium windows and ventilators shall conform to IS:1948-1961 or equivalent as approved by the Engineer. Fixed frame shall be manufactured from aluminium alloy conforming to ISS-HE-9 WP. The fixtures like handles, stoppers, stays, etc., shall also be anodized aluminium and shall be of approved make. Glazing shall be 4mm thick plain glass and shall be fixed with glazing clips and metal putty. It shall conform to IS:1081-1960. Average anodizing coating to windows ventilation and fixtures shall not be less than 15 microns as per IS:1868-1982.

10.9.3 All work shall be fitted and shop assembled to a first job, and ready for erection. Shop joins shall be made to hair lines and then welded or braced by such method as will produce a uniform colour throughout the work. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be shaped to fit type without visible screws and shall be of sizes to accommodate glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

11.0 GLAZING

11.1 General

Glazing shall be done with plain, frosted or ground glass or wired cast glass as shown on drawings, described in the Schedule of Items or approved by the Engineer. The method of glazing adopted shall be such that movement of the structure, to which the securing is done, does not transmit strain to windows, doors or ventilators as the case may be. The work shall generally conform to IS : 1081, Code of Practice for Fixing and Glazing of Metal Doors, Windows & Ventilators. The material for putting shall consist of whiting and linseed oil, raw-mixed in such proportion as to form a paste conforming to IS : 419.

11.2 Doors, Windows, Ventilators, etc.

Windows and ventilators shall be designed for putty glazing fixed from outside and glazed doors for fixing from inside. In addition, spring type glazing clips shall be provided at intervals of 30 cm, or as shown otherwise on drawings or described in the Schedule of Items. These shall be inserted into holes drilled in the shutters or frames as the case may be.

All glazing shall be puttied to the shutters or frames with good quality putty in addition to glazing clips. Glass panes shall not be placed directly against the metal/timber. A thin layer of putty shall be evenly spread over the glazing rebate and the glass pressed firmly against it. It shall be secured in position by means of teak wood beds for wooden shutters. Glass panes shall be sent without spraining and shall be bedded in putty and back puttied, except where moulding or gasket are specified. Putty, mastic cement etc., shall be smoothly finished to even lines. Figured glass shall be set with smooth side out. After completion of glazing work, all dirt stains, excess putty etc., shall be removed and the glass panes shall be left in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the Contractor's cost.
11.3 Fixed Glazing

This shall consist of steel glazing bars as shown on drawings or described in the Schedule of Item and be subject to approval of Engineer. The glazing parts shall be securely fixed in their frame and shall be weather-proof. All glazing shall be flashed to the surrounding so as to be weather-proof. Glass shall be fixed to the a strangles with glazing clips and putty.

12.0 WHITE WASHING, COLOUR WASHING AND PAINTING

12.1 Scope

This chapter deals with white washing, colour washing, distempering, cement washing, emulsion painting, silicate painting etc., to concrete and masonry surfaces and painting to the wood works and steel works.

12.2 Materials

Materials shall conform to Part-I of this series.

12.3 White Washing, Colour Washing

12.3.1 General

Wherever scaffolding is required/necessary, it shall be erected on double support tied together by horizontal pieces, over which the scaffolding planks shall be fixed. No part of it shall rest on or touch the surface which is being washed. Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls. For white washing the ceiling, proper stage scaffolding shall be erected. The surface on which wash is to be applied shall be thoroughly brushed free from mortar droppings and foreign matter.

12.3.2 White wash

The wash shall be prepared from fresh stone white lime of approved quality and shall be thoroughly slaked on the spot mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for 24 hours and then shall be screened through a clean course cloth. 4 Kg of gum dissolved in hot water shall be added to each cubic meter of the cream.

The approximate quantity of water to be added in making the cream will be 5 litres of water to 1 kg of lime. Indigo upto 3 gm per kg of lime dissolved in water shall then be added and wash stirred well. Water shall then be added at the rate of about 6 litres per kg of lime to produce a milky solution. The white wash shall be applied with approved brushes to the specified number of coats. The operation for each coat shall consist of stroke of brush given from the top downwards, another from the bottom upwards over the first stroke and similarly one stroke horizontally from the right and another from the left before it dries.

Each coat shall be allowed to dry before the next-one is applied and shall subjected to inspection and approval by the Engineer. No portion of the surface shall be left out initially to be patched up later on.
The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed. Doors, windows, floors and such other parts of the building not to be white washed shall be protected from being splashed upon.

12.3.3 Colour wash

A priming coat of white wash with lime shall be applied before applying two or more coats of the colour wash (as specified). Entire surface should represent a smooth and uniform finish. Sample of colour wash shall be duly approved by the Engineer before application. Same specification as that of white wash shall be followed for colour wash also using necessary amount of colouring ingredient of approved tint.

12.3.4 White washing with whiting

Whiting (ground white chalk) shall be dissolved in sufficient quantity of hard water and thoroughly stirred to form a thin slurry which shall then be screened through a clean coarse cloth. 2 Kg of gum and 0.4 kg of copper sulphate dissolved separately in hot water shall be added for every cum. of slurry which shall then be diluted with water to the consistency of milk so as to make wash ready for use. Other specification remains same as per white washing with lime.

12.4 Cement primer coat

The surface shall be thoroughly cleaned of dust etc., and shall be allowed to dry for at least 48 hours. It shall then be rubbed thoroughly be sand paper to give a smooth and even surface. Any uneveness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry. The cement primer shall preferably be applied by brushing and not by spraying. Horizontal strokes shall be given first and vertical strokes shall be applied immediately, afterwards. This entire operation will constitute one coat. The surface shall be finished as smooth as possible, leaving no brush marks.

12.5 Water proof cement paint

The prepared surface shall be thoroughly wetted with clean water before water proof cement paint is applied. The paint shall be prepared strictly as per manufacturer's specifications, in the absence of which it shall be mixed in two stages. The first stage shall comprise of 2 parts of water proof cement paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. The paint shall be mixed in such quantities as can be used up within an hour of its mixing.

Paint shall be applied with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that direct heat of the sun on the surface is avoided. Method of application shall be similar to oil bound distemper. The completed surface shall be watered, after the day's work. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted and a uniform shade should be obtained after application of paint. Cement paint shall not be applied on surfaces already treated with white wash, colour wash, distemper, varnish paint etc., and on
12.6 Oil bound distemper

The surface shall be prepared as for ‘Cement Primer Coat’. A primer coat of cement primer or distemper shall be applied as specified in the description of the item. After the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth, taking care not to rub the priming coat out. All loose particles shall be dusted off. One coat of distemper properly diluted with thinner, shall be applied with brushes/rollers in horizontal strokes followed immediately by vertical ones which together constitute one coat. The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied to obtained an even shade. A time interval of at least 24 hours shall be allowed between consecutive coats. The brushes shall be of 15 cm. double bristled type. They shall be maintained in proper condition and those that are dirty or caked will not be allowed to be used.

12.7 Dry Distemper

The surface shall be prepared in the same manner as for oil bound distemper. A primer coat using approved primer or sizes shall be applied. Distemper prepared as per manufacturer’s direction shall be applied and each coat shall be allowed to dry before subsequent coat is applied. The finished surface shall be free from chalking when rubbed, even, uniform and shall show no brush marks.

12.8 Plastic emulsion paint

The surface on which plastic paint has to be laid must be thoroughly cleaned and prepared and all defects rectified. The surface shall be dry and rubbed smooth by means of sand paper to the satisfaction of the Engineer. One coat sealer and two coats of plastic emulsion paint are to be applied. The work is to be carried out under direct guidance and instructions from the manufacturers whose expert advise and supervision are to be made available in order to achieve the high grade finish. The painters employed for this work must be capable of producing the highest standard of workmanship required. If the finish is of doubtful nature, the contractor shall have to rectify at his own cost to the entire satisfaction of the Engineer.

Plastic emulsion paint of ‘Jenson Nicholson’ or equivalent quality and of approved colour and shade shall only be used.

12.9 Silicate paint

Silicate paint shall consist of two parts mixed in the ratio of 1 : 1 by volume.

a) Liquid part consisting of liquid glass whose density has been reduced to 1.15 to 1.20 by addition of water.

b) Solid part consisting of a pigment and chalk in the ratio of 1 : 9 by weight. Pigment shall be selected on the basis of colour requirement and shall have the approval of the Engineer.

The two parts shall be mixed thoroughly and the paint passing through a sieve of 600 mesh per sq.cm. only shall be used for painting. The paint shall be used within 12 hours after mixing and the painting shall not be carried out in open sunlight or under...
moist conditions.

12.10 Bitumen painting

Bitumen painting to concrete surface shall be done as follows:

i) Hot application

The surface shall be cleaned of all mud etc., before painting. The honey-combs and other defects of concrete surfaces to be painted shall be rectified properly. Any projection of binding wire shall be cut to keep it 10 mm inside the concrete surface and then filled with mortar. Before application the surface shall be absolute dry.

Bitumen of standard quality of 20/30 or equivalent shall be heated to the temperature specified by the maker and then applied hot with brushes on the prepared surface. The surface shall be allowed to cool before applying the second coat.

ii) Cold application

The surface shall be prepared in the same way as for hot application. The bitumen emulsion of approved quality shall be applied with special brushes.

Where acid resistant treatment is specified such surface shall be covered with approved acid resisting coating to the satisfaction of the Engineer. Before the coating is applied, the surface shall be properly cleaned and prepared in the manner described above.

12.11 Tarring

i) Timber surfaces in contact with earth/concrete/plaster shall be treated with one coat of hot tar mixture before fixing as specified in schedule.

ii) If required steel work in holdfasts and the like shall be treated as above and sanded in addition before being fixed in position.

12.12 Painting to Timber & Steel Surface

12.12.1 General

The priming coat for steel/wood work shall be applied after the surface has been prepared. After the priming coat has dried, all nails, screw holes and cracks shall be filled with putty and surface smoothened with sand paper.

All stains of paint to glasses, walls, fittings and fixtures etc. shall be cleaned thoroughly by applying required turpentine or thinner. The contractor’s rate shall include all these.

12.12.2 Painting to timber

i) Unless otherwise specified, all timber surfaces shall be treated with one priming coat, one under coat and one finishing coat. Under coat and finishing coat shall be synthetic enamel and priming coat shall be of pink primer or as specified in
schedule of quantities and as approved. In case the surface are to be polished or varnished, a priming coat of approved polish or varnish shall be given. No primer shall be applied to wood work until it has been inspected and passed by the Engineer.

ii) Polishing

The surface to be polished shall be prepared in the same manner as specified under painting.

The number of coats to be applied shall be as specified.

The polish shall be applied with a pad consisting of cotton wool inside a clean white cloth. Several coats shall be applied with light sand papering from time to time and cleaning the dust before applying next coat except the final coat. The final coat of the polish shall be rubbed thoroughly until the wood feels perfectly dry when touched and gives a satisfactory smooth shining.

12.12.3 Painting to steel surfaces

12.12.3.1 General

All surfaces shall be thoroughly cleaned of all dirt, grease, rust and mill scale. Areas which become inaccessible after assembly shall be painted before assembly after cleaning the surfaces as described above. The surfaces shall be perfectly dry before painting.

Wherever shop primer painting is damaged, the surfaces shall be thoroughly cleaned and touched up with corresponding primer.

Site painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surface to be painted.

12.12.3.2 Steel structures

Unless otherwise specified all structures shall be painted with two coats of primer as specified and approved. One coat shall be applied at shop and the second coat at site. All structures after erection shall be given two coats of finishing paint and shall be of synthetic enamel of approved colour. The under coat shall have different tint to distinguish from the finishing coat.

12.12.3.3 Galvanized iron sheets

All plain and CGI sheets requires surface pre-treatment or use of other patented primer to ensure adhesion of paint to zinc coated surfaces. Such pre-treatment shall be as per manufacturer's specifications. Where pre-treatment is adopted one coat of primer paint of suitable quality shall be applied. Unless otherwise specified the finishing coats shall consist of an under-coat of an aluminium paint having blue tint and a second coat of aluminium paint having aluminium colour.

12.12.3.4 Structures exposed to corrosion

Structures exposed to corrosive atmosphere, acid fumes, chemical action etc., shall be
given two coats of primer, one at shop and one at site and two coats of finishing anticorrosive paint of reputed manufacturer. Red lead primers are not permitted. The finishing coats shall be of specified colour. The type and procedure of such painting shall be as per manufacturer’s specification and the same shall be subject to Engineer’s approval.

12.12.3.5 Structures exposed to heat

Structures exposed to heat shall be given two coats of primer, one at Shop and one at Site and two finishing site coats of heat resistant paint of suitable commercial type in accordance with relevant standards or manufacturer’s specification, and shall be subject to the Engineer’s approval.

12.12.3.6 Structures embedded

Exposed surfaces of embedded parts shall be given two coats of red lead graphite primer at shop and finished with two coats of anti-corrosive paint at site after embedment. Type of paint and procedure of painting shall be as per relevant standards or as per manufacturer’s instructions. Surfaces to be field welded shall have no paint applied within 100 mm of the welding zone.

13.0 INTERNAL WATER SUPPLY PLUMBING, DRAINAGE & SANITATION

13.1 Scope of Work

The work comprises supply, laying testing, commissioning etc. of water supply, plumbing, drainage & sanitation. The work includes the following activities connected with the job:

i) Supply and delivery of all required pipes and other materials.

ii) Earthwork in excavation for trenches, pits/ chambers/ manholes etc.

iii) Civil works connected with the laying/erection of pipe lines such as making holes in the wall etc. and repairing them after pipe erection, construction of pipe supports, valve chambers, manholes, bedding and covering of pipe laying wherever required.

iv) Laying and jointing of pipe lines as per relevant IS codes.

v) Testing of pipe lines after laying as per IS or any other standard test.

vi) Back filling of trenches after successful & satisfactory testing.

vii) Disinfection of the complete piping system in the case of water supply.

viii) Commissioning of entire network.

ix) Safe custody of the pipes/materials/equipment/work and other obligation stated elsewhere in the specification.

x) Any other activities which are not mentioned above but essential and required.
### 13.1.1 Materials

The materials shall conform to Part-I of this series.

### 13.2 Water Supply & Plumbing

#### 13.2.1 General

13.2.1.1 General requirements

The Contractor shall lay all the pipes and fittings in the best workman like manner by skilled workmen and licensed plumbers in conformity with the regulations and requirements of the local appropriate authorities and to the satisfaction of the Engineer. Unless otherwise specified water supply works in buildings shall be carried out in accordance with IS : 2065 "Code of Practice for Water Supply in Buildings".

#### 13.2.2 Installation

All works like earth work, masonry, concrete, steel work, cutting holes, chases in brick or in concrete works, cutting of roads, repairs and rectifications associated directly with the installation of water supply system shall come under the scope of the contractor and shall be governed by the specification of the relevant chapter.

#### 13.2.3 Laying

Before lowering down the pipes for laying the trenches shall be checked against crack by means of light hammering and for any other damage. All fixing shall be carefully aligned and spaced at a distance from the main structure to give reasonable all round access for maintenance and inspection and laid true to line plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface holder or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. Pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer. Pipes embedded in floors and wall shall be securely bound with bituminous impregnated type and so fixed as to allow for any movement due to expansion and contraction. Adequate width shall be provided to lay the pipes as per standard practice.

Excavation below the required level is not permitted. The contractor shall make good any excess excavation as directed by the Engineer.

Soft spots in the bottom of beds for pipe lines in rock shall be levelled with sand or soft soil or concrete as approved by the Engineer and the thickness of the layer shall not be less than 100 mm.

#### 13.2.4 Excavation for pipe lines in trenches

Excavation shall comply with chapter 2. The sides of pits and trenches shall be adequately supported at all times, except where otherwise directed by the Engineer.
13.2.5 Underground piping in and around building

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable, and as shown in the drawing and instructed by the Engineer. The thrust blocks shall be provided wherever required. The size and depth of the trench shall be as approved by the Engineer. Backfilling in trenches shall be done with selected fine earth, unless otherwise permitted, in 150 mm layers and carefully consolidated and well treated so that it does not set as a drainage channel. Special care shall be taken while filling in the vicinity of the pipe to avoid damages. Before backfilling the laid pipe shall be fully tested and approved.

13.2.6 Concealed piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the adjoining structure by making chases in walls/floors and these shall be secured by hooks and the chases filled with concrete 1:2:4 (1 cement, 2 sand and 4 aggregate). The contractor will rectify if required the chases, openings and conduits, supplement and make good after laying and testing of the concealed pipelines.

13.2.7 GI Piping

13.2.7.1 The pipes shall be fixed in longest lengths possible with all necessary bends, tees, couplings, reducing sockets and tees etc. in perfect straight lines both vertically and horizontally.

13.2.7.2 All exposed GI pipes shall be fixed at least 15 mm clear of wall face with holder bat clamps at suitable places not exceeding (2.5 meters) center to center. Where the pipes are laid in chases in walls as shown in the drawing, these shall be secured to walls by hooks. Cases in walls and floors shall be filled in with cement concrete 1:2:4. Where the pipes are to be run underground these may be laid at least 60 cm below ground level.

13.2.7.3 The joints of pipes and fittings shall be sealed with red lead paint and fine spun yarn. Joints must be perfectly water tight when put under maximum test pressure.

13.2.7.4 Unless otherwise specified the exposed portion of pipes and fittings shall be given two coats of approved paint over a coat of approved priming. For pipes laid underground, these shall be treated with two coats of bituminous paint.

13.2.8 Jointing of pipes

The interior of all pipes and joints shall be cleaned before jointing commences. Jointing of pipes shall be done in such a manner as to render them completely leakproof and durable. Instruction of the manufacturer shall be followed unless desired otherwise by the Engineer. However, the general norms and recommended practice for different types of pipes are given below for guidance:

(a) Cast Iron

i) Spigot and socket joints:
Interior surface of bells and exterior surface of smooth ends of pipes shall be cleared of redundant insulting cover and other foreign materials particularly of oil, burning off
materials from bells and smooth pipe ends is not permitted. Sharp rises on interior bell surface shall be smoothed out. Bells should be lined up, in compliance with direction of pipe. Laying work shall be started from lower points.

Lead Joint:
The joint is made by first caulking in with packing material hemp, resin of bituminous strand or rubber rings up to half depth and filling the remainder by running in molten lead taking care that no dross enters the joint and then thoroughly caulking the lead. The lead need not extend into the joint further than the back of the groove formed in the socket. After completing the joint it shall not be allowed to move. For rectification the joint shall be completely redone.

ii) Flanged joints:
Flanged joints shall be made by jointing rings of good quality, smooth and hard compressed fibre material of thickness not less than 1.5 mm and of such width as to fit inside the circle of bolt. Diagonally opposite bolts shall be tightened in pairs and in stages so that degree of all bolts in a joint are similar. Damaged gaskets shall be replaced.

(b) For Steel Pipes
Plain ended steel pipes may be jointed by welding. Screwed and socket joints shall be carefully tightened. Care shall be taken to remove any burring from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer.

(c) For GI Pipes
Threads shall be cut with sharp tools, and before jointing all scale shall be removed from pipes by suitable means. The screw threads of the pipe shall be cleaned out and the joint made by screwing the fitting after treating the threads with approved pipe jointing compound. Once a joint has been screwed up it shall not be backed off unless threads are re-cleaned and new compound applied.

(d) For Asbestos cement pipes
Socket and spigot ended pipes shall be jointed by caulking with tarred gaskets and grouted with 1:3 cement sand mortar.

(e) For Lead Pipe
Lead and lead alloy pipes shall be jointed with wiped solder joints.

(f) For Concrete Pipe
Concrete pipes may be socket and spigot ended, collar or bend jointed. Joint shall be effected by caulking with tarred rope yarn and the socket completely filled in with 1:3 cement sand mortar. A fillet being worked round the socket extending for a length not less than 50 mm from the face of the socket.

(g) For PVC pipe
The joint shall be either solvent weld joints or of loose collar type with two rubber rings. The fittings, joints and installation shall be done as per recommendations of manufacturer.

(h) Tyton joint
The manufacturer's instruction shall be strictly followed in making such joints. Tyton joints shall be made by push-on type 'tyton' rubber gasket and such rubber gasket shall
conform to the specification stipulated by the pipe manufacturer. The tools specified by the pipe manufacturer shall be used to secure the joint fully.

13.2.9 **Precautions**

(a) All water supply pipes shall be so laid and so fixed and maintained as to be and remain completely water tight.

(b) During installation open ends of each pipe shall be protected by suitable covers or plugs so that the ends, thread, sockets or spigot are not damaged and no foreign materials can make its way into the pipe line.

(c) Due care should be taken to ensure that there shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting containing impure water or water liable to contamination or of an uncertain quality of water which has been used for any other purpose.

(d) Fittings and fixtures liable to be stolen shall be fitted and fixed just before testing and handing over.

13.2.10 **Painting**

When mentioned in the schedule of item underground steel and cast iron pipes shall be treated with 2 coats of anticorrosive bituminous paint on the outside surface after cleaning the surface from soil, dust, moisture, rust, scales soot etc. When painting is to be done for pipes above ground GI pipes shall be given a coat of zinc chromate primer, C.I. & MS pipes shall be given one coat of red lead or zinc chromate primer over which at least 2 coats of best quality and manufacture as approved by the Engineer shall be provided or as specified in the schedule of item.

13.2.11 **Water meters**

Water meter shall be installed in the building at suitable location on the main supply line to the building/dwelling units.

13.2.12 **Ferrule and stop cock box with chamber**

Square cast iron surface box 15 cm square and 22.5 cm deep weighing not less than 4.54 kg with hinged lid shall be provided in masonry chamber. Top of box shall be made flush with the finished level of the chamber. The chamber 25 cm x 25 cm inside shall be with half brick wall in cement mortar 1:4 over a bed concrete of 75 mm thick in proportion 1:4:8 with stone chips. The inside wall faces shall be plastered with 12 mm thick cement mortar 1:4 finished smooth with a floating coat of neat cement.

The exposed surfaces of cast iron box and cover shall be treated with two coats of bituminous paint.

13.2.13 **Inspection, Testing and Acceptance**

13.2.13.1 **Pipes, fittings and fixtures before laying**

All pipes, fittings and appliances shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items
shall be clearly marked as rejected and forthwith removed from the site.

13.2.13.2   Testing of pipes after laying

a) The contractor shall ensure the safety of the pipework under test and provide all necessary stoppers, testing apparatus etc, that are required for testing.

b) The contractor shall be responsible for any damage done to pipework and ancillary work while testing and shall replace any pipe or fitting which does not satisfactorily withstand the test.

c) The contractor shall give written notice of the times at which tests are to take place. On completion of each test two copies of the complete records shall be given to the Engineer.

d) The work will not be considered complete until the tests have proved satisfactory and a certificate issued by the Engineer.

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits and then tested under pressure. The test pressure shall be 6kg/cm² or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or a large diameter, by a power driven test pump, provided that pump is not left unattended. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrate before the test. The pump having been stopped, the test pressure shall maintain itself without measurable loss for at least five minutes. The end of the main shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

13.2.13.3   Testing of service pipes and fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off tape are closed, the service pipes shall be absolutely watertight. All piping, fittings and appliance shall be checked for satisfactory support and protection from damage, corrosion and frost.

13.2.14     Storage Tank

13.2.14.1   Pressed steel tank

Pressed sheet water storage tanks shall be of nominal size and capacity as mentioned in the Schedule of Item and fabricated with all flanges external/internal or bottom flange internal and side flanges external, as shown on drawings or schedule of items. Inlet, overflow vent pipes manholes shall be arranged and provided as shown in drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50 mm above the bottom of the tank and there shall be 150 mm free board at the top of the tank. The fabricator shall supply 5 prints of fabrication drawing to the Engineer for prior approval showing thickness of plates, method of jointing the plates, all supports, stays, gussets etc. Pads, cleats etc., required for supporting the tanks shall also be supplied.
by the manufacturer.

All tanks shall be supplied with mosquito-proof top with manhole not less than 450 mm diameter. Tanks deeper than 1.00 Meter shall be provided with MS internal access ladder adjacent to the manhole. Meter level indicator shall be provided if asked for. Two coats of anti-corrosive paint over a suitable primer shall be applied to both internal and external surface of tanks. The paint shall be so selected as not to impart any taste or odour of water and be of lead free composition.

13.2.14.2 GI water tank

GI water tanks shall be procured from a reputed manufacturer. The design shall be good enough to withstand the loads safely. Galvanized iron water storage tank shall be made of minimum 16 gauge galvanized iron sheet. Plain sheets shall be fixed at the corner to angle iron frames by means of 6 mm rivets at 40 mm pitch for tanks upto 1000 litres capacity and 8 mm rivets at 35 mm pitch for tanks above 1000 litres capacity. Tanks above 1000 litres shall have 20 mm dia. galvanised iron stays, one fixed to angle framing at top and two in the body of the tank for extra strength. Holes for riveting shall be drilled and not punched. White lead shall be applied to the joints before riveting.

Tanks shall have 400 mm dia. holes at the top with hinged covers. The covers shall be made of galvanised iron sheet with angle iron frame. The cover shall be just loose but close fitting to keep out dust and mosquito and will not be airtight. It shall be complete with lockable arrangement.

Tanks unless otherwise specified shall be provided with rising main inlets of 40 mm dia galvanised iron pipe or as shown on drawing and 25 mm dia GI overflow pipe and 25 mm washout with plug. The rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing.

The ball valve shall permit the entry of water when the tank is empty and disconnect the supply when the tank is full. It consists of a hollow floating ball made of copper plastic or hard rubber, 110 mm in diameter attached to an arm which is so pivoted that the end near the pivot close the orifice of the main when the ball is raised to the required height of water in the tank and opens the main as soon as the ball drops with the fall of water level as it is drawn off through the distribution. The ball valve shall be fixed to the tank independent of the pipe and set in such a position that the body of the ball valve submerge when the tank is full up to the water line. The ball valve shall be so adjusted as to limit the level of the water in the tank below the lip of the overflow pipe, and above the maximum water filled level shall be as per the standard norms for GI water tanks.

13.2.14.3 Water reservoirs made of concrete or masonry shall be governed by the specification of the relevant chapter. It shall have, inlet, outlet, overflow and wash out with plug and a top MS/CI cover as per schedule of items and drawings.

13.3 Drainage and Sanitation (Internal)

13.3.1 Scope

This section covers the layout and construction of drains for waste water, surface water and sewage together with all fittings and fixtures inclusive of ancillary works, such as connections, manholes and inspection chambers used within and around the building and the connection to a public sewer up to treatment work, septic tank and soak pit. All sewerage and drainage works shall be executed in accordance with specifications.
given for different works. All sewerage and drainage works shall be executed by a licensed plumbing supervisor or a licensed plumber and in accordance with IS : 1742 "Code of Practice for Building Drainage " unless otherwise specified.

13.3.1.1 Installation

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and shall be located so as to allow easy maintenance.

All pipelines, fittings and fixtures shall be installed leakproof when the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gasses.

13.3.2 Rainwater downcomers

Rainwater downcomers shall be standard cast iron or asbestos cement pipes. In case where specifically desired, MS pipes may also be used. MS pipes shall be painted outside with two coats of anticorrosive paint over a coat of primer. Rainwater downcomers shall run along and be secured to walls columns, etc. Where desired by the Engineer these may have to be installed in chases cut in the structure. All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clamp type, split ring type or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed. Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings. All horizontal pipes shall have a minimum fall in 1 in 100.

13.3.3 Gutter

The gutters shall be made of GI or A.C., gutters shall be supplied by reputed specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. GI gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no deflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated of MS brackets. All junctions shall be thoroughly watertight. The joints may be made by riveting, bolting or soldering. All joints between successive lengths of gutters shall have an overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater downcomers shall be made fully watertight and secured.

13.3.4 Soil and drainage pipes

13.3.4.1 Gradients:

If not specified the minimum gradients of soil and drainage pipe line shall be as follows:
100 mm nominal dia : 1 in 35  
150 mm nominal dia : 1 in 65  
230 mm nominal dia : 1 in 120  
300 mm nominal dia : 1 in 200

13.3.4.2 Relation with water supply pipe lines :

Unless specifically cleared by the Engineer, under no circumstances shall special drainage and soil pipes be allowed to come close to water supply pipelines.

13.3.4.3 Laying

Each separate pipe shall be individually set for lines and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 16 m apart. The excavation shall be boned in at least one in every 2 m. The foot of the boning rod shall be set on a block of wood of the exact thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

13.3.4.4 Support and protection on pipelines :

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

Where pipes are not bedded on concrete, the bed shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of sand or gravel as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows :

a) When cover is less than 1 meter and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased surrounded with concrete as per relevant IS.

b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipes, the sewer shall be bedded on concrete 1:4:8 mix with 20 mm aggregates down.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched with concrete of 1:4:8 mix with 20 mm down aggregates.

d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased/surrounded with 1:4:8 concrete 20 mm down aggregate.
Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The support shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate support shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means. Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

### 13.3.4.5 Entry into structures

For entry of the pipe lines into any building or structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. Where openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

### 13.3.4.6 Ducts

Where soil, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connecting waste water drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin or backflow.

### 13.3.4.7 Traps and Ventilating pipes

Pipes carrying the sewage from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap. Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof top of the building or as shown on drawings. All vertical ventilating, antisyphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer. Connecting to existing sewer lines shall be through a manhole. Manholes shall be provided with standard covers, usually C.I or as desired by the Engineer. The covers shall be close fitting so as to prevent gases from coming out.

### 13.3.4.8 Cutting of pipes

Manufacturer’s instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

### 13.3.4.9 Jointing

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone. All joints between pipes, pipes and fittings and manholes shall be gastight when above ground and watertight when underground. Method of jointing shall be as per instructions of the pipe and fitting manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the
methods as detailed hereunder shall be used.

a) Cast Iron Pipes
   Socket and spigot pipes shall be jointed by cast lead joints. The spigot shall be centered in the socket of the next pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured into fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

   Joints in cast iron pipes with special jointing arrangements like "Tyton" joints etc. shall follow the instructions of the manufacturers.

   In special cases if flanged joint are accepted by the Engineer the joints shall be made leakproof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete pipes:
   Care shall be taken to place the collar centrally over the joint.

c) Glazed stoneware pipes
   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 placed 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 so as not to fill more than 1/4 of the socket. The reminder of the socket shall be filled with a stiff mixture of cement mortar of 1:1 proportion. 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. The newly made joints shall be protected, until set, from sun and rain and shall be covered with damp sacking or other suitable materials.

d) Vitrified clay pipes:
   These shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact and glazed to make them acid resistant and impervious, and shall be obtained from approved manufacturer.

   Special care shall be taken in handling these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1) which shall have very little water and levelled to form a splayed fillet at an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scraper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead pipes:
   The joints in lead pipes shall be made as wiped solder joint. The minimum and the
maximum length of the wiped solder joints shall be 8 cm and 9 cm respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) Polyethylene pipes:
The joints shall be thermowelded or bolted as per manufacturer's instructions.

g) Jointing cast iron pipes with stoneware pipes:
Where any cast iron soil pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe or drain communicating with a sewer the beaded spigot end or such cast iron soil pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe or drain and the joint made with mortar consisting of one part of cement and one part of clean sharp sand after placing a rattled gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of caulking tool.

h) Jointing stoneware with cast iron pipes:
Where any water closet pan or earthenware trap connected to such a pan is to be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fibre.

13.3.5 Trenches and other excavations

Excavation shall be carried out according to chapter 2, Earthwork.
Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to become such as endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside turf being carefully rolled and stacked for use in reinstatement. All excavations shall be properly timbered, where necessary. Efficient arrangements for dewatering during excavation and keeping it dry till back filling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the contractor from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe for packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand.

Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All settlements shall be made good regularly to minimize inconvenience or traffic where applicable.
13.3.6 Installation of fittings & fixtures

13.3.6.1 General

All fittings & fixtures shall be laid out as per drawings in proper line, level and shall be firmly secured to floors with screws and ditto fix and to walls with wall plugs and screws. Unless otherwise specified only C.P. Brass screws shall used for fixing sanitary fittings to wall plugs and floors.

13.3.6.2 European pattern WC

Water closet shall be fixed with floor with ditto fix and screw and soil, vent pipe with putty.

13.3.6.3 Indian Pattern WC

The water closet pan shall be sunk into the floor and embedded in a cushion of average 150 mm cement concrete 1:4:8 (1 cement, 4 sand and 8 broken brick ballast of 40 mm size). The concrete shall be left 125 mm below the top level of the pan so as to allow for flooring and its bed concrete. The joint between the pan and trap shall be made with cement mortar 1:1 and joint between trap and CI soil and waste pipe to be made with lead. All the joints shall be leak proof. The WC floor shall slope towards the pan.

The cast iron cistern, brackets and flush pipe etc. shall be painted with two coats of approved paint, over a coat of approved paint, over a coat of approved priming.

13.3.6.4 Wash basin and sink

Wash basin and sink shall be fixed to C.I. concealed brackets. The brackets shall be fixed to teak wood wall plugs with screws.

13.3.6.5 Urinals

The urinal shall be fixed to the walls with C.P. Brass screws fixed to teak wood wall plugs. Urinal partitions shall be fixed to walls by making chases in walls and grouting the same in 1:2:4 concrete.

13.3.6.6 Mirror

Fixed type mirror shall be screwed to wall plugs with CP brass screws and shall have a backing of asbestos or similar material.

Swivel type mirror shall be fixed with C.P. brackets which shall be fixed to wall plugs with CP brass screws.

13.3.6.7 Soap tray/toilet paper holder

This shall be of flush mounting design and shall be housed in walls by making chases and grouting the same in cement mortar 1:3. All other fittings shall be fixed with screw or as per manufacturer's specification.

13.3.6.8 Towel rail
This shall be fixed with CP Brass screws which shall be fixed to wall plugs.

13.3.6.9 The gully trap shall be fixed on 100 mm thick bed and encased to the full height of trap (and of square base of 600 mm) with cement concrete or proportion 1:4:8 with 40 mm broken stone aggregate. The gully outlet shall be jointed to the branch drain as specified or directed by the Engineer.

13.3.6.10 Masonry chamber for Gully Trap - After fixing and testing gully and branch drain, a brick masonry chamber 300 mm x 300 mm x 450 mm deep or as specified (internal dimensions) in cement mortar 1:4 (1 cement and 4 sand) shall be built with half brick thick wall round the gully trap from the top of the concrete. The internal faces of the chamber shall be finished smooth with 15 mm thick cement plaster (1:4) and neat cement finish. The outside of brick wall exposed to outside shall be finished with 12 mm thick cement plaster 1:4. The precast R.C. cover shall be fixed in groove made in 100 mm thick concrete base of proportion 1:2:4 and made water tight by providing suitable beading in the band.

13.3.7 Septic tank and effluent disposal

13.3.7.1 Septic tank

Septic tank shall consist of the tank itself with inlet and outlets therefrom complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawing. This item shall also include ventilating pipe of at least 100 mm dia whose top shall be provided with a suitable mosquito proof wire mesh and cowl. Ventilating pipe shall extend to a height of about 2 meters when the septic tank is at least 15 meters away from the nearest building and to a height of 2 meters above the top of building when it is located closer than 15 meters. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

13.3.7.2 Effluent disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approved or into a neck pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed S W pipes laid in a trench filled with broken bricks.

13.3.7.3 The soak pit shall be complete as shown on drawing. In absence of a detailed drawing it shall consist of a 900 mm dia pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks set in cement mortar (1:6) and filled with brick bats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

13.3.7.4 Open jointed S W pipes

Minimum dia of the S W pipes shall be 200 mm nominal. The trench for laying the pipes shall be minimum 600 x 600 mm. The joints of the pipes shall be left unsealed.

13.3.7.5 Commissioning septic tank

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion
tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cowdung may be introduced.

### 13.3.8 Manhole/Inspection chambers

Necessary excavation as required for the manhole shall be done true to dimensions and levels as shown in the drawing. The manhole chamber shall be built with brick work in cement mortar 1:4 on a base of 100 mm thick cement concrete 1:4:8 with 40 mm down aggregate or as specified. The concrete bed shall extend beyond the external face of brick work on all sides by at least 75 mm. The thickness of wall shall be as indicated. The brick work shall be carefully built in English bond, the jointing faces of each brick being well buttered with cement mortar before laying so as to ensure a fully joint.

The inside of the walls shall be plastered with 15 mm thick cement mortar 1:4 and finished with a floating coat of neat cement and outside shall be plastered with 12 mm thick C.M. 1:4.

The channels and benching shall be done in cement concrete 1:2:4 with 20 mm down stone aggregate and finished with 12 mm thick cement plaster in C.M. 1:3. The channels shall be semicircular in the bottom half and of diameter equal to the sewer. Above the horizontal diameter and the top edge shall be suitably rounded off. The Branch channels shall also be similarly constructed with respect to benching but at their junction with the main channel it shall be suitably rounded off in the direction of flow of the main channel. The benching at the sides shall be carried up in a slope of 1 in 3.

The branch channels shall be similarly constructed with respect to benching but at their junction with the main channel, an appropriate fall suitably rounded off in the direction of the main channel shall be given.

All angles shall be rounded to 75 mm radius with cement mortar 1:4 and shall be rendered smooth. The internal surfaces shall have a hard impervious finish obtained by using a steel trowel.

The manhole chamber shall be covered on top with RCC (1:2:4) slab with necessary reinforcement as per drawings. Unless otherwise specified circular type light duty M.H. cover with single seal weighing 25 kg. will be provided in each RCC cover.

### 13.3.9 Testing and acceptance

#### 13.3.9.1 Inspection before installation

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

#### 13.3.9.2 Testing of pipelines

Comprehensive tests of all pipe lines shall be made by stimulating conditions of use. The method of actual test shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below:

#### 13.3.9.3 Smoke Test
All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

13.3.9.4 Water test

For pipes other than cast iron
Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, 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 the vertical pipe jointed to it so as to provide the required test head or the top end 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 suitably for observation. Subsidence of test water may be due to one or more of the following causes:

a) Absorption by pipes and joints.
b) Sweating of pipes or joints.
c) Leakage at joints or from defective pipes.
d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut and made good.

13.3.9.5 For cast iron pipes

Cast iron sewers and drains shall be tested as for glazedware and concrete pipes. The drain plug shall be suitably strutted to prevent their being forced out of the pipe during the test.

13.3.9.5.1 For straightness

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball will roll down the invert of the pipe and emerge at the lower end and;

ii) By means of a mirror at one end of the line and lamp at the other. If the pipe line is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.

13.3.9.6 Testing septic tank

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm.

13.3.9.7 Fixtures etc.,
All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

14.0 EXTERNAL WATER SUPPLY, SEWERAGE & DRAINAGE

14.1 Scope of Work

The work comprises supply, laying, testing, commissioning etc., of water supply sewerage & drainage network as specified.

The work includes the following activities connected with the job.

i) Supply and delivery of all required pipes and other materials.

ii) Earth work in excavation for trenches and pits/manholes.

iii) Civil works connected with the laying/erection of pipe lines such as making holes in the walls etc., and repairing them after pipe erection, construction of pipe supports, valve chambers, concrete manholes, preparation of concrete bedding and covering for pipe laying wherever required etc.

iv) Laying and jointing of the pipelines as per relevant IS codes.

v) Testing of the pipelines after laying as per IS or any other standard test.

vi) Back filling of the trenches after successful and satisfactory completion of tests for the pipeline laid.

vii) Disinfection of the complete piping system in the case of water supply.

viii) Commissioning of entire network laid.

ix) Safe custody of types/material/equipment/work and other obligations stated elsewhere in the specification.

x) Any other activities which are not mentioned above but essential and required.

14.2 Materials

The materials shall conform to part-I of this series.

14.3 Water Supply (External)

14.3.1 Excavation of trenches & pits

Excavation shall be carried out according to Chapter-2, Earthwork.

Before starting earth work in excavation, temporary drainage arrangement shall be provided to prevent surface water entering the trenches and pits at the cost of Contractor.

Excavation of trenches and pits for pipelines shall be carried out in shortest possible time so as to avoid sinking of ground and consequent damage to the pipelines.

Excavation of trenches for pipelines and surface drains, shall be in exact accordance
with the plans and section, alignment, levels and gradients as indicated on the drawings or as directed at site by the Engineer. The final bed must be dressed, levelled or trimmed to proper gradient and rammed with sprinkling of sand and got passed by the Engineer before laying blinding concrete of pipes. No excavation shall be made below the specified levels without written permission of the Engineer. Should any excavation be taken below the specified level due to carelessness of the Contractor, he will fill in such excavation at his own expense with lean cement concrete (1:5:10) well rammed in position.

14.3.2 Back filling

For the purpose of back filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench to its top.

ZONE-"A" From the bottom of the trenches to the level of the center line of the pipe.

ZONE-"B" From the level of the center line of the pipe to a level 300 mm above the top.

ZONE-"C" From a level 300 mm above the top to the top of the trench.

Trenches shall not be back filled until the pipe joints have been tested, alignment and gradient passed by the Engineer but back filling shall be done at least from the bottom of the trench to the level of the centerline of the pipe (ZONE "A") leaving 450 mm on either side of the joints uncovered with earth fill testing is completed. These joints should however be kept covered with mats, gunny, straws etc., to avoid damage to joints by temperature effects.

While back filling care should be taken to ensure that no damage shelled be done to the pipeline. All back fill materials shall be free from cinders, ashes, slag, refuse, rubbish, vegetables or organic material, lumpy or foreign material, boulders, rocks or stones or other materials which in the opinion of the Engineer is unsuitable or deleterious. However, materials containing stones upto 20 cm as the greatest dimension may be used in Zone-"C" unless specified otherwise herein. Backfilling in Zone-"A" shall be done by hand with sand, fine gravel or other approved material placed in layers of 80 mm and compacted by tamping. The back filling material shall be deposited in the trench for its full width of each side of the pipe, fitting and appurtenances simultaneously.

Backfilling in Zone-"B" shall be done by hand or approved mechanical methods. Special care being taken to avoid injuring or moving the pipes. The type of back fill materials to be used and the method of placing and consolidating shall be prescribed by the Engineer to suit individual locations.

Back filling in Zone-"C" shall be done by hand or approved mechanical methods. The type of back fill materials and method of filling shall be as prescribed by the Engineer.

Paving and metalling shall be reinstated in as good order as before removal and the Contractor shall do adequate ramming and watering of under layers to guard against subsequent settlement.

14.3.3 Custody of pipes

The Contractor shall remain responsible for the safe custody of pipes, special and other materials supplied by him/issued to him either free or on cost recoverable basis till
these are laid installed, tested, back filled etc., and handed over to the Engineer. The Contractor shall verify the conditions of the pipes, specials etc., at the time of receipt from sources and shall be responsible for all damages during handing, transporting, laying, installing, testing etc., and the cost of such damages shall be borne by the Contractor.

14.3.4 Erection/laying of pipelines

i) Erection of all equipment shall be carried out with highly skilled workers.

ii) The pipelines shall be laid and supported properly and it shall be deemed as a contractual obligation that the lines are not thrown out of alignment or lifted off during commissioning and subsequent operation.

14.3.5 Pipeline erection

a) Overhead pipelines

i) Suitable slopes, draining arrangements and air vents/air release valves shall be provided.

ii) Sliding and fixed supports shall be provided, wherever necessary.

iii) As far as possible joints shall be located at 1/3 span of supports.

b) Underground pipelines

All the underground pipelines shall be laid in accordance with IS : 3114 and the following shall be included in the scope of work of the Contractor.

14.3.5 Pipe jointing

The type of jointing will be defined in the details working and tender schedule i.e. whether they should be (i) socket and spigot with molten lead or lead wool joint or (ii) flanged joint.

14.3.6.1 Socket & spigot joints

a) Molten lead joints

Unless otherwise specified, socket and spigot joints shall be done with molten lead. The spigot shall be cleaned of the coating, carefully entered in the socket of the adjacent pipe by one or more laps of white damp spun yarn, sufficient yarn only being driven into the socket to leave the depth of the lead specified. The proper depth of each joint shall be tested before running the lead by passing completely round it a wooden gauge, notched out to the correct depth of lead, the notch being held close up against the face of the socket. The pipes shall be carefully packed underneath so that they shall bear properly throughout their whole length.

The lead shall be carefully skinned of all scale when melted in a cast iron pot or patent melting machine. The joints must be perfectly dug before being run with lead. The pipes shall again be examined for line and level and the space left in the socket shall be filled in generally by pouring in melted lead. This may be done best by using proper loading rings or if these are not available, by wrapping a ring or hamp rope. Covered with clay round the pipe at the end of the sockets leaving a hole into which lead shall be poured. For large pipes, it is also necessary to leave one or more air vents around...
lower half of the joints. The lead shall be rendered thoroughly fluid and each joint shall be filled at one pouring. If the pipe is too large for the joint to be filled from one ladle, two or more ladles shall be used. It is to be noted that the lead should be heated to such a temperature as will ensure that it flows completely around the joint. Overheating of lead shall be avoided.

After a section of convenient length has been leaded, caulking shall be commenced. The lead shall be freed from the loading pipe outside the socket of the other pipe with a flat chisel, and then caulked around 3 separate times, with proper caulking tools of increasing thickness and a hammer 2 to 3 kg in weight in such a manner as to make the joints sound and water tight. After being well and evenly set, the joint is to be left flush neat and even with the socket. The approximate weight of lead and spun yarn for different size of cast iron pipe socket and spigot joints, as per IS : 3114 are given in the following Table-I.

**TABLE-I**

**QUANTITY OF LEAD AND SPUN YARN FOR DIFFERENT SIZES OF PIPES**

<table>
<thead>
<tr>
<th>Nominal size of pipe mm</th>
<th>Lead/Joint kg</th>
<th>Spun yarn/Joint kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>1.8</td>
<td>0.10</td>
</tr>
<tr>
<td>100</td>
<td>2.2</td>
<td>0.18</td>
</tr>
<tr>
<td>125</td>
<td>2.6</td>
<td>0.20</td>
</tr>
<tr>
<td>150</td>
<td>3.4</td>
<td>0.20</td>
</tr>
<tr>
<td>200</td>
<td>5.0</td>
<td>0.30</td>
</tr>
<tr>
<td>250</td>
<td>6.1</td>
<td>0.35</td>
</tr>
<tr>
<td>300</td>
<td>7.2</td>
<td>0.48</td>
</tr>
<tr>
<td>350</td>
<td>8.4</td>
<td>0.60</td>
</tr>
<tr>
<td>400</td>
<td>9.5</td>
<td>0.75</td>
</tr>
<tr>
<td>450</td>
<td>14.0</td>
<td>0.95</td>
</tr>
<tr>
<td>500</td>
<td>15.0</td>
<td>1.00</td>
</tr>
<tr>
<td>600</td>
<td>19.0</td>
<td>1.20</td>
</tr>
<tr>
<td>700</td>
<td>22.0</td>
<td>1.35</td>
</tr>
<tr>
<td>750</td>
<td>25.0</td>
<td>1.45</td>
</tr>
<tr>
<td>800</td>
<td>31.5</td>
<td>1.53</td>
</tr>
<tr>
<td>900</td>
<td>35.0</td>
<td>1.88</td>
</tr>
<tr>
<td>1000</td>
<td>41.0</td>
<td>2.05</td>
</tr>
<tr>
<td>1100</td>
<td>46.0</td>
<td>2.40</td>
</tr>
<tr>
<td>1200</td>
<td>50.0</td>
<td>2.60</td>
</tr>
<tr>
<td>1500</td>
<td>66.5</td>
<td>2.80</td>
</tr>
</tbody>
</table>

b) Lead wool joint

In the event of the Engineer specifying or permitting the use of lead wool the joint shall be made as follows :-

While hampen spun yarn shall be driven into the socket and thoroughly caulked with suitable caulking tools. Lead wool shall then be introduced and this caulking shall be repeated with each turn of lead wool under which the socket is fully within 3 mm and the wool of the lead wool uncompressed into dense mass. The joint shall then be finally pressed with finishing tool. The table giving the quantity of lead wool and yarn to be
used in different sizes of pipes is given in the following Table-2.

<table>
<thead>
<tr>
<th>Nominal Internal dia in mm</th>
<th>Lead Wool Weight in kg</th>
<th>Spun Yarn Weight in Kg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>1.30</td>
<td>0.17</td>
</tr>
<tr>
<td>100</td>
<td>1.70</td>
<td>0.23</td>
</tr>
<tr>
<td>150</td>
<td>2.41</td>
<td>0.34</td>
</tr>
<tr>
<td>175</td>
<td>2.89</td>
<td>0.37</td>
</tr>
<tr>
<td>200</td>
<td>3.37</td>
<td>0.57</td>
</tr>
<tr>
<td>225</td>
<td>3.63</td>
<td>0.64</td>
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<tr>
<td>250</td>
<td>4.11</td>
<td>0.74</td>
</tr>
<tr>
<td>300</td>
<td>4.82</td>
<td>0.82</td>
</tr>
<tr>
<td>350</td>
<td>6.04</td>
<td>1.17</td>
</tr>
<tr>
<td>375</td>
<td>6.52</td>
<td>1.25</td>
</tr>
<tr>
<td>400</td>
<td>7.00</td>
<td>1.33</td>
</tr>
<tr>
<td>450</td>
<td>9.64</td>
<td>1.84</td>
</tr>
<tr>
<td>500</td>
<td>10.86</td>
<td>1.99</td>
</tr>
<tr>
<td>600</td>
<td>12.79</td>
<td>2.83</td>
</tr>
<tr>
<td>750</td>
<td>5.68</td>
<td>3.52</td>
</tr>
<tr>
<td>825</td>
<td>17.12</td>
<td>3.88</td>
</tr>
<tr>
<td>900</td>
<td>18.80</td>
<td>4.25</td>
</tr>
<tr>
<td>1200</td>
<td>28.44</td>
<td>6.01</td>
</tr>
</tbody>
</table>

Note: Higher tolerance may be permitted under special circumstances depending upon site condition for quality of lead wool and spun yarn.

14.3.6.2 Flanged joints

Flanged joints should be made by painting the facing of the flanged with graphite or red lead freely. Packing should be of rubber insertion cloth 3 ply and of approved thickness. The packing should be of full diameter of the flange with proper pipe hole and bolt holes cut out and even at both the inner and outer edges. All the bolts shall be tightened up evenly on all sides keeping the longitudinal axes of adjoining pipe in exactly the same straight line.

The interior of the pipe must be carefully free from all dust and other foreign matters as the work proceeds. For this purpose a disc plate or brush sufficiently long to pass two or more joints from the end of the pipe last laid shall be continuously drawn forward as the pipes are laid.

The ends of the pipes must be securely protected preferably with wooden plugs during the process of the work. The pipes laid must not be made receptacles either for tools, cloth or any other matter during progress of the work.

14.3.7 Fixing specials and fittings

All fittings shall be fixed carefully and the heavy pieces shall be suitably supported at the time of erection on wooden pieces and after erection on suitable masonry supports.

a) Fixing of sluice valves

The sluice valves to be fixed on the pipeline shall be examined, cleaned and placed in the position indicated by the Engineer. The valves shall be placed on the pipelines in valve chambers constructed according to the drawings furnished to the Contractor.
The depth at which the valve is to be laid shall vary where necessary under the orders in writing of the Engineer. The dimensions of the concrete and masonry shall also vary where necessary on receipt of written orders from the Engineer. The valves shall be supported in the valve chamber so that no stress or strain occurs at the flange or other joints of the valve. The valves shall be carefully protected from lime or other dust by a suitable covering and the pit itself shall be cleaned of lime mortar and other refuse.

b) Fixing of non-return valves
The non-return valve to the fixed on the delivery line of the pump shall be examined, cleared and placed in position indicated by the Engineering. The non-return valve shall be fixed with proper alignment.

c) Fixing of foot valves
The foot valve to be fixed on the suction line of the pump shall be examined, cleaned and placed in position indicated by the Engineer.

14.3.8 Inspection & testing

a) If required all materials shall be inspected by the Engineer before despatch to site. All the tests shall be carried out in the manufacturer’s works and necessary test certificates shall be furnished as proof of such testing. The Contractor shall intimate the Engineer atleast two weeks in advance for any such inspection/testing. All facilities for inspection/ testing shall be provided by the Contractor.

b) After completion of erection all pipelines shall be inspected by the representative of the Contractor and the Engineer. Any discrepancy, defect pointed out during this inspection shall be made good by the Contractor to the entire satisfaction of the Engineer without additional cost.

c) All pipes with valve and fittings shall be tested to 1.5 times maximum working pressure. The pressure should remain constant for a period of 8 hours. All arrangements for testing shall be done by the Contractor. Any defect found during testing shall be made good by the Contractor to the entire satisfaction of Engineer and the test shall be repeated till acceptable results are achieved. Any special tools, instrument or equipment required for these tests shall be provided by the Contractor for tests only.

d) All oils, lubricants and other consumables required during tests and trials of different equipment shall be supplied by the Contractor.

14.3.9 Painting

i) All equipment, valves and other exposed steel parts shall be given a cost of red oxide, zinc chromate or red lead and two coats of final paint according to the colour scheme of the Purchaser.

ii) All the exposed pipes and fittings shall be painted with two coats of paints of approved quality.

14.3.10 Commissioning

The system shall be commissioned after all necessary tests have been conducted successfully. All lubricants, oils, and other consumables required for commissioning of the system shall be supplied by the Contractor. Commissioning of the equipment to be
supplied, if any, by the Owner, shall be carried out by the Contractor under guidance of the representatives of the supplier of these equipment and Engineer. Any adjustment and/or changes/rectifications that may be found necessary during commissioning of these equipment shall be carried out by the Contractor.

14.4 Sewerage & Drainage (External)

14.4.1 Excavation of trenches & pits & excavated materials

Same specification as for "Water Supply" shall be followed in respect of excavation of trenches and pits.

14.4.2 Stoneware pipelines

14.4.2.1 Back filling

Trenches shall not be back filled until the pipe joints have been tested, alignment and gradient passed by the Engineer, but back filling shall be done at least for equal depth of the diameter of the pipe or 300 mm whichever is greater over the pipes leaving 450 mm on either side of the joints uncovered with earth till the testing is completed. These joints should however be kept covered with mats, gunny bags, straws etc., to avoid damage to joints by temperature effects.

While back filling care should be taken to ensure that no damage is done to the pipelines. The first 300 mm of filling material immediately over and around the pipe should be of soft material free from clods and stones etc. The remainder of the filling materials shall be watered and rammed in layers not exceeding 250 mm at a time.

Paving and metalling shall be reinstated in as good order as before laying of the pipelines.

Unless otherwise required by the Engineer, there shall be a minimum cover of 700 mm over the pipes and at road crossing etc., it shall not be less than 1000 mm.

Unless otherwise specified in the schedule of items the cost of the work involved under this clause shall be held to be inclusive in the contract rate for supplying and/or laying of the pipes.

14.4.2.2 Laying of pipes

The laying of the pipelines shall commence only after the levels of the bottom of the trench at various points have been checked by the Engineer. Cracked pipes whether at the socket or in the body shall be rejected. All SW pipes shall be fitted together on the surface of the ground to ensure a proper fit before they are lowered. The bowels spigots and sockets shall be properly cleaned and brushed, if necessary, then lowered by hand to the bottom of the trench.

The pipes shall be carefully laid to the alignment, levels and gradients shown on the plans and sections, and great care shall be taken to prevent, sand, earth or other matter from entering the pipes during laying. As it is not permitted to rectify errors of grade by packing up underneath with earth, care should be taken in excavating and slight scraping, if necessary, done to bring to grade. The pipes between manholes shall be laid truly in straight lines without vertical or horizontal undulations.

Encasing of the pipes during laying shall be in accordance with IS : 4127 (latest revision) and shall be done with mass concrete in proportion (1:4:8) to prevent ground water from entering the pipelines.
All inverts shall be laid from site rail fixed at the true levels, with proper boning rod. The sight rails and boning rods shall be provided, fixed and maintained by the Contractor at his own expense.

The pipes shall be laid, sockets facing up the gradient, beginning at the lower end, and with the sockets, resting in the socket rest holes out in the trench bottom. Each pipe shall be laid singly and no pipe shall be laid until the trench has been excavated to its required depth to a distance of twenty yards in front of the pipes to be laid.
No pipes of any description shall be covered until they have been passed by the Engineer.

14.4.2.3 Jointing of pipes

In each joint, a gasket of tarred yarn shall be passed round the joint and inserted in it by means of suitable jointing tools. Strings of white hemp spun yarn shall then be added and well rammed home. The yarn shall be moistened to avoid its absorbing moisture from cement mortar.
The yarn should be so placed as to center the spigot of one pipe within the socket of the other and shall prevent the jointing mortar penetrating inside the pipe where it might set and interfere with the flow of sewage.

The cement shall be thoroughly mixed with medium sand in the proportion of 1:1 (1 cement : 1 sand) and then just enough water shall be added to make the mix plastic. On no account, the mortar shall be made soft or sloppy. The mix shall then be carefully inserted by hand into the joint.
Special care shall be taken for inserting the mortar into the portion of the joint underneath the pipe. When the cement mortar has been inserted, it shall be punched or caulked into the joint with wooden caulking tools, and more cement mortar shall be added until the space of the joint has been filled completely with tightly caulked cement.
No fillet of cement shall be added.
No mortar which is older than 30 minutes shall be permitted.
The inside of each pipe shall be carefully wiped out with a mop or scraper sufficiently long to pass two joints from the end of the pipe and any projecting cement shall be removed.
All pipes entering the manholes should be set in cement mortar 1:3 and a completely watertight junction effected.

14.4.2.4 Testing of pipes

Testing of pipes shall be done wholly at contractor’s expense inclusive of apparatus, provision of water etc., and/or as per IS : 4127.
After cement has had time to set, the pipes shall be tested in lengths between manholes in the following ‘manner’. In the lowest manhole a plug shall be inserted in the pipe. The disc in the pipe and at the upper manhole shall be fitted with a filling pipe with a right angle bend and an air cock. The length of pipe shall then be filled with water by means of the pipe shall then be filled with water by means of the pipe connection on the upper disc. The air cock in the upper disc shall be kept open, while the pipeline is being filled to permit the escape of air.

When the pipes have been filled with water and air excluded, the air cock shall be shut and water shall be poured into a conical "Filler" attached to the testing and filling pipe of
the disc in the upper manhole until water remains in the filler. The testing or filling pipe shall then be raised and fastened so that the height of the pipe is six feet, which will be the usual test pressure for stone ware pipe joints. The test will be for an hour or such longer period as may be set by the Engineer. If the water level does not fall more than 25 mm in the length of 90 meter, the test may be considered satisfactory.

If it is found that certain pipe joints are leaking, the water shall be run off and joints recaulked with cement mortar and the test repeated till it is proved by the Contractor that the joints are leak-proof.

14.4.2.5 Concrete bedding & cover

Unless otherwise specified in the Schedule of Quantities, all SW pipes shall be laid on a bed of cement concrete, space being left under each joint for making the joints. After successful completion of tests the spaces left shall be covered with cement concrete, and the pipe shall be covered with cement concrete on either side of slope away towards the side of the concrete bed. The proportion of cement concrete as well as the dimensions of concrete bedding and covering shall be as per Schedule of Items and drawing. Where sewers have less than 1.2 m cover at places of heavy traffic, these shall be surrounded with mass concrete if desired by the Engineer.

14.4.3 RCC pipeline

14.4.3.1 Handling & laying of pipes

Reasonable care shall be exercise in loading, transporting and unloading of concrete pipes. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain 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.

If the sides of the trench are not vertical, the toes of side slopes shall end at the top of the pipe, and practically vertical sided trench shall be dug from these down to the subgrade.

Trench shall be of sufficient width to provide free working space on each side of the pipe. The free working space shall be, preferably, not more than one third of the diameter of the pipe and not less than 15 cm on either side.

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 always proceed upgrade of a slope. Where pipes have spigot the 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, wherever necessary.

The sections of the pipe shall be jointed together in such a manner that there shall be as little unevenness as possible along the inside of the pipe.

In cases where the foundation conditions are unusual such as in the proximity of trees or poles, under existing or proposed tracks under manholes etc., the pipe shall be encased in low strength concrete bedding or compacted sand or gravel.

In places where the natural foundation is inadequate, the pipes shall be laid either in a
concrete cradle supported on proper foundations or on any other suitably designed structure.

Pipes laid in trenches in earth shall be bedded evenly and firmly and as far up the haunches of the pipes 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 the around the curve of the pipe to form an even bed. Necessary provision shall be made for joints wherever required.

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

Bedding of the pipes in trench shall follow the specifications as per IS : 783.

Trenches shall be kept free from water until the material in the joints has hardened. When the pipe is closed and the trench liable to be flooded by rain, care shall be taken to prevent the pipe from floating.

Walking on the completed pipe shall not be permitted until the trench has been back filled to a height atleast 30 cm over the pipe, except as may be necessary in tamping or backfilling.

Trenches shall be backfilled immediately after the pipe has been laid, to a depth of 30 cm above the pipe (subject to the condition that the jointing material has hardened). The backfill material shall be selected and deposited with reference to the future safety of the pipe. Only suitable soils, clean, free from boulders, large roots, excessive amounts of sods or other vegetation and free from lumps, shall be used and care shall be taken where back filling not to injure or disturb the pipe or the joints.

The tamping around the pipe shall be done by hand or other hand operated mechanical means. The water content of the soil shall be as near to the optimum moisture content as possible.

Filling of the trench shall be carried on simultaneously on both sides of the pipe in such a manner that unequal pressure does not occur.

14.4.3 Jointing of pipes

The joints shall be either spigot and socket joint or collar joints. The joints may be rigid or flexible type. Specification of joints shall follow IS : 783.

In case of rigid joint, the caulking material shall be slightly dampened mix of cement and sand (1:2), rammed with caulking irons.

Every joint shall be kept wet for about ten days for maturing. The section of the pipeline laid and jointed shall be covered immediately to protect it from weather effects. A minimum coat of 10 cm is considered adequate. The joints may be left exposed for observation.

Expansion joint shall be provided for buried lines at maximum interval of 45 m, but for exposed pipes, the joint interval shall not exceed 15 m, cast iron or steel collar, and lead caulking conforming to IS : 782 shall be used for expansion joints. In the case of spigot and socket joint an adopter piece and a collar for making an expansion joint shall be provided. Where flexible rubber joints are used, expansion joints need not be provided.

14.4.4 Testing of pipes
When testing a pipeline hydraulically the line shall be filled completely with water and kept filled for a week. In testing pipelines, a seepage allowance of 2.5 litres per kilometer per hour per centimeter diameter of the pipe shall be permissible. The pipelines can be tested similar to stoneware pipes.

**14.4.5 Manholes**

All manholes shall be of the size and type as given in the Schedule and shall be provided as per drawing or as desired. All the manholes shall be circular in shape. The bed shall be in cement concrete of Mark-100B (Size of coarse aggregate 40 mm and down) of 100 mm thickness or as shown in the drawing and shall be projected out 75 mm from the outside face of the wall all round. The working part including channeling, benching etc., made of P.C.C. shall be of grade-15C. All manholes shall be plastered inside 20 mm thick in 1:3 cement plaster and finished with a floating coat of neat cement.

Concrete used for precast RCC cover slabs shall be of grade 20C and shall be constructed as per drawing.

The top level of manholes shall be generally 100 mm above the surrounding ground levels or as directed by the Engineer. Channeling inside the manhole shall be done in smooth bends.

The end of pipe shall be neatly built in and finished in cement mortar 1:3. Cast iron water sealed manhole cover and frames, 560 mm clear opening and nominal weight 128 kg shall be provided for each manhole and shall be in accordance with IS:1726. Manhole covers with double seals shall be provided within compound near the buildings. Step irons shall be provided with two coats of bituminous paint and shall be as per drawing.

In cases where branch pipe sewers enter the manhole or main pipe sewer at a level more than 1m, from the main sewer, a drop connection shall be provided. The extra pipe length required for this connection will be paid under item for pipelines. No other extra payment will be allowed.

All exposed surfaces of cast iron frame and cover shall be painted with two coats of bituminous painting.

The rate of manholes shall be inclusive of excavation in all kinds of soil, dewatering, shorting, planking, back filling in layers of 150 mm, watering, consolidating and top dressing, removal of surplus soil, bricks, masonry, cement concrete work, RCC cover slabs, CI manhole cover and step iron providing all connections, channels, benching, painting etc., and is for complete work.

**14.4.6 Marker plates**

Marker plate indicating the particular service installed shall be provided along the routes of pipes laid below ground. These shall be of mild steel, with the type of service and direction of flow painted on it. The markers shall sit firmly in a concrete base and installed at all corners and turning points. Over straight runs markers shall be spaced at 100 m intervals generally.

**15.0 ROAD WORK**
15.1 General

Road works in general shall be constructed according to the requirements to the various specifications and codes of practices of the Indian Roads Congress.

Works such as earthwork, masonry, concreting and the like, wherever they occur in association with construction of roads, shall be governed by the respective specifications of these series.

15.2 Trenching and Preparation of Subgrade

The surface of the formation of width equal to that of soling coat shall first be cut to a depth below the proposed finished level equal to the combined depth of soling and wearing coat, (due allowance being made for consolidation), and dressed parallel to the finished profile. Any roots of bushes, trees etc., shall be taken out to the full depth and the cavities thus formed shall be filled up and rammed. The subgrade shall then be consolidated with a road roller true to proper camber and grade, and surplus earth shall be disposed off as directed by the Engineer.

15.3 Ash Carpet

Wherever the ground is soft and slushy, ash carpet consisting of common boiler ash shall be laid to 5 cm thickness over the subgrade and then rolled. In firm ground no ash carpet is necessary and boulder soiling shall be laid directly over the soling.

15.4 Boulder Soling

Boulders shall be hand packed true to camber and grade and shall be of the thickness specified. The boulders shall be laid in such a manner that the gap in between them is reduced to a minimum.

It shall then be rolled with a power roller of not less than 10 tons, so that the boulders are well locked together and the top surface of the soling is perfectly true to camber and grade. Any disturbance in grade or camber shall be rectified. The top surface shall then be blinded with atleast 5 cm of moorum of approved quality or any other approved material, and rolled wet to obtain proper compaction. The Contractor shall supply camber board, spirit level, straight edge etc., at site for checking the camber and grade at any time during the execution of work.

15.5 Kerbs

Concrete or stone kerbs, where shown in drawings, shall be fixed in position after laying and consolidation of soling. They shall be fixed true to line and level and secured and position by approved means.

15.6 Water Bound Macadam Surfacing

The construction of water bound macadam shall be carried out according to IRC:19, "Standard Specification and Code of Practice for Water Bound Macadam".

15.7 Preparation of Base and Shoulders

The subgrade shall be reshaped to the required grade and camber. Where water bound
macadam is to be laid over an existing black top surface, 50 mm x 50 mm furrows shall be cut in the existing surface at 1 m intervals inclined 45 degree to the center line of the carriageway, before laying of coarse aggregates. Necessary arrangements shall be made for the lateral confinement of aggregates by constructing shoulders in advance.

15.8 Spreading Coarse Aggregate

The coarse aggregates shall be spread uniformly and evenly upon the prepared base in required quantities from stock piles along the roadside or directly from vehicles. In no case shall these be dumped in heaps directly on the base. The aggregates shall be spread to proper profile by using templates placed across the road about 6 mm apart. Where possible, mechanical devices shall be used to spread the aggregates uniformly.

The water bound macadam layer shall be constructed in layers of not more than 75 mm thickness. However, the Engineer may permit courses of 100 mm compacted thickness to be constructed in a single layer. Each layer shall be tested by depth blocks. No segregation of large or fine particles shall be allowed.

15.9 Rolling

The coarse aggregates spread as described above shall be compacted to full width by rolling with either three wheel power roller of 6 to 10 tonnes capacity or an equivalent vibratory roller. The weight of roller shall depend on the type of coarse aggregate.

The rolling shall begin from edges and after the edges have been compacted, progress gradually towards the center, parallel to the center line of the road, uniformly lapping each proceeding rear wheel track by one half width. On super elevated portions, rolling shall commence from the lower edge. Where screenings are to be applied, rolling shall be discontinued when the aggregates are partially compacted with sufficient voids to permit application of screenings. Where screenings are not to be applied, as in the case of crushable aggregates compaction shall be continued until the aggregates are thoroughly keyed, with no creeping of stones ahead of the roller. Slight sprinkling of water may be done during rolling, if necessary.

Rolling shall not be done when the subgrade is soft or yielding nor when it causes a wave like motion in the base course. If irregularities develop during rolling, which exceed 12 mm when tested with a 3m straight edge, the surface shall be loosened and aggregates added or removed before rolling again. The surface shall be checked by template for camber. In no case shall screenings be used to make up depressions.

15.10 Application of Screenings

After coarse aggregates have been rolled, screenings to fill the interstices shall be applied gradually over the surface in thin layers. Dry rolling shall be done when the screenings are being spread, so that the jarring effect of roller causes them to settle into the voids of the coarse aggregates. Damp and wet screenings shall not be used and the spreading, rolling and brooming of screenings shall be taken up on sections which can be completed within one day’s operation.

15.11 Sprinkling and Grouting

After application of screenings, the surface shall be copiously sprinkled with water, swept
and rolled. The sprinkling, sweeping and rolling operations shall be continued and additional screenings applied where necessary until the coarse aggregates are well blended and firmly set and a grout of screenings and water form ahead of the wheels of the roller.

15.12 Application of Binding Material

After the application of screenings, binding material, where it is required to be used, shall be applied at a uniform and slow rate in two or more successive thin layers to a thickness of 2.5 cm. After each application of binding material, the surface shall be copiously sprinkled with water and the resulting slurry swept in with brooms, so as to fill the voids properly. This shall be followed by rolling with a 6-10 tonne roller, during which, water shall be applied to the wheels to wash down the binding material that may get stuck to them. The spreading of binding material, sprinkling of water, sweeping with brooms and rolling shall continue until the slurry of binding material and water forms a wave ahead of the wheels of moving roller.

15.13 Setting and Drying

After final compaction the road shall be allowed to cure overnight. Next morning, hungry spots shall be filled with screenings or binding material, lightly sprinkled with water and rolled. No traffic shall be allowed till the macadam sets.

15.14 Surface Evenness

The surface evenness of completed water bound macadam course in longitudinal direction shall be within 12 mm when tested with a 3 m straight edge and in cross profile within 8 mm when checked with a template.

15.15 Bituminous Pavements

15.15.1 Bitumen premix carpet

15.15.2 Surface preparation

Waterbound macadam surface on which black topping is to be provided shall be thoroughly cleaned of dust, loose materials, caked mud and other foreign material with the help of wire brush, chisel, picks etc. Cleaning shall be such as to expose the stone metal to a depth of 1 to 2 mm without dislodging the interlock of the metal. All dust and other materials thus removed shall be thrown away at a suitable place as directed by the Engineer.

Any potholes, depressions and undulations found after cleaning shall be made good with premixed chippings, and well rammed.

15.15.3 Tack coat

Just before the application of tack coat, the surface shall be thoroughly cleaned by gunny bags.

Bitumen heated to 177 degree to 188 degree 'C' shall be spread on the prepared surface uniformly at the rate of 1 kg/sqm. by means of sprayers. It shall be applied just ahead of and keeping pace with, laying of premix carpet.
15.15.4 Premix carpet

In preparing premix carpet the following method shall be adopted.

Bitumen heated to a temperature of 177 degree 'C' to 188 degree 'C' shall be first mixed in an asphalt mixer with hot metal chips at the rate of 60 kg/cbm of metal and thoroughly mixed, till chips are completely coated with bitumen. Sand shall then be added and a further quantity of hot bitumen at the rate of 110 kg/cbm of sand shall be added to the mixer and mixed till complete coating of aggregate with bitumen is obtained.

The Premix shall be emptied on to wheel barrows or stretchers and carried to the site of work. It shall then be spread uniformly on the prepared surface with rakes, to the desired thickness and camber. When the premix has been laid for a length of 15-20 meters it shall be rolled. Rolling shall commence from edges and proceed towards the center. The roller wheels shall be moistened continuously so as to prevent metal chips sticking to it. After preliminary rolling, all honeycombs shall be filled up with smaller size precoated chips, and rolled again. Camber and grade shall be checked at every stage to ensure correctness, and any defect found shall be rectified.

The following quantities of materials shall be used per 100 sqm. of bituminous macadam.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>4cm thick carpet</th>
<th>5 cm thick carpet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Slag/ stone chips</td>
<td>4 cbm</td>
<td>4.8 cbm</td>
</tr>
<tr>
<td>2.</td>
<td>Sand</td>
<td>2 cbm</td>
<td>2.4 cbm</td>
</tr>
<tr>
<td>3.</td>
<td>Binder for premixing the sand @ 60 kg/cbm of chips</td>
<td>240 kg</td>
<td>288 kg</td>
</tr>
<tr>
<td>4.</td>
<td>Binder for premixing the chips @ 120 kg/cbm of sand</td>
<td>240 kg</td>
<td>288 kg</td>
</tr>
<tr>
<td>5.</td>
<td>Binder for tack coat @ 1 kg/sqm of road surface</td>
<td>100 kg</td>
<td>100 kg</td>
</tr>
</tbody>
</table>

15.15.5 Asphaltic concrete

Asphaltic concrete surface course shall be prepared, laid and finished in accordance with the Indian Roads Congress "Tentative Specification for 4 cm Asphaltic Concrete Surface Course", IRC : 29.

15.15.6 Surface evenness

The finished surface of premix carpet and asphaltic concrete shall be tested with a straight edge 4.5 m long and any irregularity greater than 6 mm shall be corrected.

15.16 Cement Concrete Roads

Cement concrete roads shall be constructed in accordance with IRC : 15, "Standard Specification and Code of Practice for Construction of Concrete Roads".
15.17 **Berms**

Shoulders and berms shall be prepared as shown on the drawings. Work on making berms shall not lag more than 100 meters behind the water bound macadam consolidation. Suitable drains shall be cut on the berms so that the water bound macadam surface is kept drained till bituminous macadam is laid.

15.18 **Kerbs**

Kerbs shall be laid and set in place before completing the bituminous or concrete wearing surface as well as the wearing surface of footpath sitting shall be done in mortar where so specified with Schedule of Items. They shall be laid and set in such a way as to obtain straight lines in the finished work, the top surface matching with the finished surface of footpath.

Where the road edge forms a curve, the kerbs shall follow such curve.

Gaps shall be left as shown in drawings or as may be required to provide for drainage.

15.19 **Bridges and Culverts**

Bridges and culverts shall be constructed according to the specifications of Indian Roads Congress. Relevant chapters of earthwork, concrete, masonry etc., of these series shall apply.

15.20 **Boulder Pitching**

Wherever specified, boulder pitching shall be provided at the inlet and outlet of pipe culverts, or for embankments of bridges. The subgrade shall first be dressed to level or slight slope as indicated. The transverse slope of the pitching shall be made strictly in accordance with the drawings or as directed by the Engineer.

15.21 **Scarifying & Dismantling**

Where a new carriageway abuts or includes an existing carriageway and the Engineer so directs, the surface of the latter shall be scarified, adjusted and reshaped to conform with the existing and new camber or crossfall. Materials from the existing road shall be used or disposed off as directed by the Engineer.

Where dismantling of the existing road has been specified, the various layers of the road viz., bituminous macadam, waterbound macadam and soling shall be scarified separately. Scarifying can be done either by hand picks, or by means of scarifiers fixed to the roller. When a roller is used for scarifying, crushing of the metal shall be avoided by moving the metal clear of roller wheels after the scarifier has passed over it. The loosened material shall then be combed by means of rakes to bring out most of the larger stone. If necessary, the larger stones thus collected shall be screened to separate fine particles if any.

The remaining metal shall then be removed and screened to recover reusable metal. Different grades of metal shall be stacked separately and measured.

15.22 **Divisions**
Where the construction of the road or culvert or bridge is in progress, the road shall be closed to traffic and a suitable diversion shall be provided for traffic by the Contractor, as directed by the Engineer.

The road shall be closed by the erection of barriers and suitable sign boards at both ends which shall be provided with lights at night. Both during night and during day, one man shall be posted at each barrier to suitably divert the traffic and to keep the light burning during the night.

16.0 WATERPROOFING TO ROOFS & BASEMENTS & WATERPROOFING PAINTS

16.1 Scope

This chapter deals with different types of waterproofing on roof and different types of damp proofing treatment in basement.

16.2 Material

The materials shall conform to Part-I.

16.3 General Workmanship

The waterproofing to roofs and basements being specialized works the Contractor shall get these done by specialized firms/agencies.

16.4 Painting with Hot Bitumen

The surface to be painted shall be thoroughly dried and shall be cleaned, with wire brushes and cotton or gunny cloth of all loose materials and scales. The surface shall further be cleaned with a piece of cloth lightly soaked in kerosene oil. Bitumen shall be brought to the site in its original container and this shall not be removed from site till the painting job is completed. Before applying the main coatings of hot bitumen paints, one coat of bituminous primer shall be applied. The number of coats of hot bitumen shall either two coats or as specified in the Schedule of Items. The bitumen of approved quality (either of grade 80/100 or 30/40) shall be applied to the surface after heating it to the manufacturer’s specifications. Care shall be taken to see that no blank patches are left and the quality of bitumen to be spread shall be as specified and shall be to the satisfaction of the ENGINEER.

16.5 Painting with Bitumen Emulsion

Before applying, the surface shall be cleaned thoroughly. Generally two coats of Bitumen Emulsion are provided over a coat of emulsion primer. Since the painting is with emulsion, the surface need not be made dry.

16.6 Waterproofing of Roof

16.6.1 With Mud Phuska

Prior to laying of mud phuska preparation of surface by removing loose materials from the roof top shall be done. Mud phuska shall be laid in layer of minimum 100mm thk.
(average) of damped brick consolidated and plastered with 25mm thick mud mortar (soil shall be cohesive) mixed with bhusa (wheat straw) @10 kg per cum of earth. Brick tiles of class designation 100 are properly laid over mud phuska. Gaps between tiles are grouted with 1:3 cement mortar mixed with integral waterproof compound @ 2% by weight of cement. The surface of the finished roof shall be kept wet for a period of not less than 7 days. For better result a layer of hot bitumen over the finished roof shall be done. Care shall be exercised while doing the roof finish work to compact the mud phuska layer to the maximum density. Refer IS : 2115 – 1980 for application of mud phuska over flat roof.

16.6.2  With bitumen felt

Prior to laying the insulation, roof gradient shall be checked. If necessary, the roof shall be regarded by screed to ensure everywhere a run off gradient of not less than 1 in 120. The screed shall consist of one part cement and four parts medium to coarse sand by volume. The screed shall be cured for 7 days. The surface shall then be cleaned of all foreign matter by wire brushing and dusting.

Waterproofing unless specified otherwise in drawings shall be the "heavy treatment type" with primer coat as described in IS : 1346. The method of laying roofing treatment, surface finishing with pea gravels, special mode of treatment for drain outlets, projecting pipes, parapet walls, expansion joints, gutters, timber roofs etc., shall conform to IS : 1346. The number of layers of felts shall be as specified in the drawing or Schedule of Items. The bonding bituminous material shall be of grade 30/40 and the minimum quantity of hot bitumen to be applied, shall be 1.2 kg/m². Unless specified otherwise, the bituminous felts shall be hessian bases of Type-3 Grade-2. Pea gravel finish may be substituted by a coat of bituminous aluminium paint, where so specified in the Schedule of Items.

The cement mortar used for filling the chases shall be of mix 1:4 and the cement concrete for fillets shall be of the same grade as the roof slab.

Where special surface finish with precast concrete or clay tiles is specified, it shall be in accordance with the relevant chapter of this series.

16.6.3  With bitumen mastic

The work shall be carried out generally in accordance with IS : 4365 "Code of Practice for Application of Bitumen Mastic for Waterproofing of Roofs" or according to the manufacturer's specifications. The work shall be carried out by a firm of specialists in the trade.

The type of underlay or primer, thickness of application, surface finish etc., shall be as shown on drawing or described in the Schedule of Items. Melting shall be done in a mechanical mixer by gradually heating to about 200 degree 'C'. Coarse aggregate where required shall be added to the hot bitumen and stirred.

Each coat shall be spread evenly and uniformly by means of a float to the required thickness. Timber gauges shall be used to regulate the thickness. Particular care shall be taken to tuck the mastic into grooves on vertical surfaces, at joints, around pipes or other projections and at junction of adjoining bays.
16.7 **Waterproofing for Basement**

16.7.1 The specification covers the requirements of waterproofing of basements, tunnels, ducts, pits, bunkers, etc.

The material used shall be bitumen felt type-3 of grade-2 conforming to IS:1322, together with the specified bonding material and primer.

Waterproofing shall be provided on the outside of walls and top of the floors and shall be carried 150 mm above ground level.

The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:

- i) For depths up to five meters below ground .. 2 layers.
- ii) For depths beyond five meters .. 3 layers.

The method of laying the bitumen felts and workmanship shall be general conform to IS: 1609.

Waterproofing work shall be taken in hand only when the sub-soil water level is at its lowest the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed. For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps. In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area. Adequate arrangements shall be made to prevent the sides of excavation from slipping while the work is in progress.

The base concrete of mud-mat shall be rendered smooth by a 20 mm thick sand-cement plaster (6:1). Any sharp corner over which the waterproofing course is to be laid shall be eased out by means of cement mortar fillets 7.5 cm in radius.

The surface must be dry before the next operation is carried out. Blown bitumen conforming to IS : 702 shall be applied hot over the prepared surface at the rate of 1.5 kg/m² for the first layer and for every other subsequent layer(s). The laying of felt over the bitumen so applied shall always commence on the floor, and shall be carried to the walls only after treatment of the floor is complete. The minimum overlapping of joints at sides and ends of felts shall be 10 cm. Joints for subsequent layers of felt shall be staggered. All joints shall be completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar 1:3 or 6 cm thick cement concrete type 150B or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the waterproofing treatment to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way, the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth, where necessary with a coat of cement plaster 1:5, the felts laid as for the floor ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar 1:6 over the projecting mud-mat, the space between the wall and felt being grouted with cement slurry. Sufficient care shall be taken to ensure a perfect bond between the waterproofing on the floor and that on the walls.
16.7.2 With epoxy based emulsion

Over the mud-mat a 20 mm plaster is to be provided to make the surface even.

On the plastered surface of the mud-mat, three coats of epoxy based leakproof emulsion shall be applied with reasonable gap between each coat in order to permit sufficient drying time.

After the painting is over a 20 mm thick plaster is again to be provided before placement of R.C.C. in order to protect the film surface of the paint from the positive damage which may occur during the process of rod binding of R.C.C. The protective layer of plaster can be eliminated but precaution should be taken that during the process of rod binding if any, damages happen should be immediately rectified by making patch painting only on the affected portion and as such a complete vigilance is to be kept to rectify the defect.

After the rod binding is over the concreting should be done with high polymer based chloride and sulphide free cement waterproofing additive/admixtures @ 2% by weight of cement althrough the floor area and althrough the vertically raised walls of four sides which shall remain underground upto a depth of 8 meter and above from ground level.

After the concreting and immediately after de-shuttering cleaning of the concrete surface on the external faces of the walls are to be done and then three coats of epoxy based leakproof emulsion shall be applied with a reasonable gap between the each coat before back filling. If the back filling is with hard material again a protective layer of plaster shall also be applied on the external faces of walls in order to avoid damages on the painted surface.

If the back filling is with soft sandy or alluvial soil there is no necessity for protective layer of plastering as mentioned above.

Epoxy based paint can be applied on the wet surface hence there shall be no stoppage of the normal progress of the project works.

16.8 Surface Application

Waterproofing done by surface application of bitumen based or epoxy based material shall conform strictly to the recommendations of the manufacturer. The work shall be carried out by a firm of specialists in the trade.

16.9 Water Proofing by Self Adhesive HDPE Membrane System

The material used shall be HDPE film cross laminated to a bitumen backed compound
for self adhesion on concrete/ masonry surface, together with specified primer for achieving a high level of water proofing.

The entire work shall be executed as an effective and manufacture – such as “Bituthene – 1000 X-HC” of Grace Construction Products, UK; “SUPERTENE – 5000X” of STP Ltd., India; or any other make of standard and proven performance.

16.9.2 The following specifications shall be followed (Generally the specification shall be the line recommendations of the manufacturer/ supplier of HDPE based waterproofing system.

**On Horizontal Surfaces**

Make the surface smooth, even and free from loose dust, cement particles standing water, sharp protrusions and hollows etc. first by cleaning and then by applying two coats of cement slurry with plaster mix (in specified proportion) of approved quality and manufacture.

An approved quality bituminous primer shall be applied (as per recommendations to the manufacture/ supplier of water proofing system) in two coats.

Apply the approved quality and manufacture self adhesive membrane having cross laminated HDPE film of 100 micron thickness impregnated in designated bituminous compound having an overall thickness of 1.5mm (weighing not less than 1.5 kg/m²) on prepared surfaces using approved methodology of application.

RC concrete/ concrete screed shall be laid using an approved make and quality waterproofing admixture in recommended proportions as per specifications.

**On Vertical Surfaces**

Make the surface smooth, even and free from loose dust, cement particles standing water, sharp protrusions and hollows etc. first by cleaning and then by applying two coats of cement slurry with plaster mix (in specified proportion) of approved quality and manufacture.

At specified locations a 20mm thick waterproofing plaster in CM 1:3 shall be applied before next phase of work. The waterproofing admixture shall be mixed at specified rate.

An approved quality bituminous primer shall be applied (as per recommendations to the manufacture/ supplier of water proofing system) in two coats.

Apply the approved quality and manufacture self adhesive membrane having laminated HDPE film of 100 micron thickness impregnated in designated bituminous compound having an overall thickness of 1.5mm (weighing not less than 1.5 kg/m²) on prepared surfaces using approved methodology of application.

Construct a protective lining of 230mm thick brick masonry using CM 1:4. Apply two coats of cement slurry with plaster mix (in specified proportions) of approved quality and manufacture.

Apply 20mm thick waterproof plaster in CM 1:3 mixed (in recommended mix) with water-repelling admixture of approved quality and manufacture.
16.9.2 The sheets used shall be of maximum practicable length and width so as to keep the number of joints to a minimum. Membrane shall be properly anchored at edges/ ends by pressing or heating. The joints to have panels of approved length and width generally as per recommendations of the manufacturer.

16.9.3 The work shall be carried out by a company of specialists, completely in line with the specifications; product/ manufacturers specification to the entire satisfaction of the Engineer-in-charge.

16.10 Guarantee

For the waterproofing on the roof as well as for underground basements the Contractor shall give guarantee in writing for the period of 7 to 10 years as specified in the Schedule of Item. For such guarantee the Contractor shall get guarantee from the manufacturer/ specialized firms and forward the same to the Engineer. However, the Contractor shall be fully responsible for the serviceability of the waterproofing treatment throughout the guarantee period and any leakage during that guarantee period shall be stopped by the Contractor at no cost to the Owner and without disturbing working facility of the Owner.

17.0 MISCELLANEOUS

17.1 False Ceiling

17.1.1 Scope

This chapter deals with the specification for various types of false ceiling as listed below:

a) Wooden ceiling (solid wood) and decorative ply.
b) Ceiling with insulating Building Board/ Particle Boards etc.
c) AC Sheet and ply wood ceiling.
d) Plaster of Paris (Gypsum Anhydrous) ceiling over wooden frame.
e) Plaster of Paris (Gypsum Anhydrous) Tiles ceiling.
f) Wooden cover, fillets, beading for ceiling.

17.1.2 General

17.1.2.1 Materials

All materials shall be in accordance with the general specifications of materials, Part-I, Schedule of Items and as shown in drawings.

Special finishing materials as specified in schedule of item shall be procured from the specified source and got fixed by employing skilled worker in the trade under direct supervision of the manufacturer.

17.1.3 Openings for Installation of Light Fittings
Openings in the ceiling for installation of A/C grills, light fittings shall be provided as per drawings.

17.1.4 Recess for Pelmet

Recess for the installation of pelmets shall be provided where shown in drawings along the windows/doors.

17.1.5 Grills

Grills made of wooden, M.S. Aluminium, PVC or any other material as necessary shall be provided as indicated in the drawing.

17.1.6 Frame Work

The type of frame to receive the ceiling material may be of wood, aluminium or M.S. as specified in the schedule of item and as mentioned in the drawing.

17.1.7 Wooden Framing for False Ceiling

Unless otherwise specified in schedule of items the wooden frame work shall be of following description:-

The frame work of false ceiling shall be of approved quality teak wood scantlings, the runners shall be 75 x 50mm size and shall be spaced at 1200mm c/c and the battens shall be 50 x 50mm size spaced at 600mm c/c (approx.) forming a grid of 600 x 600 mm of any other grid suitable for fixing the false ceiling material and its size. The runner and battens shall be joined by halving joint using counter sunk 6mm bolt with washer of required length with soffit of runner and batten in perfect level. The heading joints between runners shall be made with lap joins using 2 nos. 6mm dia counter sunk bolts with washer. Heading lap joints between batten shall be made with suitable size screws. The wall ends of the runner shall be embedded in the wall (50mm deep) and shall be grunted with 1:2:4 cement concrete. The soffit of frame work shall be made perfectly horizontal. The teak wood frames shall be treated with 2 coats of wood preservations treatment before fixing the tiles/boards as the case may be.

The main runners of frames shall be suspended by M.S. flat 40 x 3 mm/12mm dia M.S. round/ T.S. hangers placed at 1200mm c/c (approx.), the top end of the hanger shall be hocked to R.C.C. reinforcement of slab or fixed to M.S. flat cleats installed in slab for the purpose or hooked to purlins of the trusses. The hangers may be twisted or ends of M.S. round/ T.S. hanger flattened to allow for fixing the same with T.W. frame or M.S. cleats with bolts of suitable size.

For teak wood framings of shaped ceilings the spacings of frames and hangers levels of false ceiling etc., shall be required to obtain the shapes/drops and profile of the ceiling and to the requirement of ceiling material. The frames shall be locally adjusted to create openings of required sizes for installation of light fittings, grills of air conditioning system.

17.1.8 Metal Framing

17.1.8.1 Galvanised pressed steel framing system

Galvanised pressed steel framing system for false ceiling shall be procured from reputed
manufacturer and installed by specialist agencies under technical guidance of the manufacturer and strictly as per their specifications. Unless specified otherwise these shall consist of G.I. rectangular pipes at 900mm c/c suspended by M.S. hanger fixed to R.C.C. slab with M.S. cleats and cross channels fixed to rectangular pipes at 450mm c/c as per “Galvolock” system of M/s Eastern Interior Pvt. Ltd. or equivalent. Ceiling materials shall be fixed to cross channels as per specifications of the manufacturer.

Framing shall be adjusted to provide openings for the light fittings and air-conditioning grills but these shall be supported independently and not on the framing.

17.1.8.2 Aluminium Grid Ceiling Framing System

Framing for Aluminium grid false ceiling system shall be of reputed manufacturer Bestlok, Eezilock or equivalent. It shall consist of aluminium main tee and cross tee’s suspended by adjustable hangers fixed to R.C.C. floor with cleats. The grid may be 600 x 600mm, 1200 x 600mm or as per drawings. Ceiling materials, shall be fixed to frames strictly as per manufacturers specification.

17.1.9 Fixing of Ceiling

17.1.9.1 Wooden Ceiling with Planks

These shall be of class of wood and thickness as specified in schedule of items. Unless specified otherwise the width of the ceiling board shall be 100mm to 150mm and shall be planed true on the exposed surface. The maximum length of the finished board shall be 1800mm. The boards/ strips shall be joined with tongue and grove joints and heading joints in adjacent board of the same strip shall be square butt type neatly finished. These joints shall be staggered in alternate strip or line. The boards shall be fixed to T.W. battens by headless brass pins. Moulding beads at junctions with walls and other locations as per drawings shall be provided. Necessary opening for installation of light fittings and A/C grill shall be provided and junctions if required shall be finished with moulded beads.

17.1.9.2 Decorative Ply Ceiling

These shall be with decorative selected group matched ply to Teak Ply, white cedar ply or any other approved class of veneer ply in strips, square or rectangular panel matching the ply of wall panelling, if any, in the same room and of thickness as per schedule of item and drawings. The strip ply, square/ rectangular panels shall be fixed to T.W. frame work with panel pins. Moulded beads of same wood as that of ply of matching shade shall be provided at junctions with walls and as specified in drawings.

Where specific pattern of grains and shade in required the ply cut into shapes as per design may be pasted on a backing ply with adhesive and such made panels shall be fixed to framing.

The ceiling shall be checked for line, and levels and exposed surfaces shall be sand papered and finally polished with colourless polish to achieve matt satin natural finish.

17.1.9.3 Ceiling with insulation board/ particle boards

Insulation boards shall be of approved manufacturer, shade, design and thickness as specified in schedule of items and drawings. These may be plain, textured, perforated...
with natural finish or with white finished surface.

The boards shall be cut to suit the panel sizes of ceiling with special tools and by skilled workmen strictly as per manufacturers specifications. The board shall be fixed to T.W. frames with brass screws or as per manufacturers recommendation and in case of metal frames as per recommendations of the manufacturer of the ceiling system. The joints where exposed shall be of uniform thickness (3mm to 6mm) and pattern as shown in drawings.

The ceiling shall be checked for line and level and exposed surfaces prepared appropriately to receive the paint as specified in schedule of item and drawings.

17.2  Expansion and Isolation Joints

17.2.1  General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved-laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior to approval of the method of forming the joints should be obtained from the Engineer before starting the work.

17.2.2  Bitumen impregnated board

Bitumen impregnated fibre board of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

17.2.3  Joint sealing strips

17.2.3.1  General

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water. The sealing strips will be either metallic like GI, Aluminium or Copper, or Non-metallic like rubber or PVC.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The jointing procedure shall be as per the manufacturer's recommendations revised if necessary, by the Engineer. If desired by the Engineer, joints in rubber seals; may have to be vulcanised.
17.2.3.2  Metal sealing strips

Metal sealing strips shall be either GI, Aluminium or Copper and formed straight, U-shaped, Z-shaped or any other shape and of thickness as indicated in the drawing and schedule of items and/or as instructed by the Engineer.

The transverse joints will be gas welded using brass rods and approved flux. In case it is found that the joints cannot be made leakproof, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor without any additional cost to the Owner. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

a) GI Strips
GI strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The Strips shall be strong, durable, without any rust or crease. At the joints, the overlapping should be for a minimum length of 50 mm.

b) Aluminium strips
Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737. A minimum lap of 50 mm length is required at the joints.

c) Copper strips
The copper strips shall be minimum 18 SWG in thickness and 300 mm width unless specified otherwise and shall conform to the relevant Indian Standards.

It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

17.2.3.3  Non-metallic sealing strips

These will be normally in Rubber or PVC Rubber or PVC joint seals can be of shape having any combination of the following features:

a) Plain
b) Central bulb
c) Dumb-bell or flattened ends
d) Ribbed and corrugated wings
e) V-shaped

Transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The actual size and shape; shall be as shown in drawings/Schedule of Items and or as directed by the Engineer.

The method of forming these joints, laps etc., shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

a) Rubber sealing strips
The minimum thickness of rubber sealing strips shall be 3 mm and the minimum width 100 mm. The material will be natural rubber and the resistant to corrosion,
 abrasion and to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows:

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>1.1 to 1.15</td>
</tr>
<tr>
<td>Shore Hardness</td>
<td>65A to 75A</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>25 - 30 N/mm²</td>
</tr>
<tr>
<td>Maximum Safe Continuous Temperature</td>
<td>75 Degree 'C'</td>
</tr>
<tr>
<td>Ultimate Elongation</td>
<td>Not less than 350%</td>
</tr>
</tbody>
</table>

**b) PVC sealing strips**

The minimum thickness of P.V.C sealing strips will be 3 mm and the minimum width 100 mm. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows:

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>1.3 to 1.35</td>
</tr>
<tr>
<td>Shore Hardness</td>
<td>60A to 80A</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>10 - 15 N/mm²</td>
</tr>
<tr>
<td>Maximum Safe Continuous Temperature</td>
<td>70 Degree 'C'</td>
</tr>
<tr>
<td>Ultimate Elongation</td>
<td>Not less than 275%</td>
</tr>
</tbody>
</table>

### 17.2.4 Bitumen compound

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer’s specifications. The compound to be used shall be approved manufacture and shall conform to the requirements of IS: 1834.

### 17.2.5 Isolation joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

### 17.3 Rubber Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer. The rubber shall have a unit weight of 1500 kg/m³, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and...
must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

17.4  Barbed Wire Fencing

17.4.1  Materials

17.4.1.1  Galvanized barbed wire

Barbed wire shall be 2.24 mm dia 2 ply lines with 4 points barbes 7.5 cm apart and shall be properly galvanized and shall be obtained from the approved manufacturer.

17.4.1.2  Other materials

The specifications of materials, for angle iron posts, concrete works, plasters, if any, and for other works, shall conform to the requirements as specified in Part-I.

17.4.2  Workmanship

The work shall comprise of the following:

a) Excavation in ground of required dimensions with all sides vertical in any type of soil including soft rock and removing the soil dressing it neatly.

b) Filling the holes in full with cement concrete 1:3:6 mix, well packed, after erecting the posts in correct line, level and plumb. In case of any post coming at local depression, the hole may not be of full depth but the depth of concrete will always be made 60 cm raising it above ground level with necessary shuttering.

c) Where the angle iron posts are specified in the item these shall be 50 mm x 75 mm x 6 mm unless mentioned otherwise, 10 mm dia holes with saw cuts for inserting the wires shall be made as per the spacing of barbed wire shown in drawing or as directed by the Engineer. The foot of the post shall be provided with base plate for anchorage. The spacing shall be 2.5 m or as per drawing. After inserting the wire into holes the socket is to be pressed back.

d) Straining bolts are to be provided 15 m apart from each row of wire for maintaining proper tension in the wire and without any sag or looseness.

e) Posts are to be painted as directed by the Engineer.

f) Complete fenced length will not be measured for payment. Any gate openings will be deducted. There should not be any misunderstanding that each wire row will be paid separately.
PART-III

NORMS OF CEMENT CONSUMPTION
## 1.0 CONCRETE

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Cement requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Concrete Grade M5A, M5B</td>
<td>164, 196</td>
</tr>
<tr>
<td>2.</td>
<td>Concrete Grade M7.5A, M7.5B</td>
<td>194, 226</td>
</tr>
<tr>
<td>3.</td>
<td>Concrete Grade M10A, M10B, M10C</td>
<td>To be mutually agreed based on mix design to be prepared by the Contractor and approved by the Engineer</td>
</tr>
<tr>
<td>4.</td>
<td>Concrete Grade M15B, M15C, M15D</td>
<td>-do-</td>
</tr>
<tr>
<td>5.</td>
<td>Concrete Grade M20B, M20C, M20D</td>
<td>-do-</td>
</tr>
<tr>
<td>6.</td>
<td>Concrete Grade M25B, M25C, M25D</td>
<td>-do-</td>
</tr>
<tr>
<td>7.</td>
<td>Concrete Grade M30C, M30D</td>
<td>-do-</td>
</tr>
<tr>
<td>8.</td>
<td>Grouting with M15D, M20D, M25D, M30D</td>
<td>359, 422, 496, 591</td>
</tr>
<tr>
<td>9.</td>
<td>Grouting with 1:2 (by volume) Cement and sand 1:3 (by volume) mortar</td>
<td>718, 540</td>
</tr>
<tr>
<td>10.</td>
<td>Jhama Brick Jelly Concrete 1:71/2</td>
<td>180</td>
</tr>
</tbody>
</table>

Note: A, B, C & D mentioned along with grade of concrete correspond to the maximum size of coarse aggregate being 75 mm, 40 mm, 20 mm, and 10 mm respectively.
2.0 MASONRY

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Cement requirement (kg/M3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Random rubble masonry with cement sand mortar</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) 1:4</td>
<td>125.40</td>
</tr>
<tr>
<td></td>
<td>(b) 1:5</td>
<td>102.30</td>
</tr>
<tr>
<td></td>
<td>(c) 1:6</td>
<td>82.50</td>
</tr>
<tr>
<td>2.</td>
<td>Brick work in Cement sand mortar</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) 1:4</td>
<td>95.00</td>
</tr>
<tr>
<td></td>
<td>(b) 1:5</td>
<td>77.50</td>
</tr>
<tr>
<td></td>
<td>(c) 1:6</td>
<td>62.50</td>
</tr>
<tr>
<td>3.</td>
<td>Half brick thick brick work in cement sand mortar</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) 1:3</td>
<td>14.30</td>
</tr>
<tr>
<td></td>
<td>(b) 1:4</td>
<td>10.60</td>
</tr>
<tr>
<td></td>
<td>(c) 1:5</td>
<td>8.70</td>
</tr>
<tr>
<td>4.</td>
<td>Half brick thick honey combed brick work in cement mortar</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) 1:3</td>
<td>8.60</td>
</tr>
<tr>
<td></td>
<td>(b) 1:4</td>
<td>6.40</td>
</tr>
<tr>
<td></td>
<td>(c) 1:5</td>
<td>5.20</td>
</tr>
</tbody>
</table>
### 3.0 FLOORING

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Cement requirement (Kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> (a)</td>
<td>25 mm thick granolithic layer with 10 mm down graded chips</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) 150 Grade</td>
<td>9.50</td>
</tr>
<tr>
<td></td>
<td>ii) 200 Grade</td>
<td>11.50</td>
</tr>
<tr>
<td></td>
<td>(b) Extra for each additional thickness of 5 mm granolithic layer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) 150 Grade</td>
<td>1.90</td>
</tr>
<tr>
<td></td>
<td>ii) 200 Grade</td>
<td>2.30</td>
</tr>
<tr>
<td><strong>2.</strong> (a)</td>
<td>100 B Grade PCC rubbed smooth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) 100 mm thick</td>
<td>26.00</td>
</tr>
<tr>
<td></td>
<td>ii) 75 mm thick</td>
<td>19.50</td>
</tr>
<tr>
<td></td>
<td>(b) Extra over above for each additional 10 mm thickness</td>
<td>2.50</td>
</tr>
<tr>
<td><strong>3.</strong> (a)</td>
<td>75 mm thick with 20 mm stone RCC floor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) 150 Grade</td>
<td>24.50</td>
</tr>
<tr>
<td></td>
<td>ii) 200 Grade</td>
<td>28.00</td>
</tr>
<tr>
<td></td>
<td>(b) Extra over above for additional 25 mm thickness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) 150 Grade</td>
<td>8.10</td>
</tr>
<tr>
<td></td>
<td>ii) 200 Grade</td>
<td>9.20</td>
</tr>
<tr>
<td><strong>4.</strong></td>
<td>Cast in situ terrazzo floor 40 mm thick with top layer of 50% grey &amp; 50% white cement</td>
<td>13.00</td>
</tr>
<tr>
<td><strong>5.</strong></td>
<td>Precast terrazzo tile floor 20 mm thick jointing with 50% white cement and under layer of 1:3 cement mortar 12 mm thick</td>
<td>11.50</td>
</tr>
</tbody>
</table>
## 4.0 FINISHING

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Cement requirement (Kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cement plaster 10 mm thick</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) 1:6</td>
<td>3.00</td>
</tr>
<tr>
<td></td>
<td>ii) 1:5</td>
<td>3.70</td>
</tr>
<tr>
<td></td>
<td>iii) 1:4</td>
<td>4.30</td>
</tr>
<tr>
<td></td>
<td>iv) 1:3</td>
<td>5.70</td>
</tr>
<tr>
<td>2.</td>
<td>Cement plaster 15 mm thick</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) 1:6</td>
<td>4.50</td>
</tr>
<tr>
<td></td>
<td>ii) 1:5</td>
<td>5.40</td>
</tr>
<tr>
<td></td>
<td>iii) 1:4</td>
<td>6.50</td>
</tr>
<tr>
<td></td>
<td>iv) 1:3</td>
<td>8.80</td>
</tr>
<tr>
<td>3.</td>
<td>Ceiling plaster 6 mm thick</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) 1:4</td>
<td>2.80</td>
</tr>
<tr>
<td></td>
<td>ii) 1:3</td>
<td>3.70</td>
</tr>
<tr>
<td>4.</td>
<td>Flush/Rule/Tuck/Weather Struck/Pointing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) 1:3</td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>ii) 1:2</td>
<td>2.00</td>
</tr>
</tbody>
</table>
PART-IV

DIMENSIONAL TOLERANCE
1.0 GENERAL

The materials used in construction shall, besides conforming to the specifications and standards mentioned, be the best of the existing kinds obtainable. Where a particular 'Brand' or 'Make' of material is specified such 'Brand' or 'Make' of material alone shall be used.

A high standard of workmanship and accuracy shall be achieved in all sections and parts of the work. The workmanship shall be in accordance with the latest and the best civil engineering practice.

The Contractor shall ensure that all sections of the work are carried out with utmost care to achieve the dimensions shown in drawings or specifications. Where special and close tolerances are required in any particular section of work, these will be shown in the drawing and such tolerances shall be met. In the absence of such specific mention in drawings the following dimensional deviations may be tolerated, provided they do not impair the appearance or render the particular section of work unacceptable to the purpose for which it is intended.

<table>
<thead>
<tr>
<th>Description</th>
<th>Permissible tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building bricks, in length width and height</td>
<td>As per IS 1077</td>
</tr>
<tr>
<td>Laterite stone, in length, width &amp; height</td>
<td>Plus or minus 5 mm</td>
</tr>
<tr>
<td>Concrete and reinforced concrete pipes</td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>Plus or minus 1% of standard length</td>
</tr>
<tr>
<td>Internal diameter, upto 300mm</td>
<td>Plus or minus 3 mm Minus 1.5 mm</td>
</tr>
<tr>
<td>Internal diameter, upto 400mm</td>
<td>Plus 6 mm Minus 3 mm</td>
</tr>
<tr>
<td>Over 400 mm</td>
<td>Plus 1.5% Minus 0.75%</td>
</tr>
<tr>
<td>Barrel wall thickness upto 25mm</td>
<td>Plus or minus 1.5mm</td>
</tr>
<tr>
<td>Over 25 to 35 mm</td>
<td>Plus or minus 2 mm</td>
</tr>
<tr>
<td>Over 35 to 50 mm</td>
<td>Plus or minus 3 mm</td>
</tr>
<tr>
<td>Over 50 mm</td>
<td>1 mm for every 15mm thickness over 50 mm, but limited to maximum of 5 mm</td>
</tr>
<tr>
<td>Cast iron pipes and fittings</td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>Plus or minus 13mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>Plus or minus 1 mm</td>
</tr>
<tr>
<td>Internal dia of socket</td>
<td>Plus or minus 3 mm</td>
</tr>
<tr>
<td>Component</td>
<td>Tolerance</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Depth of socket</td>
<td>±10 mm</td>
</tr>
<tr>
<td>External dia, up to 75 mm</td>
<td>±3 mm</td>
</tr>
<tr>
<td>100 mm to 125 mm</td>
<td>±3.5 mm</td>
</tr>
<tr>
<td>150 mm</td>
<td>±4 mm</td>
</tr>
<tr>
<td>Stoneware pipes, in length up to 75 cm</td>
<td>±10 mm</td>
</tr>
<tr>
<td>Upto 90 cm</td>
<td>±15 mm</td>
</tr>
<tr>
<td>Glazed tiles, length of all 4 sides</td>
<td>±0.8 mm</td>
</tr>
<tr>
<td>Individual dimensions and thickness</td>
<td>±0.5 mm</td>
</tr>
<tr>
<td>Metal doors, windows and ventilators</td>
<td>±1.5 mm</td>
</tr>
<tr>
<td>In overall dimension</td>
<td></td>
</tr>
<tr>
<td>Wooden doors, windows, ventilators</td>
<td>±3 mm</td>
</tr>
<tr>
<td>Overall dimension of frame and shutter</td>
<td>Minus 0 mm</td>
</tr>
<tr>
<td><strong>All components of shutter except glazing bar</strong></td>
<td></td>
</tr>
<tr>
<td>Width</td>
<td>±3 mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>±1 mm</td>
</tr>
<tr>
<td>Glazing bar, width &amp; thickness</td>
<td>±1 mm</td>
</tr>
<tr>
<td><strong>Earthwork</strong></td>
<td></td>
</tr>
<tr>
<td>Finished level of site levelling except rock</td>
<td>±50 mm</td>
</tr>
<tr>
<td>Finished level of site levelling except hard rock</td>
<td>±100 mm</td>
</tr>
<tr>
<td>Level of pits, trenches foundations</td>
<td>±50 mm</td>
</tr>
<tr>
<td><strong>Concrete &amp; Reinforced concrete</strong></td>
<td></td>
</tr>
<tr>
<td>Footings, plan dimension</td>
<td>±50 mm\</td>
</tr>
<tr>
<td>Minus 12 mm</td>
<td></td>
</tr>
<tr>
<td>Eccentricity</td>
<td>0.02 times the dimension of footing limited to 50 mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>±0.05 times the specified thickness</td>
</tr>
<tr>
<td>Description</td>
<td>Tolerance</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Deviation of planes and lines of their intersection from vertical or inclination along full height</td>
<td>Plus or minus 20mm</td>
</tr>
<tr>
<td>Deviation of horizontal plane from horizontal line for 1 m of the plane in any direction</td>
<td>Plus or minus 5mm</td>
</tr>
<tr>
<td>For the whole plane</td>
<td>Plus or minus 20 mm</td>
</tr>
<tr>
<td>Sizes of cross section</td>
<td>Plus or minus 8 mm</td>
</tr>
<tr>
<td>Surfaces of inserts to support loads</td>
<td>Plus or minus 5 mm</td>
</tr>
<tr>
<td>Length of elements</td>
<td>Plus or minus 20 mm</td>
</tr>
<tr>
<td><strong>Equipment foundations</strong></td>
<td></td>
</tr>
<tr>
<td>Top level of bolt</td>
<td>Plus 20 minus 0 mm</td>
</tr>
<tr>
<td>Top level of foundation before grouting</td>
<td>Minus 30 mm</td>
</tr>
<tr>
<td></td>
<td>Plus 0 mm</td>
</tr>
<tr>
<td>Axes of anchor bolts in plan</td>
<td>Plus or minus 5 mm</td>
</tr>
<tr>
<td>Axis of foundation in either direction</td>
<td>Plus or minus 20 mm</td>
</tr>
<tr>
<td>Deviation in vertical line along height</td>
<td>Plus or minus 20 mm</td>
</tr>
<tr>
<td>Sizes of pits in plan</td>
<td>Plus or minus 20 mm</td>
</tr>
<tr>
<td>Sizes of steps in plan</td>
<td>Plus 0 mm Minus 20 mm</td>
</tr>
<tr>
<td>Levels of steps, benches and pits</td>
<td>Plus 0 mm Minus 20 mm</td>
</tr>
<tr>
<td>Axes of inserts in plan</td>
<td>Plus or minus 10 mm</td>
</tr>
<tr>
<td>Basic dimensions in plan</td>
<td>Plus or minus</td>
</tr>
<tr>
<td><strong>Deviation of horizontal plan from horizontal line</strong></td>
<td></td>
</tr>
<tr>
<td>For 1 m of plane in any direction</td>
<td>Plus or minus 5 mm</td>
</tr>
<tr>
<td>For the whole plane</td>
<td>Plus or minus 20 mm</td>
</tr>
<tr>
<td>Local deviations of top surface when checked with a 2 m long straight edge</td>
<td>Plus or minus 8 mm</td>
</tr>
<tr>
<td><strong>Buildings</strong></td>
<td></td>
</tr>
<tr>
<td>Surfaces when checked with a 2 m long straight edge</td>
<td>Plus or minus 8 mm</td>
</tr>
<tr>
<td>Description</td>
<td>Tolerances</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Sizes of cross section</td>
<td>Plus 8mm Minus 0 mm</td>
</tr>
<tr>
<td>Length of elements</td>
<td>Plus or minus 20 mm</td>
</tr>
<tr>
<td>Deviation from horizontal plane, for whole Building</td>
<td>Plus or minus 10 mm</td>
</tr>
<tr>
<td>Deviation of planes and lines of their intersection from vertical or design slope along height</td>
<td></td>
</tr>
<tr>
<td>For columns supporting floor beams</td>
<td>Plus or minus 15mm</td>
</tr>
<tr>
<td>For framed columns linked with crane girders and beams</td>
<td>Plus or minus 10mm</td>
</tr>
<tr>
<td><strong>Reinforced concrete walls</strong></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>Plus or minus 20 mm</td>
</tr>
<tr>
<td>Flatness of surface when checked with a 2 m long straight edge</td>
<td>Plus or minus 20 mm</td>
</tr>
<tr>
<td>Level of top surface to support assembled elements</td>
<td>Plus or minus 5mm</td>
</tr>
<tr>
<td>Deviation in planes and lines of intersection from vertical</td>
<td>Plus or minus 15mm</td>
</tr>
<tr>
<td>Size of cross section</td>
<td>Plus or minus 8 mm</td>
</tr>
<tr>
<td><strong>Placing of reinforcement</strong></td>
<td></td>
</tr>
<tr>
<td>Length of bar upto 75 cm long</td>
<td>Plus 3 mm Minus 5 mm</td>
</tr>
<tr>
<td>75 - 150 cm long</td>
<td>Plus 5 mm Minus 10 mm</td>
</tr>
<tr>
<td>150 - 250 cm long</td>
<td>Plus 6 mm Minus 15 mm</td>
</tr>
<tr>
<td>250 cm long</td>
<td>Plus 7 mm Minus 25 mm</td>
</tr>
<tr>
<td>Straight bars, all lengths</td>
<td>Plus or minus 25 mm</td>
</tr>
<tr>
<td>Spacing of bars</td>
<td>Plus or minus 5 mm</td>
</tr>
<tr>
<td><strong>Anchor bolts</strong></td>
<td></td>
</tr>
<tr>
<td>Shift in location in plan</td>
<td>Plus or minus 5 mm</td>
</tr>
<tr>
<td>Same, when bolts are located outside of structural columns</td>
<td>Plus or minus 10 mm</td>
</tr>
<tr>
<td>Top level</td>
<td>Plus 20 mm Minus 0 mm</td>
</tr>
<tr>
<td>Threaded length</td>
<td>Plus 30 mm Minus 0 mm</td>
</tr>
</tbody>
</table>
length and width
<table>
<thead>
<tr>
<th>SI No</th>
<th>Description</th>
<th>SPEC. No.</th>
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<tr>
<td>1</td>
<td>Specification for Installation of Instruments</td>
<td>MEC/S/05/26/01</td>
</tr>
<tr>
<td>2</td>
<td>Specification for Instrument Tubing</td>
<td>MEC/S/05/26/02</td>
</tr>
<tr>
<td>3</td>
<td>Specification for Inlet Outlet Sections &amp; FS</td>
<td>MEC/S/05/26/03</td>
</tr>
<tr>
<td>4</td>
<td>Specification for Instrument Tube Fittings</td>
<td>MEC/S/05/26/04</td>
</tr>
<tr>
<td>5</td>
<td>Specification for Instrument Valves and Manifolds</td>
<td>MEC/S/05/26/05</td>
</tr>
<tr>
<td>6</td>
<td>Specification for Junction Boxes and Cable Glands</td>
<td>MEC/S/05/26/06</td>
</tr>
<tr>
<td>7</td>
<td>Specification for Signal Cable</td>
<td>MEC/S/05/26/07</td>
</tr>
<tr>
<td>8</td>
<td>General Technical Specification for Instrumentation</td>
<td>MEC/S/05/26/08</td>
</tr>
<tr>
<td>9</td>
<td>Specification for Cabling</td>
<td>MEC/S/05/26/21</td>
</tr>
<tr>
<td>10</td>
<td>Specification for Earthing</td>
<td>MEC/S/05/26/23 A</td>
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</tbody>
</table>
SPECIFICATION
FOR
INSTALLATION OF INSTRUMENTS

SPECIFICATION NO.: MEC/S/05/26/01

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
# Amendment Status

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<th>Page No.</th>
<th>Revision</th>
<th>Date</th>
<th>By (Name)</th>
<th>Verified (Name)</th>
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</tbody>
</table>
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1) SCOPE
2) STANDARDS OF MATERIALS
3) INSTALLATION OF INSTRUMENTS
4) TESTING
5) CALIBRATION OF INSTRUMENTS

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**PREPARED BY:** (N.S.KANNAN)  
**CHECKED BY:** (R.SANJAY BABU)  
**APPROVED BY:** (PANKAJ SHIVASTAVA)  
**ISSUE DATE:** 30.07.09
INSTALLATION, TESTING AND CALIBRATION OF
INSTRUMENTATION AND CONTROL SYSTEM

1.0 SCOPE

1.1 The purpose of this specification is to define the general requirements for the
installation, installation materials, testing and calibration of instruments and control
system.

1.2 The work shall be carried out in accordance with the codes, standards and
recommended practice listed in this specification and in accordance with local
`Statutory regulations'.

1.3 For installation of instruments and control system, of the new material where quality
is of the prescribed standards and which is in every way fit for its intended purpose
shall be used.

1.4 Unless otherwise specified all the materials shall be indicated in this specification
except where it is not compatible with fluids being handled. In such cases the
selection of the material shall be approved by MECON.

1.5 Only the best trade practices shall be used. All the work shall be carried out in a
neat, workman like manner and to the satisfaction of MECON.

2.0 STANDARDS OF MATERIALS

2.1 Instrument process piping / tubing upto and including the first block valve and
'in-line' instrument equipment shall conform to the line class or vessel rating
cconcerned instrument piping or tubing after the first lock valve may use alternate
materials consistent with service conditions. In general they shall conform to the
following specification as a minimum.

2.1.1 Stainless tubes shall be fully annealed and cold drawn seam less as per ASTM A
269 TP316 with size 1/2"OD x 0.65" WT (wall thickness).

2.1.2 Monel tubing shall be fully annealed seamless as per ASTM B165 with size 1/2" OD
x 0.35"WT.

2.1.3 Carbon steel pipe shall be 1/2" seamless and shall be as per ASTM A106 Gr B min
of sch 80 & dimensions as per ANSI B36.10.

2.1.4 Seamless stainless steel pipes shall be as per ASTM A 312 Gr TP 316L Sch 80S,
dimensions as per ANSI B 36.19.
2.1.5 Instrument air supply piping from the main instrument air header shall be galvanised heavy class pipes to IS 1239.

2.2 Individual pneumatic signal and air supply tubing shall conform to the following specifications:

2.2.1 Stainless tubes shall be used in general and shall be fully annealed and cold drawn seamless as per ASTM A269 TP 316 with 6mmOD x 1mmWT.

2.2.2 Copper tubing where specified shall be seamless 6mmOD x 1.0mmWT soft annealed as per ASTM 868.74a cd No. 122 (DHP) sheathed with PVC 1.0mm thick coloured Black.

2.3 All fittings shall be as a minimum of 100 rating except for tube fittings. The fittings shall have threading as per B2.1 and socket weld connections as per B 16.11. These shall conform to the following specifications in general.

2.3.1 Tube fittings shall be flare type compression fittings Swagelok or equivalents make double ferrule and pressure seat type.

All tube fittings in impulse lines shall be rated to 5000 PSIG at 38°C.

2.3.2 Carbon steel pipe fittings shall be forged as per ASTM A105 stainless steel pipe fittings shall be as per ASTM –182 Grf 316L

2.4 Valve shall have normally Globe body and shall be fabricated out of Bar-stock and rated to min. of 1500. These shall be screwed bonnet type with 13% GSS trim and plug shall be integral with the stem. Face to face dimensions shall be approx. 80mm. End connections shall be socket weld to ANSI 16.11 and threaded to B2.1

2.5 Multibore tubing shall have a maximum 19 single polyethylene tubes, 6mmOD x 1mm numbered for easy identification. The bundle shall be marked with inner and outer fire resistance PVC sheath. They shall carry a pair of telephone wire 0.6mm diameter flexible.

2.6 Single pair and multi pair extension cables for Thermocouples shall be matched and calibrated in accordance with ISA MC 96.1. Conductor size shall be AWG for single pair and 20 A for Multipair.

The cable shall be armoured, each twisted pair shall be individually shielded with aluminium Mylar tape and a tinned copper drain wire. The wires and the cable shall be colour coded as per ISA recommended practices.
2.7 Instrument Electrical cables shall conform to the following specifications:

2.7.1 Instrument electronic signal cables single pair/ Multipair shall have copper conductor, twisted in pair and individually shielded with Aluminium Mylar tape with drain wire. In multipair cables, each pair shall be armoured with inner and cut PVC sheath. Minimum conductor size shall be 1.5 mm².

2.7.2 Control Cables for control signal, alarms actuating devices and solenoid valves of the interlock and shutdown valves shall generally be 1.5 mm² copper conductors armoured with inner and cut PVC sheath.

2.7.3 All power supply cables shall have copper/Aluminium conductor depending upon the conductor size. The cables shall be armoured with inner and cut PVC sheath. The cables shall be sized adequately. Minimum conductor size shall be 2.5 mm².

2.7.4 2-core armoured cable shall be used for illuminator on level gauges.

2.7.5 The material and construction of all electrical cables shall conform to IS- 1554 Part I or appropriate equivalent code and standard.

3.0 INSTALLATION OF INSTRUMENTS

3.1 Instrument Mounting

3.1.1 No instrument shall be installed in such a way that it bends for support on the impulse piping or electrical connection on it.

3.1.2 Pressure gauges and temperature indicator shall normally be mounted directly on line. However direct on line mounting shall be avoided where vibrations are likely to be present.

3.1.3 Local mounted instruments shall be mounted on brackets, panels or placed on a suitable pedestal. Transmitters shall be mounted on 2” pipe supports where practical. Instruments to be mounted on steel columns, masonary structure etc. These shall not be mounted on heating equipments, pipelines and structures.

3.1.4 Blind transmitters shall be mounted at 130mm above graded platform. Local controllers, indicating transmitters and indicating instruments shall be mounted at approximately 1500 mm.

3.1.5 All the instruments shall be accessible from grade, ladder or platform etc. Pressures gauges and other local indicating instruments shall be readable from grade or operating level and if used for manual control shall be visible from the related valve.
All the instruments shall be located such that they don’t impede the process operation.

3.1.6 Local mounted instruments which are not available in weather proof housing shall be mounted inside a weather proof case.

3.1.7 Items such as pilot valves, solenoid valves etc. shall be located local to its point of application or near to the device being actuated by them.

3.1.8 For blind transmitters output meters shall be mounted on instrument supports.

3.1.9 Filter regulators shall be mounted on the instrument supports below pneumatic transmitter or on the control valve yoke.

3.1.10 Instruments or instrument lines shall not be supported on hand rails, in general.

3.1.11 The use of process piping to support instrument lines shall be avoided as far as possible.

3.1.12 The instrument impulse piping shall be kept as short as possible.

3.1.13 Instruments and impulse lines shall be protected against mechanical damage.

3.1.14 In case of capillary tube instruments, capillary tube is to be supported and protected against mechanical damage.

3.1.15 Orifice meters shall not be installed on the top of orifice fittings. On horizontal lines orifice pressure taps shall be located as follows:

a) On top for air and gas service
b) Horizontal for liquid and condensable vapour service.

3.2 Instrument Piping & Tubing.

3.2.1 Impulse Piping/tubing

3.2.1.1 The primary instrument block valves for all instruments shall be as per piping specifications.

3.2.1.23 Valve manifold in general shall be integral type. For pressure gauges, 2-valve manifolds shall also be acceptable instead of isolation valve, drain valve and pipe fittings.

3.2.1.3 Differential or static pressure sensing lines shall not exceed 6 mtrs. (20 feet) in general for direct connected or locally mounted instruments.
3.2.1.4 All impulse lines shall be run with a slope not less than 1 in 12 except where otherwise specified. Direction of slope is to be downward from the process for liquid service and upward from the process for gas service.

3.2.1.5 Tubing shall be joined by compression fittings.

3.2.1.6 Piping shall be joined by pipe fittings/flanges as per the piping specifications.

3.2.1.7 All instruments pipes and tubes shall run in horizontal and vertical planes only and shall run with minimum number of changes in direction, consistent with good engineering practices and neat appearance.

3.2.1.8 Tubing shall be bent with correct size tube bender as far as possible to avoid use of fittings. Hot bending shall be totally avoided.

Tubing cutter shall always be used to cut tubing. The use of short lengths of tubing in long runs shall be avoided in order to avoid the fittings.

3.2.1.9 All tubing shall run in such a manner as to give the maximum protection against mechanical damage. Tubing runs shall be grouped together and clamped.

3.2.1.10 Tubing shall be arranged so that the unions can be tightened without distorting lines.

3.2.1.11 Instrument tubing or piping shall not run on trays intended for cables and shall not share the same transit.

3.2.1.12 No pipe or tube shall be left with mechanical strain on them.

3.2.1.13 A mechanical ferrule seater shall be used on tubing for 140 kg/cm² (2000 psi) or more.

3.2.1.14 Pipe bushings shall not be used.

3.2.1.15 Pipe plugs shall be fabricated out of bar stock and shall have hex-head.

3.2.2 Air/Signal Tubing

3.2.2.1 Signal Transmission tubes shall be laid on perforated trays prefabricated out of min 2.5 mm. thick steel plates. The width of the tray shall be selected as per the number of tubes to be laid.

3.2.2.2 Where tubing is run in permanent enclosures, it should be ensured that entry and exit of such enclosures is clean and smooth.
3.2.2.3 Tubing run in permanent enclosures shall not have joints, except at special junctions boxes provided for this purpose.

3.2.2.4 Where permanent enclosures are left with space for instrument tubing to be laid at some later date, a galvanised pull wire of adequate size shall be left in the tray.

3.2.2.5 Where the length of transmission tubing exceeds 60 mtrs (200ft) necessity of installing signal booster relays shall be considered.

3.2.2.6 In case of `Skidded' equipment or vessels with instrumentation, where off- skid alarms shutdown or control functions are provided the signal tubes shall be terminated on the control bulk head near the skid boundary.

3.2.3 All threaded pipe joints shall be joined after applying Teflon tape. It should be applied in a manner to ensure that the tape does not spill over the end of the male fitting. No other pipe joining compound shall be used except on high temperature service where graphite sealing compounds shall be used.

3.2.4 All reasonable precautions shall be taken to prevent foreign materials entering pipe lines or tubing before and during erection.

3.2.5 Pipes and tubes installed but not connected, shall have the ends clad in approved fashion to prevent the entry of foreign material. For a period upto one week adhesive tape may be used, for longer periods, caps or plugs shall be used.

3.2.6 Piping/Tubing supports

3.2.6.1 Piping and tubing shall be adequately supported and fixed at a distance not exceeding that in the following table:

<table>
<thead>
<tr>
<th>Single tubing/Piping</th>
<th>Max. distance between supports</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot; OD or less</td>
<td>Continuous</td>
</tr>
<tr>
<td>1/2&quot; to 3/4&quot; Nom. size</td>
<td>2 meters (6ft.)</td>
</tr>
<tr>
<td>3/4&quot; to 1&quot; Nom. size</td>
<td>3 meters (9ft.)</td>
</tr>
<tr>
<td>Multitube bundle</td>
<td>3 meters (9ft)</td>
</tr>
</tbody>
</table>
3.2.6.2 All field mounted instrument air tubing shall be supported with galvanised steel angles or channels of minimum 1/8” thickness fabricated to present neat appearance.

3.2.6.3 All instruments tubing supports shall be galvanised prior to installation.

3.2.6.4 Trays shall be properly supported either from any rigid steel structure or concrete member. In case of non-availability of above, a suitable support shall be fabricated.

3.3 Instrument Air Supply Distribution

3.3.1 Piping material for instrument main and branched air headers upto the isolation valve at each take-off from main or branch header shall conform to piping specification.

3.3.2 The air header size shall be established in accordance with the table below, unless otherwise specified, for a header pressure of 4 to 8.5 kg/cm²

<table>
<thead>
<tr>
<th>Max number of users</th>
<th>Nominal pipe size</th>
</tr>
</thead>
<tbody>
<tr>
<td>upto 5</td>
<td>1/2”</td>
</tr>
<tr>
<td>upto 10</td>
<td>3/4”</td>
</tr>
<tr>
<td>upto 25</td>
<td>1”</td>
</tr>
<tr>
<td>upto 80</td>
<td>1-1/2”</td>
</tr>
<tr>
<td>upto 150</td>
<td>2”</td>
</tr>
<tr>
<td>upto 500</td>
<td>3”</td>
</tr>
</tbody>
</table>

3.2.3 All take off for branch lines are to be from the top of the main header with block valves equal in size to the branch line. All low point shall have a 1/2” valve installed as a drain and blow down point.

3.3.4 A minimum size of ½” pipe shall be run to the instrument with a ½” valve for each user. Tubing from the isolation valve to the instrument shall be 6.0 mm.

3.2.5 Union shall be provided at convenient location in the air header.

3.3.6 Filter regulator shall be provided for individual field mounted consumer and shall be complete with an output gauge.

3.3.7 In case of skid mounted equipments or vessels which incorporate instrumentation requiring pneumatic supply, on skid supply piping shall terminate at the skid boundary location and size of the supply connections shall be noted on the vendor approval drawings.
<table>
<thead>
<tr>
<th>TITLE</th>
<th>INSTALLATION OF INSTRUMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.4</td>
<td>Installation of multitude and Multicore cables.</td>
</tr>
<tr>
<td>3.4.1</td>
<td>Multicore/ Multitube cables shall generally be installed on trays or ducts and properly clamped. At bends minimum radius shall be maintained as per cable manufacturer's standards.</td>
</tr>
<tr>
<td>3.4.2</td>
<td>All cables shall be rigidly supported on structural steel and masonry. Drilling of steel member should normally be avoided. However, if the drilling of steel must be resorted to, it must be drilled where minimum of weakening of structure will result cables shall be support at every 500 mm. At every vertical drop these shall be clamped at more frequent intervals max of 300 mm.</td>
</tr>
<tr>
<td>3.4.3</td>
<td>Directly buried cables shall be laid underground in excavated cable trenches. Trenches shall have sufficient depth and width to accommodate all cables correctly spaced and arranged with a view of heat dissipation and economy of design construction of trenches laying of cables and filling up of trenches shall be as per relevant standard.</td>
</tr>
<tr>
<td>3.4.4</td>
<td>Each underground cable shall be provided with identifying tag of load securely fastened every 30 M of its underground length with at least one tag at each end before the cable enters the ground. Before cables are placed, the trench bottom shall be filled with a layer of sand. The cables shall be covered with 150 mm of sand on the top of the largest dia. cable tube and sand shall be lightly pressed. A protective covering of 75 mm thick second class red bricks shall be laid flat and the balance portion of the trench shall be filled with soil, compacted and levelled.</td>
</tr>
<tr>
<td>3.4.5</td>
<td>At each road crossing and other places where cables enter pipe sleeves, adequate bed of sand shall be given so that the cables don’t slack and get damaged by pipe ends after back filling.</td>
</tr>
<tr>
<td>3.4.6</td>
<td>At the entry into concrete blocks loops shall be provided at either end to prevent any damage to cable.</td>
</tr>
<tr>
<td>3.4.7</td>
<td>The cable entry to control room shall be suitably filled and sealed after laying of cables so as to achieve a positive sealing against the entry of gas/water.</td>
</tr>
<tr>
<td>3.4.8</td>
<td>All wiring, tubing, cables, Junctions boxes and auxiliary equivalent shall be suitably identified as per applicable codes and practices. All piping and tubing shall be tagged with slip-on or clip on wire marker at both ends.</td>
</tr>
<tr>
<td>3.4.9</td>
<td>Jointing of cables is generally not permitted. Cables shall be cut after the exact site measurements at the cable drums shall be so selected before cutting the lengths as to avoid any unnecessary wastage.</td>
</tr>
</tbody>
</table>
3.4.10 Low signal cables like alarms, analysers cables, special cables for turbine meter, thermocouple compensating cables etc. shall be laid separated from power supply cables in ducts/trenches/trays.

3.4.11 Electric signal lines for electronic transmitters to receive and to final control element shall be continuously shielded with the shield grounded at the same point as the signal circuit generally at the control instrument.

3.4.12 Separate junction boxes shall be used for intrinsically safe cables.

3.4.13 Different intrinsically safe systems e.g., systems having different rounds shall not be run in the same multicore cable, in general.

Recommended minimum separation distance between twisted pair signal leads and AC Power Lines.

<table>
<thead>
<tr>
<th>AC Power Cable</th>
<th>Minimum Distance to Signal Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage (Volts)</td>
<td>Current (Am) in (cm)</td>
</tr>
<tr>
<td>0 to 125</td>
<td>0 to 10 12&quot; (30)</td>
</tr>
<tr>
<td>125 to 250</td>
<td>0 to 50 15&quot; (38)</td>
</tr>
<tr>
<td>250 to 440</td>
<td>0 to 200 18&quot; (46)</td>
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<tr>
<td>5KV &amp; Up</td>
<td>200 Amp. &amp; Up 24&quot; (61)</td>
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Different intrinsically safe circuits e.g., circuits having different voltage levels, of the same intrinsically safe system shall not be run in the same cable unless each conductor insulation is at least 0.25mm or no hazard can result from interconnection.

3.4.14 The physical separation of power and signal cables shall be as per API 550 Part I Section VII. Cable in intrinsically safe circuits shall preferably be not run in the same tray where-- on intrinsically safe circuits cables are being run. If these are being run in the same tray, a metallic earthed separately shall be provided.

3.4.15 For temperature controllers, single pair thermocouple extension cable or cable for resistance thermometer, shall be laid directly from the element to the transducer in the control room without intermediate terminal blocks.
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<th>TITLE</th>
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3.4.16 In case of skid mounted equipment or equipment which incorporate skid instrumentation like alarms, shutdown or control function shall terminate signals or control junction box near skid boundary for connection of off skid equipment.

3.4.17 No wire shall be terminated or left with mechanical strain within any conductor.

3.4.18 Splices shall be made only at terminals, in instruments or approval equipment/junction boxes using lugs and screwed connections. No intermediate splices shall be made in cable trays or in conduct. Number of junction boxes in any cable path shall be limited to only one.

3.5 **Installation of Zener barriers**

3.5.1 Zener barriers shall be installed in the circuit to make the system intrinsically safe provided:

a) There is no energy storage system in excess to the minimum permitted by the barrier design on the hazardous side of the barrier. The same shall be met by taking intrinsically safe transmitters and selecting the cable electrical parameters like inductance L/R ratio & capacitance in accordance with the maximum parameters given in barrier specifications.

b) No power source exceeding the voltage rating of Zener barrier shall be connected on safe side of the Zener barrier.

c) No outside power source including other intrinsically safe circuits shall be connected to the hazardous side of the barrier.

3.5.2 Zener barriers shall be located as close as possible to the field wiring entry point in the control room.

3.5.3 Single barrier are bolted directly to copper bus bar and multiple barriers on the barrier mounting plates. Copper bus or barriers mounting plates shall be isolated from the panel frame.

3.5.4 The signal ground system for intrinsically safe system shall be separate from power ground system and shall be connected to the signal ground reference point. The maximum resistance allocable between the farthest point on intrinsically safe barrier ground bus and signal ground reference point shall be less than 1 ohm.

3.5.5 Field wires shall directly terminate at the barriers and not through intermediate terminals.
3.6   **Installation of Analyser / Gas Chromatograph**

3.6.1 Installation of all analyser shall be in general, as per APIP 550 Part II.

3.6.2 The analyser housing at its installation shall meet all safety requirements as per classifications.

3.6.3 Sampled process fluid, if not returned to the process shall be disposed to a safe location. Piping shall be provided so that vapours can be vented to a safe location and liquids shall be drained in a clean and orderly fashion to a safe place. Toxic vapours shall not be vented to atmosphere.

3.6.4 Analyser shall be located as near to the sampling point as possible.

3.6.5 Analyser equipment must be protected from the following:

   a) Hot equipment
   b) Severe ambient temperature changes
   c) Shock
   d) Mechanical damage
   e) Vibration

3.6.6 If a separate vent for the analyser is used, the location of that vent shall be in area of minimum air Turbulence. If the vents of different analysers are vented into a common vent, a back pressure regulator shall be used.

3.6.7 Vent piping shall be designed to prevent condensate from accumulation in low point and obstruct a free vent flow.

3.7   **Ducts, Trays and Supports**

3.7.1 Main cable duct shall be of bottom open type with flat/angle --- construction with side sheet and top cover of 3.2 mm thickness.

3.7.2 The ducts and trays shall be properly supported at regular intervals. Wherever insert plates are not available, support on concrete structure or ceiling shall be fixed with a minimum of 10 mm expansion bolts Angle supports for ducts shall be fabricated from minimum of 40 mm angle.

3.7.3 All supports shall be neatly cut with hacksaw only and not with gas cutting. Free ends of angle supports shall not have sharp ends and shall be properly rounded off.

3.7.4 Ducts and supports shall be painted with one coat of Red oxide Zinc chromate primer conforming to IS-2074 after cleaning to remove scale and then painted with
2 coats of final enamel paint as given below:

a) Duct - Dark admirately Grey as per IS0632.
b) Supports - Black.

3.8 Instrument Steam Tracing

3.8.1 Steam for Tracking of instruments shall be taken from main steam header take of valve through carbon steel pipes supported at regular intervals.

3.8.2 Steam tracing around individual instrument shall be by copper tube of 1/8" diameter.

3.8.3 Piping or tubing for steam tracing shall be installed in such a way as to avoid condensate pockets.

3.8.4 After steam tracing, the line is connected to drain funnel through steam trap.

3.9 Identification of Lines and Instruments

3.9.1 All site mounted instruments, junction boxes, air headers, tubing and wiring terminations shall be labelled or tagged.

3.9.2 Instruments shall be furnished with stainless steel name tags containing Tag no., manufacturer’s name, and model no. serial number. This tag number shall be approximately 3"x1" size and shall be attached to the instruments with -- gauge stainless steel wire.

3.9.3 Unused cable entries in junction boxes and field instruments are to be plugged.

4.0 TESTING

4.1 Instrument Impulse piping/Tubing

4.1.1 All process impulse lines shall be disconnected both from the instrument and vessel/piping end and flushed with water.

4.1.2 After thorough flushing the impulse lines shall be isolated from the instruments and pressurised hydraulically to 1.5 times the maximum working pressure corrected for ambient temperature. They shall then be isolated from the pressure source and the pressure reading on a test pressure gauge shall not fall at a rate exceeding one psig/hour.

In case no isolation valve is provided near the instrument, impulse piping/tubing shall be pressurised along with the instrument to the maximum pressure of scale in case of pressure transmitter and max. Operating pressure in case of differential
pressure instrument with equalising valve open

4.1.3 In special conditions where hydro-testing is not permissible due to service requirements, testing shall be carried out by using compressed air/nitrogen.

4.1.4 The external displacer type instruments and cage type level switches shall be tested to 1.5 times the operating pressure using air/nitrogen after thorough flushing.

4.2 Instrument Air lines/signal tubing.

4.2.1 Instrument air lines/signal tubing shall not be hydrostatically tested.

4.2.2 Instrument air tubing shall be disconnected upstream of all filter regulators and blown down to remove water, slag and mill scale, from lines at 7.0 kg/cm² G for fifteen minutes.

Air filter shall be taken in line and tubing shall be disconnected at instrument end, and blown for 3 minutes to remove traces of dirt.

4.2.3 Testing of instrument air shall be carried out with instrument air at 7 kg/cm² G upto the upstream of the filter regulator after thorough flushing. All lines shall be checked with soap solution and bubbler unit for possible leak at joints.

4.2.4 All signal tubing shall be checked with 1.5 kg/cm² after proper flushing. After pressuring, source shall be cut off and rate of fall in pressure shall be less than IPSL for each 100 feet of tubing for a test period of 2 minutes as per instrument society of American RP 7.1 ‘Pneumatic Control Circuit Pressure Test’

4.3 Cables

4.3.1 All wiring shall be checked to ensure that it is correctly connected and properly grounded.

4.3.2 All cables shall be checked for continuity proper connection and insulation testing.

Insulation test shall be carried out on all wiring with a certified magger after disconnecting the cables at both ends.

4.4 All the results of the above mentioned testing shall be recorded and submitted for check.

4.5 All the in line instruments like orifice plates, turbine meters, Rotameters, Target meters, vortex meters, control valves, safety valves etc. shall be removed and
spool pieces shall be provided prior to the flushing of the lines.

5.0  CALIBRATION OF INSTRUMENTS

5.1  All instruments shall be calibrated strictly as per manufacturer’s instructions prior to the installation. In addition to calibration of instruments, setting of safety devices like process switches, safety valves etc. and simulation testing of all interlock and shutdown system shall be carried out.

5.2  In general, all tests shall simulate, as closely as possible, design process condition by the use of manometers, potentiometers, deadweight testers, test pressure gauges etc. Pour point calibration shall refer to the input signal to an instrument equivalent to 0, 25, 50, 75, 100% of instrument range upscale (rising) and 75, 50, 25, 0% of instrument (downscale) (falling).

All instruments unless otherwise noted shall be calibrated in upscale and downscale direction and if necessary, adjusted until their accuracies conform to those limits state by the manufacturer.

Upon completion of these tests, the instruments shall be drained, completely.

5.3  Temperature Instruments

5.3.1  Temperature Gauges Filled type and Bi metallic dial type Thermometers shall be four point bench checked for proper operation and calibration using a temperature bath prior to installation.

5.3.2  Temperature Elements and Temperature Transmitters.

Temperature Elements and Transmitter shall be four point bench calibrated using a temperature bath precision meter or precision gauge prior to installation.

5.4  Pressure Instruments

5.4.1  Pressure Gauges

5.4.1.1  Direct connected bourdon type pressure gauges shall be dead weight tested or tested against a test gauges prior to installation.

5.4.1.2  Receiver type pressure gauges shall be four points calibrated using a precision gauge and precision air regulator.

5.4.1.3  Pressure and Differential Pressure Transmitters.
Pressure and differential pressure transmitters shall be four points calibrated using a hydraulic or dead weight tester or a precision pneumatic calibrator prior to the installation. A precision output meter or gauge shall be used to monitor the output.

5.5.1 Orifice plates shall be checked visually for the name plate and for an upstream sharp edge. Bore dia. shall be checked for compliance with the specification.

5.5.2 Differential pressure type of flow instruments shall be four points calibrated using precision pneumatic calibrator or a manometer and precision regulator. A precision output meter or gauge shall be used to monitor the output of the transmitter.

5.5.3 a) Rotameters shall be installed as received. A check shall be made to confirm that shipping stops have been removed and float has been installed.

b) Where rotameters have transmitting mechanism, the float shall be raised and lowered mechanically and output shall be checked. Vendor calibration data/ curve shall be checked.

C) A check shall be conducted with plumb for a vertical installation.

5.5.4 Turbine meters, Annubar, positive displacement meters, vortex meter, ultrasonic flow meter, etc. shall be installed as received.

5.5.5 Target meters shall be checked for calibration using calibration weights. Output shall be monitored using precision output meter.

5.6 Level Instruments

5.6.1 Level Gauge Glasses

Gauge glasses shall be installed as received installation of illuminators, frost protectors and other accessories shall be checked.

5.6.2 Displacer Type, Level Transmitter

- Displacer type level transmitter shall be checked by raising and lowering mechanically the displacement and checking the pilot or transmitter action. Check transmitter with output gauge or meter for smooth and full output change.

- A check shall be conducted with plumb for a vertical installation.

5.6.3 Differential pressure type level transmitter Differential pressure type level transmitter shall be calibrated with pneumatic calibrator at four points prior to installation. A precision meter or gauge shall be used to monitor the output of the transmitter.
5.6.4 Tank level gauges
   a) Tank level gauges shall be checked by raising and lowering mechanically the
      displacer and checking the indicator on the gauge board.
   b) Check for proper liquid seal prior to installation in case of liquid seal tank
      gauges.
   c) In case of servo type gauges, the displacer is hoisted from the tank into the
      calibration chamber.

5.7 Control Valves, shutdown valves and self actuated valves

5.7.1 All diaphragm and piston operated control valve shall be stroked pneumatically
      using a pressure regulator and pressure gauge against the spring range specified
      on the name plate of the valve.

5.7.2 Mechanical seating and travel of the valve stem shall be checked against the side
      indicator and the name plate

5.7.3 Valve positioner shall be calibrated with the control valve in accordance with the
      name plate data and specifications with the help of pneumatic calibrator or gauge
      with precision regulator. Zero position or fully close position of the valve shall be
      a live zero i.e., the plug shall be just off the seat at the minimum setting.

5.7.4 Volume bottles, where used shall be checked for proper filling. The signal line
      shall be bled to zero pressure and failure action shall be confirmed.

5.7.5 Control valve accessories such as handwheels, boosters, relays etc. shall be
      checked operationally. Declutch able handwheel shall be operable both with and
      without an air signal to the diaphragm.

5.7.6 Self actuated control valves shall be installed as received, checking inlet and
      outlet points and name plate data. Regulators with external pressure connections
      shall be inspected for proper installation.

5.7.7 Butterfly shall be checked carefully to see that the vane moves freely into the
      upstream and down stream piping. Proper vane movement to stroke shall be
      confirmed.

5.7.8 All control valves and regulators shall be removed from the line prior to flushing
      and during hydro testing.
5.8  Safety Relief Valves

5.8.1  Safety relief valves shall be installed as received after carefully checking the name plate data. Pilots, if used, shall be checked carefully for installation on the proper safety valve.

5.8.2  Valves, which are installed in such a manner as to permit on line testing, shall be pressure tested after installation to determine proper operation and setting. Compressed air or nitrogen shall be used for testing of safety relief valves.

5.9  Switches

5.9.1  Level Switches shall be actuated mechanically for switch operation but shall not be calibrated for level setting.

5.9.2  Pressure switches shall be calibrated using hydraulic or dead weight tester or precision air regulator and gauge. The setting/trip point shall be checked using a continuity tester.

5.9.3  Temperature switches shall be calibrated using a temperature both prior to installation and set to the required alarm/ trip point using a continuity tester.

5.10  Receiver Instruments

5.10.1  Receiver Indicator/Recorders

5.10.1.1  Pneumatic indicators/ Recorders shall be calibrated using pneumatic calibrator/ precision pressure regulator and gauge.

5.10.1.2  Electronics indicators/ Recorders shall be calibrated using a current generator and a precision meter.

5.10.1.3  Chart drive assembly shall be checked for proper operation.

5.10.2  Controllers

5.10.2.1  Proper balancing of the controller shall be checked as per the manufacturers catalogues.

5.10.2.2  Controllers shall be checked for manual and Auto operation and Transfer. The transfer from manual to Auto and vice versa shall be bumpless and smooth.

5.10.3.1  Manual loader station Output of the manual loader shall be checked with a precision meter.
5.10.4.1 Multipoint Temperature Recorders

Each point shall be calibrated using a temperature simulator/decade box for RTD/voltage generator and precision meter for the thermocouples.

5.10.4.2 Point synchronisation shall be checked.

5.10.5 Pneumatic receiver switches shall be calibrated using precision air regulator and gauge. The setting/alarm/trip point shall be checked using a continuity tester.

5.10.6 Trip Amplifiers

Trip amplifiers shall be calibrated using a temperature simulators or voltage generator and precision meter for thermocouple or Resistance box for RTD’s. The required setting/alarm point/trip point shall be checked using a continuity tester.

5.10.7 Receiver Switch modules

Receiver switch modules shall be calibrated using a current source and a precision meter. The required setting/alarm/trip point shall be checked using a continuity tester.

5.10.8 Alarm and Annunciator system

5.10.8.1 Alarm and annunciator system shall be checked for visual and audio alarm operation using dummy signals. Full alarm sequence of each alarm point shall be checked.

5.10.8.2 Each point shall be checked for proper engraving.

5.10.9 Shutdown System

5.10.9.1 Operation of final actuating elements shall be checked for proper operation using dummy signals.

5.10.9.2 All timers, push buttons and switches shall also be checked for their proper operation.

5.11 Analytical Instruments

5.11.1 Check the full analyser system including sample handling system for leakage.

5.11.2 Check the full sample handling system for its proper operation. Calibrate and check completely all analysers using zero and span samples as per vendor catalogues.
5.12 Flow computer / Volume corrector

5.12.1 Corrected flow values shall be checked for various D.C. inputs and pressure and temperature variations for upscale and downsacle ranges.

5.13 The list of test and calibration instruments with traceability certificates shall be submitted to MECON for approval before carrying out the tests / calibration of instruments at site.

5.14 The formats / description of tests / calibration of all instruments shall be submitted to MECON for approval.

5.15 Daily / weekly reports shall be submitted during execution of work at site.

***********************
SPECIFICATION
FOR
INSTRUMENT TUBING

SPECIFICATION NO.: MEC/ S/ 05/ 26/ 02

ELECTRICAL & INSTRUMENTATION (OIL & GAS SBU)
MECON LIMITED
DELHI  110 092
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CONTENTS

1.0 GENERAL
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5.0 REJECTION
1.0 GENERAL

1.1 Scope

1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, testing and shipping of Instrument Tubing which includes the following types:

a) SS tubes
b) Copper tubes

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of Purchaser's enquiry:

ASTM A 269 - Specification for seamless and welded ferritic stainless steel tubing for general services.
ASTM B 251 - Specification for general requirements for wrought seamless copper and copper alloy tube.
ASTM B 251M - Specification for general requirements for wrought seamless copper and copper alloy tube (Metric)
ASTM B 68 - Specification for seamless copper tube, bright annealed.
ASTM B 68M - Specification for seamless copper tube, bright annealed. (Metric)

1.1.3 In the event of any conflict between these specifications, data sheets, related standards, codes, etc., the vendor shall refer the matter to the purchaser for clarifications and only after obtaining the same shall proceed with the manufacture of the items in question.

1.2 Bids

1.2.1 Vendor's quotation shall include a detailed specification sheet for each type of tube which shall provide the following information:

a) All the details regarding the type, construction, materials etc. of the items.
b) Overall the dimensions in mm.

1.2.2 All the units of measurement and material specifications for various parts in the vendor's specification sheets shall be to same standards as in purchaser's data sheets.

1.2.3 Vendor shall attach a list of items, type wise, summing up all the deviations from this specification and purchaser's data sheets if there are any. Also vendor shall provide reasons for these deviations.
1.2.4 Vendor shall enclose catalogues giving detailed technical specifications and other information for each type of tube in the bid.

1.2.5 Vendor's quotation, catalogues, drawings etc. shall be in English language.

1.3 Drawings, Data and Certification

Detailed drawings, data, catalogues and manuals etc. required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible and prints shall be despatched to the address mentioned, adhering to the time limits indicated.

2.0 CONSTRUCTION

2.1 Stainless Steel Tubes

2.1.1 SS tubes of the tubes shall be Rockwell RB 70-70. Tubes shall be free from scratches and to be suitable for bending.

2.1.3 Tube wall thickness shall be 0.049" for 1/2" OD and 1mm for 6 mm unless otherwise specified.

2.1.4 Maximum working pressure shall be 153.0 kg/cm² at 38°C for 1/2" OD Tube, unless otherwise specified and 80.0 kg/cm² at 38°C for 6mm OD tube.

2.1.5 Tubes shall be supplied in minimum length of 6 metres without brazing in between.

2.1.6 Dimensional tolerances shall be as per ASTM A 269.

2.1.7 The following shall be marked on the tube:

a) Name of manufacturer
b) Type and material grade of tube
c) Tube O.D. and wall thickness

2.2 Copper Tubes

2.2.1 Copper Tubes (PVC Jacket)

2.2.1.1 The tube shall be soft annealed copper with 6mm OD and a wall thickness of 1.0 mm as per ASTM B 68M Copper No.C12200.

2.2.1.2 The tube shall be jacketed with black PVC. The jacket thickness shall be 1.6mm. The PVC jacket shall confirm to ASTM D-1047.
2.2.1.3 The tube ends shall be plugged prior to transportation.

2.2.1.4 The tube shall be of continuous length without any brazing in between for 100 metres length.

2.2.1.5 Minimum length of single tube shall be 100 metres.

2.2.1.6 The dimensional tolerances shall be as per ASTM B 251M.

2.2.2 Bare Copper Tubes (For Steam Tracing)

2.2.2.1 The tube shall be soft annealed copper with 3/8" OD or 6mm OD with a wall thickness of 1.0 mm as per ASTM B68 copper No.C12200.

2.2.2.2 The tube ends shall be plugged prior to transportation.

2.2.2.3 The tube shall be of continuous length without any brazing in between for 100 metres length.

2.2.2.4 Minimum length of tube shall be 100 metres.

2.2.2.5 The dimensional tolerances shall be as per ASTM B 251.

3.0 TESTING

3.1 The following tests shall be done for SS tubes.

a) Hardness test
b) Hydrostatic test at 153.0 kg/cm² at 38°C for 1/2" tube and at 80.0 kg/cm² at 38°C for 6mm tube, unless otherwise specified.

3.2 PVC jacketed copper tubes shall be tested at 7.0kg/cm² g with dry air for leak check.

3.3 Bare copper tubes shall be hydrostatically tested at 80.0 kg/cm² g at 38°C.

3.4 Final test before delivery shall include ball test to ensure clear opening of the tube for copper tubes. The O.D of the ball shall be minimum 1mm for 6mm O.D tube and 2mm for 3/8" tube.

4.0 SHIPPING

4.1 The tubes shall be plugged at both ends to avoid entry of foreign matter. The tubes shall be packed carefully so as to avoid damage during transport.

5.0 REJECTION
Vendor shall make his offer in detail, with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summarily rejected.
SPECIFICATION

FOR

INLET / OUTLET SECTIONS
AND FLOW STRAIGHTENER

SPECIFICATION NO.: MEC/ S/ 05/ 26/ 03

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
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1.0 FLOW STRAIGHTENER

2.0 INLET SECTION/OUTLET SECTION

PREPARED BY: (N.S.KANNAN)  
CHECKED BY: (R.SANJAY BABU)  
APPROVED BY: (PANKAJ SRI VASTAVA)  
ISSUE DATE: 30.07.09
1.0 FLOW STRAIGHTNER

1.1 Flow straightener shall be installed in the inlet section upstream of flow meter.

1.2 Flow straightener shall consist of a bundle of tubes designed and assembled as per ISO 5167-1980 (E) or AGA Report no.3 or AGA Report no.7.

1.3 Tube diameter shall be 0.2 D or less where D is the diameter of Meter inlet section pipe. Tube shall be seamless quality of SS 316 material thickness 1.5 or 1 mm. Tube shall be hydrostatically tested for 75kg/cm² pressure and then cut to the required length for assembly.

1.4 On both the sides of tube bundle a very thin retaining rings of SS316 shall be provided for avoiding the dislocation of pipes.

1.5 The tube bundle shall be kept in position by 6mm threaded bolt. After tightening the bolt shall seal welded.

1.6 Tube ends shall be tempered at 45° angle.

2.0 INLET SECTION/OUTLET SECTION

2.1 Inlet/Outlet sections of pipe for flow meter shall be of same inside diameter (ID) as turbine meter.

2.2 The pipe used should be circular and with no ovality or any other deformation, the inside surface of pipe shall be smooth, welded portion shall be grind to smooth finish.
SPECIFICATION

FOR

INSTRUMENT TUBE FITTINGS

SPECIFICATION NO.: MEC/ S/ 05/ 26/ 04

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
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1.0 GENERAL
2.0 CONSTRUCTION
3.0 TESTING
4.0 SHIPPING
5.0 REJECTION

PREPARED BY: (N.S.KANNAN)  
CHECKED BY: (R.SANJAY BABU)  
APPROVED BY: (PANKAJ SHIVASTAVA)  
ISSUE DATE: 30.07.09
1.0 GENERAL

1.1 Scope

1.1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, testing and shipping of instrument tube fittings which includes the following types:-

a) SS compression fittings (SS tube)
b) Brass compression fittings (copper tube)

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of Purchase's enquiry:

ANSI B 2.1 - Pipe Threads
B16.11 - Forged steel fittings-socket welding and threaded.
IS:319 - Specification for free cutting brass bars, rods and sections.
ISA RP 42.1 - Nomenclature for instrument tubing - fittings.

1.1.3 In the event of any conflict between these specifications, data sheets, related standards, codes etc., the vendor shall refer the matter to the purchaser for clarifications and only after obtaining the same shall proceed with the manufacture of the items in question.

1.2 Bids

1.2.1 Vendor's quotation shall include a detailed specification sheet for each type of tube fittings which shall provide the following information:

a) All the details regarding the type, construction, materials, etc. of the items.
b) Overall dimensions in mm.

1.2.2 All the units of measurement and material specifications for various parts in the vendor's specification sheets shall be to same standards as in purchaser's data sheets.

1.2.3 Vendor shall attach a list of items, typewise, summing up all the deviations from this specification and purchaser's data sheets if there are any. Also vendor shall provide reasons for these deviations.

1.2.4 Vendor shall enclose catalogues giving detailed technical specifications and other information for each type of fitting in the bid.

Vendor's quotation, catalogues, drawings, etc. shall be in English language.
1.3 **Drawings, Data and Certification**

Detailed drawings, data, catalogues and manuals etc., required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducibles and points shall be despatched to the address mentioned, adhering to the time limits indicated.

### 2.0 CONSTRUCTION

#### 2.1 SS Tube fittings:

- **2.1.1** Nomenclature of all tube fittings shall be as per ISA RP 42.1.
- **2.1.2** Fittings shall be flareless compression type and of three piece construction with ferrule, nut and body suitable for use on SS tubes conforming to ASTM A 269 TP316, hardness not exceeding RB80.
- **2.1.3** All parts shall be of SS 316.
- **2.1.4** Hardness of the ferrules shall be in the range of RB 85-90 so as to ensure a minimum hardness difference of 5 to 10 between tube and fittings, for better sealing.
- **2.1.5** Nuts and ferrules of particular size shall be interchangeable for each type.
- **2.1.6** Spanner hold shall be metric.
- **2.1.7** Threaded ends of fittings shall be NPT as per ANSI B 2.1.
- **2.1.8** *Copper Tube Fittings*

- **2.2.1** Nomenclature of all tube fittings shall be as per ISA 42.1.
- **2.2.2** Fittings shall be of flareless compression type and of three-piece construction consisting of ferrule, nut and body suitable for use on copper tubes conforming to ASTM B 68/B 68M hardness not exceeding RB 50.
- **2.2.3** All parts shall be manufactured from Brass as per IS 319 barstock and Nickel plated.
- **2.2.4** For better grip, vendor shall maintain hardness difference between tube & ferrule and indicate the same along with the offer.
- **2.2.5** Nuts & ferrules of particular size shall be interchangeable for each type.
2.2.6 Threaded ends of fittings shall be NPT as per ANSI B 2.1.

2.2.7 Spanner hold shall be metric.

2.2.8 Vendor shall ensure that the ferrules and nuts supplied for fittings shall be suitable for sample tube which shall be supplied during manufacture.

3.0 TESTING

3.1 Random samples of SS tube fittings shall be hydrostatically tested as follows:

For 6 mm fittings at 80.0 kg/cm², 1/2" fittings at 153.0 kg/cm² at 38°C unless otherwise specified.

3.2 Random samples of brass compression fittings shall be hydrostatically tested as follows:

For 1/4" fittings, at 10 kg./cm², 3/8" at 80.0 Kg/cm² and all at 38°C.

4.0 SHIPPING

4.1 All thread/ends shall be protected with plastic caps to prevent damage/entry of foreign matter.

5.0 REJECTION

Vendor shall make his offer in detail, with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summarily rejected.
SPECIFICATION

FOR

INSTRUMENT VALVES AND MANIFOLDS

SPECIFICATION NO.: MEC/ S/ 05/ 26/ 05

ELECTRICAL & INSTRUMENTATION (OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
**STANDARD SPECIFICATION**

**MECON LIMITED**
REGD. OFF: RANCHI 834002

**ELECTRICAL & INSTRUMENTATION**
OIL & GAS SBU, DELHI

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**SPECIFICATION FOR**

**INSTRUMENT VALVES AND MANIFOLDS**

**DOCUMENT NO.**

**MEC/ S/ 05/ 26/ 05**

**REVISION : 0**

**EDITION : 1**

**AMENDMENT STATUS**
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3.0 TESTING
4.0 SHIPPING
5.0 REJECTION

PREPARED BY: (N.S.KANNAN )
CHECKED BY: (R.SANJAY BABU)
APPROVED BY: (PANKAJ SRI VASTAVA)
ISSUE DATE : 30.07.09
1.0 GENERAL

1.1 Scope

1.1.1 This standard specification, together with the data sheets attached herewith, covers the requirements for the design, materials, testing and shipping of Instrument Valves & Manifolds which includes the following types:

a) Miniature instrument valves
b) Instrument valve manifolds
c) Instrument air valves

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of Purchaser's enquiry:

ANSI B 2.1 - Pipe threads
ANSI B 16.11 - Forged steel fittings-socket welding and threaded.

1.1.3 In the event of any conflict between these specifications, data sheets, related standards, codes etc., the vendor shall refer the matter to the purchaser for clarifications and only after obtaining the same shall proceed with the manufacture of the items in question.

1.2 Bids

1.2.1 Vendor's quotation shall include a detailed specification sheet for each type of Valves & Manifolds which shall provide the following information:

a) All the details regarding the type, construction, materials etc. of the items.
b) Overall dimensions in mm.

1.2.2 All the units of measurement and material specifications for various parts in the vendor's specification sheets shall be to same standards as in purchaser's data sheets.

1.2.3 Vendor shall attach a list of items, typewise, summing up all the deviations from this specification and purchaser's data sheets if there are any. Also vendor shall provide reasons for these in the bid.

1.2.5 Vendor's quotation, catalogues, drawings etc. shall be in English language.
Detailed drawings, data, catalogues and manual etc. required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible and prints shall be despatched to the address mentioned, adhering to the time limits indicated.

### 2.0 CONSTRUCTION

#### 2.1 Instrument Valves (Miniature)

2.1.1 The instrument valves shall be globe pattern-needle valves forged/barstock with inside screwed bonnet.

2.1.2 Body and trim material shall be 316 SS unless otherwise specified.

2.1.3 The valve body rating shall be 3000 lbs unless specified in piping material specification which shall govern in case it is specified.

2.1.4 The end connection shall be 1/2” NPTF to ANSI B2.1.

2.1.5 The packing material shall be teflon unless otherwise specified.

2.1.6 The hand wheel material shall be carbon steel zinc plated.

2.1.7 Flow direction shall be marked on the body.

2.1.8 The valve dimension shall be as follows:

a) End to end dimensions 76 mm (approximately).

b) Height in fully open condition - 135mm maximum.

#### 2.2 VALVE MANIFOLDS

2.2.1 3-Valve & 5-Valve manifolds:

2.2.1.13 Valve manifold shall be designed for direct coupling to differential pressure transmitters having 2 bolt flanges with 54 mm (2-1/8”) centre to centre connections and 41.3 mm (1-5/8”) bolt to bolt distance. The manifold shall contain two main block valves and an equalizing by-pass valve. The valves shall be needle valves. They shall use self aligning 316SS ball seats.

2.2.1.25 Valve manifold shall contain two main line block valves and a combination double block and bleed for the bypass line.

2.2.1.3 The manifold shall be suitably for mounting directly on the stanchion (2” pipe).
2.2.1.4 All bonnets shall have teflon packing unless otherwise specified.

2.2.1.5 The material of construction shall be 316 SS unless otherwise specified.

2.2.1.6 The flanges shall be integral part of the block.

2.2.1.7 The process connection shall be 1/2" NPTF to ANSI B2.1.

2.2.1.8 The manifolds shall be supplied along with mounting accessories. The bolts and nuts shall be alloy steel as per ASTM A 193 Gr B ASTM A 194 GR 2H respectively. Rings shall be teflon and other accessories shall be cadmium plated.

2.2.1.9 Vendor shall furnish the material certificate for body.

2.2.2 3 Way 2 Valve Manifold for pressure gauges.

2.2.2.1 The manifold shall be designed for use with pressure gauges.

2.2.2.2 The valve shall be a ball valve.

2.2.2.3 The body shall be either straight or angle as specified in data sheets.

2.2.2.4 The body and trim material shall be 316SS, packing material shall be teflon unless otherwise specified.

2.2.2.5 The inlet connection shall be 3/4" plain end (female) for socket weld as per ANSI B 16.11.

2.2.2.6 The gauge connections shall be with union nut & tail piece threaded 1/2" NPT (F).

2.2.2.7 The drain connection shall 1/2" NPTF.

2.3 Instrument Air Isolation Valves

2.3.1 The valves shall be full bore ball valves.

2.3.2 Body material shall be Nickel or Cadmium plated carbon steel.

2.3.3 Trim material shall be 316SS.

2.3.4 The end connection shall be 1/2" NPTF to ANSI B2.1 unless otherwise specified.
2.3.5 The packing material shall be teflon.

2.3.6 The handle/wrench material shall be cadmium or nickel plated carbon steel.

2.3.7 The valve body rating shall be ANSI 800 lb.

2.3.8 End to end dimensions shall be 70mm (approximately).

3.0 TESTING

3.1 The instrument valves (miniature) shall be hydrostatically tested at 200kg/cm² g at 38°C.

3.2 All manifolds (3 valves, 5 valves and 3 ways, 2 valves) shall be hydrostatically tested at 200 kg/cm² at 38°C.

3.3 The instrument air valves shall be hydrostatically tested at 15.0 kg/cm² g at 38°C and at 10.5 kg/cm² g with dry air.

4.0 SHIPPING

4.1 All threads/ends shall be protected with plastic caps to prevent damage/entry of foreign matter.

5.0 REJECTION

Vendor shall make his offer in detail, with respect to every item of the purchaser’s specifications. Any offer not conforming to this shall be summarily rejected.
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# JUNCTION BOXES AND CABLE GLANDS

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5.0 SHIPPING

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**PREPARED BY:** (N.S.KANNAN)  
**CHECKED BY:** (R.SANJAY BABU)  
**APPROVED BY:** (PANKAJ SRI VASTAVA)  
**ISSUE DATE:** 30.07.09
1.0 General

1.1 Scope

1.1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, nameplate marking, testing and shifting of junction boxes & cable glands which include the following types:

   a) Electrical junction boxes.
   b) Pneumatic junction boxes
   c) Cable glands (whenever specified)

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

   ANSI B 2.1 : Pipe threads
   IS-5 : Colours for ready mixed paints and enamels
   IS-2147 : Degrees of protection provided by enclosures for Low voltage switchgear and control gear.
   IS-2148 : Flame proof enclosure of electrical apparatus.

1.1.3 In the event of any conflict between specifications, data sheets, related standards, codes etc., the vendor shall refer the matter to the purchaser for clarifications and only after obtaining the same should proceed with the manufacture of the items in questions.

1.2 Bids

1.2.1 Vendor's quotation shall include a detailed specification sheet for each type of junction box and cable gland which shall provide the following information:

   a) All the details regarding the type, construction, materials, housing, entries, etc.
   b) All dimensions in millimetre.
   c) Sketch for each type of JB with dimensional details showing the terminal and entries arrangement.
   d) Mounting details.
   e) Vendor shall furnish certificate from statutory body for explosion proof enclosure, indicating the gas group and temperature class.

1.2.2 All the material specifications for various parts in the vendor's specification sheets shall be to the same standards as those in purchaser's data sheets (e.g. BS IS, etc.)
Vendor shall attach a list of items, tag number wise, summing up all the deviations from the purchaser's data sheets, if there are any. Also vendor shall furnish reasons for these deviations.

Vendor shall enclose catalogues giving detailed technical specifications and other information for each type of JB/cable glands and its accessories covered in the bid.

Vendor's quotation, catalogues, drawings, etc. shall be in English language.

Drawings, Data and Certification

Detailed drawings, data, catalogues required from the vendor are indicated in vendor data requirements sheets. The required number of reproducible and prints shall be despatched to the address mentioned, adhering to the time limits indicated.

After placement of purchaser order, vendor shall submit certified drawings and specifications sheets for each type of JB/cable gland which shall include the following:

a) Detailed dimensional drawings
b) Weight of each in grams/Kg.
c) Certificate from statutory body suitable for installation in specified hazardous area.

Junction Boxes

Junction boxes shall be either of the following type as specified in data sheets.

I. Weather proof junction boxes.
II. Weather proof & Explosion proof junction boxes.

The enclosure shall be as per IS-2147 for weather proof junction boxes and for Explosion proof it shall be as per IS-2148 suitable for the area classification specified.

Number of entries and locations shall be as per data sheets.

Junction boxes shall be provided with telephone sockets and plugs for connection of hand powered telephone set.
2.5 Electrical Junction boxes

2.5.1 Material shall be die-cast aluminium of minimum 5 mm thick (LM-6 alloy)

2.5.2 Explosion proof junction boxes shall have detachable cover which is fixed to the box by means of cadmium plated triangular head/hexagonal head screws.

2.5.3 Weather proof junction boxes shall have doors which shall be hinged type and these shall be fixed with cadmium plated countersunk screws.

2.5.4 Explosion proof junction boxes shall have a warning engraved/integrally cast on the cover as given below:

"Isolate power supply elsewhere before opening"

2.5.5 Terminals shall be spring loaded, vibration proof, clip-on type, mounted on nickel plated steel rails complete with end cover and clamps for each row.

2.5.6 All terminals shall be suitable for accepting minimum 2.5 sq. mm copper conductor, in general. However for power supply distribution boxes, terminal detail shall be as per job specification/Data sheets.

2.5.7 Sizing shall be done with due consideration for accessibility and maintenance in accordance with the following guidelines.

i) 50 to 60 mm between terminals and sides of box parallel to terminal strip for up to 50 terminals and additional 25 mm for each additional 25 terminals.

ii) 100 to 120 mm between terminals for up to 50 terminals and additional 25 mm for each additional 25 terminals.

iii) Bottom/top of terminal shall not be less than 100 mm from bottom/top of the junction box.

2.5.8 Terminals shall be marked as per the various types indicated in data sheets.

2.5.9 Shall be provided with external earthing lugs.

2.6 Pneumatic junction boxes

2.6.1 Pneumatic junction boxes shall be made of 3 mm thick hot rolled steel. They shall have necessary neoprene gasket between door and body. Door shall be flush with the box and shall be hinged type and provided with wing nuts.

2.6.2 Single tube entries shall be suitable for 6 mm O.D. copper tube with bulk head fittings. Multi tube bundle entry shall be suitable for the data furnished in data sheets.
2.7  **Painting**

2.7.1  Surface shall be prepared for painting. It shall be smooth and devoid of rust and scale.

2.7.2  Two coats of lead-free base primer and two final coats of lead free epoxy based paint shall be applied both for interior and exterior surfaces.

2.7.3  The colour shall be as specified in data sheets.

3.0  **Cable glands & plugs, Reducers/Adaptors**

3.1  Cable glands shall be supplied by vendor whenever specified.

3.2  Cable glands shall be double compression type for use with armoured cables.

3.3  The cable glands shall be of Nickel plated brass.

3.4  The cable gland shall be weather proof. Whenever specified they shall be explosion proof and certificate from statutory body shall be furnished.

3.5  Cable glands shall be supplied to suit the cable dimensions indicated along with tolerance indicated in data sheets. Various components like rubber ring, metallic ring, metallic cone and the outer/inner nuts etc. shall be capable of adjusting to the above tolerances of cable dimensions.

3.6  Reducers/Adaptors shall be supplied as per details indicated in data sheets. They shall be nickel plated brass. These shall be weather proof in general. These shall also be explosion proof wherever specified and certificate from statutory body for explosion shall be furnished.

3.7  Plugs shall be provided wherever specified. They shall be of Nickel plated brass.

3.8  Plugs shall be certified explosion proof when used with explosion and junction boxes.

4.0  **Name Plate**

4.1  Each junction box shall have an anodised aluminium name plate permanently fixed to it at a visible place bearing the tag no. & enclosure. The name plate shall also bear the stamp of certifying agency with certificate number.
5.0  Shipping

5.1  All threaded openings shall be suitably protected to prevent entry of foreign material.

5.2  All threaded components shall be protected with plastic caps to prevent damage of threads.

6.0  Rejection

Vendor shall furnish his offer in detail, with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summarily rejected.
SPECIFICATION

FOR

SIGNAL CABLES

SPECIFICATION NO.: MEC/ S/ 05/ 26/ 07

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
## Amendment Status

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PREPARED BY: (N.S. KANNAN)

CHECKED BY: (R. SANJAY BABU)

APPROVED BY: (PANKAJ SRI VASTAVA)

ISSUE DATE: 30.07.09
1.0 GENERAL

1.1 Scope:

This specification together with the job Specifications attached herewith forms the requirements for design, materials manufacturing, testing and shipping of PVC insulated signal cables.

1.2 Standards:

The cables shall conform to the latest editions of the various standards mentioned in the specification.

In case of any conflict between any standard and this - specifications the matter shall be referred to the purchaser before proceeding with the manufacture of the cables.

1.3 Bids:

1.3.1 Vendor’s quotation shall include the following as a minimum.

Completed job spec. Pair identification method, type test certificates, technical literatures, various testing methods and cross sectional dimensional drawings. All information/data shall be in English language.

1.3.2 Vendor’s quotation shall include a list of deviations if any from purchaser’s specifications and shall also indicate the reasons for such deviations for consideration to arrive at mutually agreed deviations. However vendor shall note that no deviation shall be accepted in respect of the permissible limits of resistance capacitance and L/R ratio of cables.

1.3.3 Vendor shall quote unit price per metre for each type of cable.

1.4 Instructions to Bidder:

1.4.1 The quantity indicated against each type of cable in the job specification may vary by+ 25% at the time of placement of order. Vendor shall confirm that there shall be no price implication on this account in unit prices typewise.

1.4.2 Drum length for each type of cable shall be 500 to 1000 metres. Vendor shall indicate the maximum drum length possible for each type of cable in his bid. Exact requirements of drum length will be specified after purchase order during detailed engineering and vendor shall confirm that the same shall not affect the price or delivery schedule. The actual produced drum length shall not vary by more than+ 5% from the value indicated in the purchase order.
1.4.3 Tolerance over the total ordered length shall be as follows:
± 5% for total length less than 5 km
± 2% for total length 5 km or more

1.4.4 Cable dimensions furnished by vendor in his bid shall be firm. Vendor shall comply with all the values during execution.

1.5 All cables shall be suitable for laying in open air, corrosive hydrocarbon plant atmosphere, direct sun and in trenches. The cable shall also be designed for prolonged use in tropical atmosphere.

1.6 On demand vendor shall furnish documents such as invoice and test certificates to prove the quality and composition of the materials used for manufacturing the cable to the satisfaction of client/ consultant or authorised representative during various stages of expediting and inspection.

2.0 Construction:

2.1 **Type 1**

(Single pair/triad shielded cable)

2.1.1 Each core shall be 1.5 sq. mm made of 7 stranded annealed electrolytic copper conductors. Each strand shall be 0.53 mm dia.

2.1.2 Primary insulation shall be 85°C polyvinyl chloride (PVC) as per IS-5831 Type C. Thickness shall be 0.5 mm minimum.

2.1.3 Each wire shall have twisted cores and No. of twists shall be not less than 10 per metre. Colour of cores insulation shall be black blue in a pair and black, blue and brown in a triad.

2.1.4 Individual pair and triad shall be shielded. Shield shall be Aluminium backed by Mylar/polyester tape bonded together with the metallic side down helically applied with either side - 25% overlap and 100% coverage. Minimum shielded thickness shall be 0.05mm. Drain wire shall be 0.5 sq.mm multistrand bare tinned annealed copy conductor. The drain wire shall be in continuous contact with Aluminium side of the shield.

2.1.5 Inner and outer jacket shall be made of extruded flame retardant 90°C PVC to IS 5831-Type ST2 Oxygen index of PVC shall be 30. Temp. Index shall be over 250°C. Inner jacket colour shall be black. Outer jacket colour shall be black except for cable to be used in intrinsically safe systems it shall be light blue.
2.1.6 Armour over inner jacket shall be of galvanised steel wire/flat as per IS-1554 part-I.

2.1.7 A pair or triad identification shall be with numbers at interval of not more than 250 mm as per vendor's standard.

2.1.8 Tolerance in overall diameter of cable shall be within $\pm 2\text{mm}$ over offered value for cables with OD less than 30mm and $+3\text{mm}$ for cables with OD more than 30mm.

2.2 Type-II

(Multipair / Multitriad cable with individual pair shield and overall shield)

The cable shall be same as single pair shielded cable except conductor size shall be 0.5 sq.mm made of 16 strands of annealed electrolytic copper conductor. Each strand shall be of 0.2mm dia.

Additional feature shall be as follows:

2.2.1 Overall shield shall be of Aluminium backed up by Mylar/polyester tape helically applied with the metallic side down either side - 25% overlap and 100% coverage. Minimum shield thickness shall be 0.075mm Drain wire shall be similar to individual pair drain wire and shall be in continuous contact with the Aluminium side of the overall shield.

2.2.2 Overall twist of all pair/triads shall be as per vendor's standard.

2.2.3 A pair of communication wire shall be provided for multipair/multitriad cables. Each wire shall be 0.5 sq. mm of plain annealed single or multistrand copper conductor with 0.4 mm thick 85°C PVC insulation. Insulation shall be green and red colour coded.

2.3 Type-III

(Multipair/Multitriad cable with only overall shield)

These cables shall be same as type-II cables except that the individual pair/triad shall not have shielding.

2.4 Type-IV

(Multipair/ multitriad cable with individual pair shield and overall shield)

The cable shall be same as Type II except conductor size shall be 1.5 sq.mm made of 7 stranded annealed electrolytic copper conductor. Each strand shall be 0.53 mm dia.
2.5 Type-V

(Multipair/ Multitriad cable with overall shield only)
The cable shall be same as type IV except that the individual pair/triad shall not have the shielding.

3.0 Electrical Characteristics

3.1 Maximum d.c. resistance of the conductor of the completed cable shall not exceed 12.3 ohms/km at 20°C for cables with 1.5 sq.mm conductor and 39.7 ohms/km at 20°C for cables with 0.5 sq.mm conductor.

3.2 Capacitance

3.2.1 Mutual Capacitance

The mutual capacitance of the pairs or adjacent cores shall not exceed a maximum of 250 pF/Meter at a frequency of 1 KHz.

3.2.2 Capacitance between any core or screen.

The capacitance between any core or screen shall not exceed a maximum of PF/Meter at a frequency of 1 KHz.

3.3 L/R ratio of adjacent core shall not exceed 40 micro henry/ohm for cables with 0.5 sq. mm conductor.

3.4 The drain wire resistance including shield shall not exceed 30 ohms/km.

3.5 Electrostatic noise rejection ratio shall be over 76 dB.

4.0 Testing

4.1 Type test: Cable shall be flame retardant to IEC 332 Part III Cat. A. For qualification certificates from third party or client /consultants authorised representative for this test shall be furnished by vendor for cables similar to those being offered.

4.2 Routine tests: (To be carried out by vendor during various stages of manufacture. Purchaser shall review the related documentation).

4.2.1 Insulation and jackets: All tests as per IS-5831 except insulation resistance, voltage and spark test shall be as per BS-5308. Part-II(1986)
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4.2.2 Armour test as per IS-3975.

4.2.3 Conductor resistance.

4.2.4 Cable capacitance and L/R ratio.
GENERAL SPECIFICATIONS FOR INSTRUMENTATION

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7.0 SCRAP AND EXCESS MATERIAL  
8.0 SPECIAL INSTRUCTIONS TO CONTRACTOR
1.0 GENERAL

1.1 INTRODUCTION

1.1.1 This part of the technical specifications covers in general, definitions, standards, scope of works, specifications of work, documentation, scope of supply of materials and scrap and excess materials and different requirements to be adhered to during the course of execution of instrumentation works.

1.1.2 Instrumentation works shall be performed in accordance with this technical specification and various other drawings and schedules supplied during the execution and time to time instructions from Engineer-in-Charge or his authorised representative(s) during the progress of the work.

2.0 DEFINITIONS

2.1 MANIFOLDS

2.1.1 For close coupled instruments "Manifold" shall mean complete piping of instruments from first block valve upto the instruments, if the distance of the instrument is within 2 feet (0.6m), from the Instrument tapping. If the distance of instrument is more than 2 feet (0.6m) from primary tapping such as orifice, then the installation is to be considered under remote installation.

2.1.2 For remote mounted instrument, "Manifold" shall mean the assembly of nipples, valves and fittings around the instrument to form a block and bleed or by pass manifold or drain manifold as the case may be. These shall be generally according to the hook up drawings enclosed with tender. Wherever the instruments are with 3--way-valve manifold, this definition shall not be applicable as 3-way manifold forms part of instrument.

2.2 FIRST BLOCK VALVE

First block valve shall mean the valve/valves that are mounted directly on equipment, columns, pipe, standpipe etc. and shall be operated to isolate the instrument and connected instrument piping from the above items.

2.3 SUPPORTS

Supports shall mean the MS angles, flats, channels that are generally provided to support the main cable ways, cable ducts, junction boxes, angle trays, perforated trays, instrument piping, signal tubing, instrument air supply lines etc., at specified intervals from the structures, concrete columns etc. to keep all items firmly secured against vibration, warping, bending etc.
2.4 SCRAP

2.4.1 Salvageable scraps

Salvage scrap shall mean lengths of tubes, pipes, multicable, other cables etc. that can be used one time or other at later date and normally they are recovered from the cut-pieces of tubes, pipes, multicable, cables, etc.

2.4.2 Non Salvageable Scrap

Non salvageable scrap shall mean the lengths of tubes, pipes, multicable, cables, etc. that cannot be used at all one time or other.

2.5 Standards

The instrumentation erection and calibration works shall be carried out generally in accordance with various international and Indian standards in instrumentation listed below but not limited to the following:


2.5.2 ISA standards and Practices for instrumentation

2.5.3 Instrumentation hook-up standards enclosed.

2.5.4 Instrumentation supports standard enclosed.

2.5.5 Manufacturer's standards and Practices.

3.0 SCOPE OF WORK

3.1.0 The Scope of work shall consist of supply of instrument items (as per schedule of quantities/rates and SCC), instruments, their erection, testing, calibration and commissioning and making it ready for commercial operation. The scope covers various jobs listed under the schedule of quantities/rates. However to ensure proper execution and completeness of instrument--work any or all of the following shall also form the part of the scope and shall be covered in the quoted rates.

3.1.1 Fabrication of pipe nipples, including threading whenever required.

3.1.2 Fabrication of seal pot/syphon/drain pot as per standards. Filling of seal pots with filling liquids as per instructions from Engineer-in-charge.

3.1.3 Back/seal welding of screwed fittings as required by standards.
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<td>Laying of cable underground including excavation, sand filling, brick laying and back filling.</td>
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<td>Coordination with mechanical and other sub-contractors for proper installation of line/ vessels/ equipment mounted instruments like control valves, orifice assemblies, turbine meters, PD meters, level transmitters, level gauges, level switches etc. which involves removal of instruments, disconnection of tubes/cables, reconnection for alignment proper installation etc.</td>
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<td>3.1.16</td>
<td>Drilling holes on all panels, shut down cabinets, power supply cabinets, control panels pneumatic enclosures etc., for cables/ multitubes/ glands/ groomats.</td>
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<td>Grounding of shield of all shielded cables to respective instruments earth bus provided in the control room/local panel/thermocouple head.</td>
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<td>3.1.26</td>
<td>Where requested by owner/Engineer-in-charge or his authorised representatives, all or any of the works detailed above and schedule quantities shall also be performed on package units, local panels/cabinets/gauge board installed by owner or by others.</td>
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<tr>
<td>3.1.27</td>
<td>Sealing of safety valves/switches with standard lead seals after final setting in the presence of Engineer-in-charge.</td>
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</table>

### 4.0 DESCRIPTION OF WORK

**4.1.0 INSTRUMENT PIPING**

**4.1.1** All primary piping shall be installed in the best workman like manner and shall follow installation standards in each case. Where there is no installation standard, the instruction of the Engineer-in-charge shall be followed.

**4.1.2.1** Horizontal and vertical lines shall be installed using levels and plumo bobs.

**4.1.3** Unless otherwise specified in the drawings pipelines shall have a slope of 8% on the horizontal runs.
4.1.4 All welding shall be carried out as per welding procedures and codes with electrodes approved by Engineer-in-charge. Only qualified welders approved by Engineer-in-charge shall carry out welding. Charges for non-destructive testing like radiography, Dye penetration tests, post heat treatment tests and stress relieving shall be carried out on the basis of actual man hours spent towards these works and man-hour charges with cost of all materials, test equipments, etc. shall be used. However, any materials like electrode, equipments, testing charges for various tests, etc., required for the initial qualification of the welder/welders shall be included in the scope of the contractor.

4.1.3.1 Pipe shall be bent using pipe benders only and any bending will be totally rejected. Pipes shall be cut using pipe cutting device. Hot cutting will not be allowed.

4.1.6 Piping for steam tracing shall be installed according to the standards and avoiding condensate pockets.

4.1.7 All threaded joints shall be jointed with Teflon tape and no other pipe jointing compound shall be used except on high temperature service where graphited sealing compounds shall be used.

4.1.8 All primary piping shall be properly supported at regular intervals of 1.0 meters. Angle supports shall be fabricated from 40mmx40mmx5mm MS angles as minimum.

4.2.0 PVC COVERED/BARE TUBE (COPPER/SS/ALUMINIUM)

4.2.1 Single copper/SS/Aluminium tubes shall be laid as per standards on trays. Fabricated out of 2.5 mm thick perforated steel plate. The width of the trays shall be selected as per the number of tubes laid. Tubes shall be clamped to the trays at every 300 mm using clamps made of galvanized steel/Aluminium strips. The practice of flattening tubes for clamping purposes shall be avoided. In case of PVC covered tubes, any exposed portion at ends and connection shall be neatly taped to appropriate thickness.

4.2.2 Trays shall be properly supported either from any rigid steel structure or concrete member as detailed under trays and supports below.

4.2.3 All male/female tube connectors shall be installed with Teflon tape only. Identification tag plates/ferrules shall be provided on either side of copper tubing as per tubing/junction box schedules. Ferrules shall be single sleeve type with letters and numbers neatly printed.
4.3.1 Multiple cables/ multitubes shall always be installed on ducts/trays and properly clamped. At every vertical drop to junction boxes, they shall be clamped at more frequency intervals (Maximum of 300mm). They shall be connected inside junction boxes strictly according to the number system as mentioned in cable schedule. At bends minimum radius shall be maintained as per manufacturer's standard. The angle tray supports shall be fabricated from 40mmx40mmx5mm angles minimum size.

4.3.2 Identification tags shall be provided on either end of multitubes, multicore cables as per cable/tubing/cable schedules. Engraved tag plates or PVC ferrules shall be used for identification of tubes/cables.

4.3.3 All Multitubes and Multicables shall be cut after the exact site measurements are taken between ends and the cable/tube drums shall be selected before cutting the lengths so as to avoid any wastage.

4.3.4 In the field, the cables shall be laid in perforated trays as per layout drawings. Cables shall also be buried or laid in concrete trenches. Inside control room, these shall be laid in concrete trenches or under false floorings.

4.3.5 In the field, the cables shall be laid in perforated trays as per layout drawings. Cables shall also be buried or laid in concrete trenches. Inside control room, these shall be laid in concrete trenches or under false floorings.

4.4.0 INSTALLATION OF INSTRUMENTS

4.4.1 All instruments shall be generally installed on supports as per installation standards in each case, and shall be accessible.

4.4.2 Receiver gauges shall be mounted on instrument support itself as per tubing hook up standards.

4.4.3 Filter regulators shall be mounted on the instruments support itself below the instruments or on the control yoke.

4.5.0 INSTRUMENT AIR SUPPLY

4.5.1 The main instrument air header in each area is laid by other contractor. Air supply from the main air header take off valve to individual instrument shall be through either galvanized steel pipe or 1/4" OD PVC covered copper tube or SS tubes.

4.5.2 Individual takes off valves shall always be located on top of the main air header. Unions shall be provided at convenient locations. There shall be one isolation valve at each instrument end. The galvanized pipe shall be supported at a minimum interval of 1000 mm with 40mmx40mmx5mm MS angles. Final
connection to be instrument shall be copper/SS tubing as per tubing hookup standards.

4.5.3 Teflon tapes shall be used on all threaded joints.

4.6.0 **INSTRUMENT STEAM TRACING**

4.6.1 The mainsteam header in each area is laid by the other contractor. From the main steam header take off valve, steam to individual instrument shall be taken through carbon steel pipes supported at regular intervals. Steam tracing around individual instruments shall be to copper tubes. After steam tracing, the line is connected to the drain funnel through individual steam trap/condensate return header/tapper point as the case may be.

4.6.2 Electrical tracing shall be done by others.

4.7.0 **PERFORATED TRAYS AND SUPPORTS**

4.7.1 The perforated trays / angle trays shall be properly supported at a regular interval of max. 1000mm from insert plates or steel structures. Wherever insert plates are not available supports on concrete structures on ceiling shall be fixed with a minimum 10mm diameter expansion bolts. Angle supports for perforated trays/angle trays shall be fabricated from 40mmx40mmx5mm M.S. angles minimum size.

4.7.2 All supports shall be cut with hacksaw and any work executed by gas cutting for cutting and drilling holes will be totally rejected. Free ends of angle support shall not have sharp edges and shall be properly rounded off.

4.7.3 Perforated trays/angle trays shall be used for branching cables and tubes from main trays. Perforated trays shall be used for branching cables and tubes from main trays. Perforated trays shall be fabricated out of 2.5 mm perforated steel sheet. Width of trays shall be selected according to number of tubes and cables. Trays shall be laid generally as per site conditions with the approval of Engineer-in-charge.

4.8.0 **LAYING OF CABLES**

4.8.1 All cables shall be laid in accordance with installation drawings and cable schedules. Before laying, cable/multicable on drums shall be meggered and tested to ascertain the transit damages.

4.8.2 All cables routes shall be carefully measured and cables cut to the required lengths, leaving sufficient amount for the final connection of the cable to the terminals on either end. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. Sufficient extra length
of cable shall be kept at the terminal on points.

4.8.3 Cables shall have complete uncut lengths from one terminal to the other.

4.8.4 All cables shall be identified close to their termination point by cable number as per cable schedules/junction boxes schedules. PVC ferrule/tag plate shall be used and these identification tags shall be securely fastened to the cables.

4.8.5 All cores of electrical cables shall be identified by their wire numbers by means of the PVC ferrules. Wire numbers shall be as per schedules. All temporary ends of cables shall be protected against dirt and moisture. For this purpose, ends of all PVC insulation cables shall be taped with an approved PVC or rubber insulating tape. Use of function type or other fabric type is not permitted.

4.8.6 The cable shall be bent in a large radius. Cables installed above ground shall be run exposed on walls, ceilings, structures and shall run parallel or at right angles with beams, walls or columns.

4.8.7 Cables shall be rigidly supported on structural steel and masonry individually or in groups as required using galvanized clips, multiple cable supports or cable trays. If drilling of steel must be resorted to, approval must be obtained and steel must be drilled where the minimum of weakening of the structure will result. Cable shall be supported at every 500 mm.

4.8.8 All special cables and power supply cables will be laid directly to the field instrument without any junction boxes, unless otherwise specified.

4.8.9 While laying cables in trenches or burying them care shall be taken to ensure that low signal cables like alarm, analyser cables, special cables, special cables from turbine meters, compensating cable etc. are separated from other power supply cables.

4.8.10 Each underground cable (either in concrete trenches or buried) shall be provided with identifying tag of lead securely fastened every 30 m of its underground length with at least one tag at each end before the cable leaves/enters the ground.

4.8.11 Directly buried cables shall be laid underground in excavated cable trenches wherever specified in layout drawings. Trenches shall have sufficient depth and width to accommodate all cables correctly spaced. Before cables are placed the trench bottom shall be filled with 100 mm layer of sand and leveled. Each layer of cables shall be covered with 150 mm of sand on top and sand shall be lightly pressed. A protective covering of 75 mm thick second-class red bricks shall be placed flat on the final layer of sand and cable. The remaining portion of the trench shall be then back filled with soil compacted and leveled. On complete of every group of cable laying and before sand filling, every cable shall be given insulation test in the presence of Engineer-in-charge. Any cable proved to be defective should be replaced before the next groups of cables are laid. Cable route markers indicating number of cables, depth and direction will be placed
enroute, on crossovers/turnings, etc. to mark the cable route.

4.8.12 At each road crossings and other places, where cables enter pipe sleeves, adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends after pack filling.

4.8.13 At the entry into concrete blocks at road crossings cable loops shall be provided at either end to prevent any damage to cables. Each cable shall have one tag at each end before the cable enters/leaves conduct pipes.

4.8.14 After laying of all the cables and multitubings, cables, the cable entry to control room shall be suitably filled and sealed so as to achieve a positive seal against the entry of gas/water.

4.8.15 All cables and tubes shall be laid in accordance with the layout drawings with sand and precast concrete slabs shall be placed on the trench.

4.8.16 On completion of cable laying in concrete trenches, the trenches shall be filled with sand and precast.

4.9.0 EARTHING

4.9.1 Earthing of junction boxes, local cabinets as per the documents and instruction from Engineer-in-charge.

4.10.0 PAINTING

4.10.1 This part of the specification is applicable to cable ducts, MS cable ways, angle trays, instrument supports, perforated trays, all structural supports for the above items, etc.

4.10.2 The surface to be painted shall be thoroughly cleaned with wire brush, sand paper to remove all scales. After cleaning, the surface is painted with one coat of red oxide zinc chromate primer conforming to IS-207 and allowed to dry completely.

4.10.3 Primer coated surface is painted with one coat of paint to the colour nearest to the final paint and allowed to dry. The colour number shall be specified from IS-5.

4.10.4 Final second coating shall be with the paint of desired colours and shall be selected from IS-5.

4.10.5 It shall be noted that final second coating of external surfaces not covered by cables, copper tubes etc. shall be applied just before handling over the plant or commissioning of the plant whichever is earlier.

4.10.6 The name of manufacturer, colour and quality of all types of primer paint shall be
subject to approval of Engineer-in-charge.

4.11.0 TESTING

4.11.1 Electrical cables for signal power supply alarms, and compensating cables for thermocouples; resistance thermometer cables shall be checked for megger values and continuity before proper termination and ferruling.

4.11.2 Testing shall be carried out after the installation of instrument with primary piping complete in all respects and approved by Engineer-in-charge.

4.11.3 Primary piping shall be tested hydraulically pneumatically to 1.5 times the operating pressure after isolating the instruments. Flushing of piping shall be carried out as per instructions of Engineer-in-charge. Lines shall be blown after hydro-testing. All external displacement/float type level instrument level gauges shall also be tested as per instructions of Engineer-in-charge.

4.11.4 Tubes and air line shall be tested with compressed air to 7 kg/cm² upto the filter regulator. The down steam side of the filter regulator shall be tested for 1.5 kg/cm². The lines shall be blown with the instrument air upto the regulator for 15 minutes to remove any traces of oil, dust & moisture. All lines shall be checked with soap solution and bubbler unit for possible leak at joints. After pressurizing, source shall be cut off and rate of fall in pressure shall be less than 1 p.s.i. for each 100 ft. of copper tubing for a test period of 2 minutes as per I.S.A.R.P.7-1 "Pneumatic control circuit pressure test".

4.11.5 All test results shall be recorded in the approved format.

4.12.0 CALIBRATION

4.12.1 All instruments shall be calibrated strictly as per manufacturer's instructions prior to installation. The scope of calibration includes all field and control rooms of all types namely, pneumatic, electronic, electrical etc.

4.12.2 Contractor shall use his own oil free instruments, air compressor for calibration purposes.

4.12.3 The level switches (external cage type) shall be set by filling the cage with water to the desired alarm/trip level, while setting the switches, it shall be ensured that the micro switches do not reset for full rated travel of the float.
4.12.4 Control valves and positioners shall be checked for hysteresis and linearity and calibration for rated strokes. Prior to calibration, valves shall be cleaned externally. The stem is then lubricated if required, and stroked few times to extreme positions of plug to ensure that movement is free from friction. The valve shall then be calibrated for rated stroke and linearity also. Subsequently the valves shall be checked for hysteresis to the accuracy of 1% FS with positioners and 5% FS without positioners.

Stroke speed has to be evaluated for all trip/shutdown valves.

4.12.5 All calibrations reading shall be recorded in the enclosed format and submitted to Engineer-in-Charge for approval. Where significant deviations from specifications are obtained, the matter shall be brought to the immediate notice of the Engineer-in-Charge for corrective actions.

4.12.6 Furnished hereunder is a list of recommended calibration and test equipments required as a minimum for calibration work. The contractor shall clearly state in his offers the complete list of calibration and test equipments along with the range, accuracy and quantity, which he proposes to use for this job. Contractor should also ensure that any equipment not listed below but required at the time of calibration shall be made available at his own cost.

4.12.7 All test equipments/kits shall be approved by NPL authorities.

4.12.7.1 Controller test stands Mft. Standard

4.12.7.2 Indicator/recorder test stands -do-

4.12.7.3 Squeeze bulb (Flow calibrator
Range: 0-770, 10,000 mm wg.

4.12.7.4 Dead weight testers (Budenberg or equivalent) - +/- 0.1%
For ranges upto 350 kg/cm²

4.12.7.5 Gauge comparator for pressure gauges Rating : upto 350 kg/cm² -

4.12.7.6 Oil bath for temperature calibrations max. Temp 350°C. Mfr's Std

4.12.8.7 Standard Mercury in glass thermometers
Range : -50 to + 50°C, 0 to 100°C ± 0.25%
(NPL certified) 0-250°C, 0-350°C

4.12.7.8 Standard gauges for Ranges upto 350kg/cm² +0.25%

4.12.7.9 U-tube differential manometers/inclined
4.12.7.10 Single leg manometers
Scale: -1500 mm water and 1500 mm hg.
Static pr. rating : 7 kg/cm². +_ 1mm

4.12.7.11 Decade resistance box MFR' std.

4.12.7.12 Millimeters +0.05Mv

4.12.7.13 Potentiometer (Cable of generating and measuring mV)

4.12.7.14 Meggers 500V/1000V -

4.12.7.15 Air hydro pump/ hydraulic pump -

4.12.7.16 Vacuum pump -

4.12.7.17 Instrument air compressor with filters and Regulators and deoilers. -

4.12.7.18 Current generator (instrument checker) 4-20mA dc(YEW make or equivalent)

4.13.0 LOOP TEST

4.13.1 Loop test shall be performed after calibration of all instruments and leak test of signal lines. Loop tests are conducted to check the functional performance of all elements comprising the loop, thereby ensuring proper connections and operations.

4.13.2 Before proceeding for loop tests the calibration results of individual elements shall be recorded on the enclosed proforma and shall get it approved by Engineer-in-Charge for correctness of installation, measurements and calibration results.

4.13.3 Loop testing for all control loops shall be generally by simulation of process
conditions and shall fix points namely 0%, 25%, 50%, 75% and 100% of full-scale inputs. Detailed procedure shall be submitted to Engineer-in-charge for approval before proceeding with the loop testing.

In case of shutdown system field/receiver pressure switches are simulated for abnormality by disconnecting the wires at terminal and function of all associated systems are checked.

4.13.5 Performance of individual loops may be accepted for an overall accuracy of ± 1.5% where deviations exist, contractor shall recalibrate the instruments, which form part of loop testing wherever required, at no extra cost.

4.13.5.1 After the loop test is complete, the contractor shall connect back any terminations and connections removed for loop test.

4.13.7 A loop shall be considered as handed over only after measurements in that particular loop are complete and certified by Engineer-in-Charge, in addition to loop sheets being duly filled in all respects and approved and accepted by Engineer-in-Charge and client.

4.13.8 In case of loops in which certain instruments of the loops are calibrated by other agency, loop testing shall be performed in coordination with the agency involved. Any defect in the calibration of the instrument in contractor’s scope is observed, it shall be rectified to the satisfaction of the Engineer-in-Charge. However, defect in calibration of the instruments in the scope of other agency, same shall be rectified by the agency involved. After the calibration has been rechecked by the other agency/agencies the loop checking would be performed to the satisfaction of Engineer-in-Charge, and this part covers under the scope of the contract.

4.13.9 Final certified loop sheets shall be submitted in 4 copies and one transparency.

5.0.0 DRAWINGS AND DOCUMENTS TO BE SUPPLIED FOR EXECUTION BY OWNER/ENGINEER IN CHARGE

5.1.1 Piping ad Instrumentation diagrams.

5.1.2 General layout plan for all units, showing all information like position of field instruments junction boxes indicative routes of cables, main ducts/cable trays.

5.1.3 Cable schedules for alarm, signal, shutdown, power supply and pneumatic cables, earthing guide lines.

5.1.4 Termination details/drawings for connecting at control room end.
5.1.5 Individual Instrument specifications

5.1.6 Bill of materials

5.1.7 Installation standards/ Hook-up

5.1.8 Manufacturers hand book with instructions for installation and calibration wherever necessary for reference.

6.0 DRAWINGS AND DOCUMENTS TO BE PROVIDED BY CONTRACTOR

6.1.1 The drawings for materials that are included on their supply and erection scope namely local control panel, junction boxes and local cabinets.

6.1.2 The detailed engineering drawing wherever such drawing is assigned.

6.1.3 Two sets of layout drawings, standards bill of materials cable schedules etc., duly incorporating the changes/modification carried out during the course of execution of works.

6.1.4 Final material appropriation statement for all free issue materials indicating shortages of any in the proforma duly approved by Engineer-in-Charge.

7.1.0 SCRAP AND EXCESS MATERIAL

7.1.1 Every month, the contractor shall submit an account for all the materials issued by the Owner in the standard proforma prescribed for this purpose by the Engineer-in-Charge.

7.1.2 On completion of the work, the contractor shall submit `Material appropriation' statements for all materials issued by the Owner in the proforma prescribed by the Engineer-in-Charge.

7.1.3 The following scrap allowances are permissible.

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<th>Length below</th>
<th>Non-salvageable</th>
<th>Unaccountable</th>
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<tr>
<td>0.5 mm</td>
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<tr>
<td>Steel pipes, SS</td>
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<td>Tubes single pair/ Twocore / Three Core cables.</td>
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length below Non-salvageable Unaccountable
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<th>MultiTube, Multicable</th>
<th>2%</th>
<th>0.5%</th>
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8.0 SPECIAL INSTRUCTIONS TO CONTRACTOR:

8.1.4 All excess materials and scrap shall be returned after duly accounting for, to the storage points designated by the Owner. Where materials are to be weighed before return, the contractor shall be responsible for making the necessary section obtained during the course of construction for fabricating temporary supports or other items, without prior permission of the Engineer-in-Charge.

8.1.5 If the contractor fails to return the surplus material as aforesaid, the owner will charge the contractor for such unreturned materials at panel rates, which will deducted from whatever amount is due to the contractor. In case any material issued by the Owner deteriorates during storage by the contractor, new materials will be issued to him at penal rates, but the delay in procuring such materials will be at the contractor's account only.

***************
STANDARD SPECIFICATION
FOR
CABLING

SPECIFICATION NO.: MEC/ S/ 05/ E5/ 021

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
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6.0 TERMINATION

7.0 TESTING
1.0 SCOPE

This is to define the requirements for supply, wherever applicable, the installation, testing and commissioning of the cabling system.

2.0 STANDARDS

The work shall be carried out in the best workman like manner in conformity with this specification, the relevant specifications, codes of practice of Indian Standards Institution, approved drawings and instructions of Engineer-in-Charge or his authorized representative issued from time to time. In case of any conflict between the standards, the instruction of Engineer-in-Charge shall be binding.

3.0 CABLE SPECIFICATIONS

3.1 Power Cables

Power cables for use on 415 V systems shall be of 1100 Volts grade, aluminium stranded conductor, PVC insulated, PVC sheathed, armoured and overall PVC sheathed. Power cables for 3.3 KV 6.6 KV and 11 KV system shall be aluminium conductor, XLPL insulated, screened, PVC bedded galvanized steel flat armoured and PVC sheathed cable. All L.T. Cables conform to standard specification and relevant sections of IS: 1554 Part-I and H.T. Cables shall conform to IS: 7098 (Part II). Unarmoured cables will be used wherever specified on the cable schedule.

3.2 Control Cables:

Control cables shall be 1100 Volt Grade, 2.5 mm² copper conductor PVC insulated PVC sheathed, single wire armoured with an overall PVC sheath, as per IS: 1554 Pt. Unarmoured cables shall be used wherever specified on the cable schedule.

3.3 Communication cables:

Communication cables shall comprise 1 pair unarmoured, 2-pair, 5-pair and multipair armoured cables of sizes as specified in the cable schedule. Minimum conductor size shall be 0.5 mm telephone system and 0.71 for plant communication system.
4.0 MISCELLANEOUS MATERIALS SPECIFICATIONS

4.1 Connectors:
Cable terminations shall be made with aluminium / tinned copper crimped type solder less lugs of M/s. Dowell’s make or approved equivalent for all aluminium conductors and stud type terminals.

4.2 Cable Identification
Cable tags shall be of 2 mm thick, 20 mm wide aluminium strap of suitable length to contain cable number, equipment no., etc.

4.3 Ferrules
Ferrules shall be of approved type size to suit core size mentioned and shall be employed to designate the various cores of control cable by the terminal numbers to which the cores are connected for case in identification and maintenance.

4.4 Cable Glands:
Cable glands to be supplied shall be nickel-plated Brass double compression type of approved/reputed make. Glands for classified hazardous areas shall be certified by CMRS.

4.5 Cable Trays:
This shall be either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron trays as specified elsewhere. Prefabricated hot dip galvanized sheet steel cable trays shall be used for maximum support span of 2000 mm unless design is approved for larger span. For requirements of larger than 750 mm width two trays shall be run side by side. Cable trays shall be suitable for a cable weight of 50 kg/meter running length of tray. Minimum thickness of sheet steel/galvanizing shall be 2mm/86 microns respectively.

Cable trays fabricated from standard rolled sections shall use 50x50x6 / ISMC 100 Sections for runners for supporting spans limited to 2000 mm/more than 2000 mm respectively. Cross support shall be 32 x 6 mm flat/ 25x25x6 angle for width upto 500 mm/ more than 500 mm respectively.

Vertical supports for both the above type of trays shall be fabricated out of ISMC 100 and horizontal supports with 75 x 50 x 6 angle iron/ ISMC 75 as approved by Engineer-in-Charge.
If unit rate is not included in schedule of rates, then cable trays if required, shall be fabricated and installed at site as per tone rate for electrical structural supports etc.
5.0 CABLE LAYING

5.1 Cable network shall include power, control, lighting and communication cables, which shall be laid in trenches, cable trays or conduits as detailed in the relevant drawings and cable schedules. Erection of cable trays as required shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc. and minor adjustments shall be done to suit the field conditions wherever deemed necessary without any extra cost.

5.2 High voltage, medium voltage and other control cables shall be separated from each other by adequate spacing or running through independent pipes, trenches or cables trays, as applicable.

All communication cables (telephones, P.A.S.) RTD Cables shall run on instrument trays/ducts/trenches. Wherever these are not available, cables shall be taken in a separate trench with a minimum clearance of 300 mm away from electrical trench as per the direction of Engineer-in-Charge and Communication cables shall cross power cables at right angles.

All cable routes shall be carefully measured and cables cut to the required lengths, leaving sufficient lengths for the final connection of the cable to the terminal of the equipment. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. The quantity indicated in the cable schedule is only approximate. The contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works. Before the start of cable lying, cable drum schedule; shall be prepared be electrician contractor and get that approved by Engineer-in-Charge to minimize/avoid straight through joints required. Contractor shall work out the actual number of straight through joints required.

5.4 Cables as far as possible shall be laid in complete, uncut lengths from one termination to the other.

5.5 Cables shall be neatly arranged in the trenches/trays in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the Contractor. Cable routing between lined cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 45° to the trench wall. In case of larger dia cables, i.e., 50 mm and above, adequately sized pipe with larger bend radius shall be provided for ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Engineer-in-Charge.
5.6 All cables will be identified close to their termination point by cable numbers as per cable schedule. Cable numbers will be punched on aluminium straps (2 mm thick) securely fastened to the cable and wrapped around it. Alternatively cable tags shall be circular in construction to which cable numbers can be conveniently punched.

Each underground cable shall be provided with identity tags of lead securely fastened every 30 m of its underground length with at least one tag at each end before the cable enters the ground. In unpaved areas, cable trenches shall be identified by means of markers as per standard drawing. These posts shall be placed at location of changes in the direction of cables and at intervals of not more than 30 M and at cable joint locations.

5.7 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be taped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.

5.8 RCC cable trenches shall be with removable covers. Cables shall be laid in 3 or 4 tiers in these trenches as indicated on the sectional drawings. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases, RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. The electrical Contractor at no extra cost shall do removal of concrete covers for purpose of cable laying and reinstating them in their proper positions after the cables are laid.

Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving trenches shall be coiled and provided with a protective pipe or cover, until such times the final termination to the equipment is connected.

5.9 Directly buried cables shall be laid underground in excavated cable trenches where specified in layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables correctly spaced and arranged with a view of heat dissipation and economy of design.

Minimum depth of buried cable trench shall be 750 mm for low voltage and 900 mm for H.V. Cables, the depth and the width of the trench shall vary depending upon the number of layers of cables.

Cables shall be laid in trenches at depth as shown in the drawing. Before cables are placed, the trenches bottom shall be filled with a layer of sand. This sand shall be levelled and cable laid over it. These cables shall be covered with 150 mm layer of sand.
mm of sand on top of the largest diameter cable and sand shall be lightly pressed. A protective covering of 75 mm thick second class red bricks shall then be laid flat. The remainder of the trench shall then be back-filled with soil, rammed and levelled.

5.10 As each row of cables is laid in place and before covering with sand every cable shall be given an insulation test in the presence of Engineer-in-Charge / Owner. Any cable, which proves defective, shall be replaced before the next group of cables is laid.

All wall openings / pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/-lined trench.

Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection upto a minimum of 300 mm above finished ground level.

Cable ends shall be carefully pulled through the conduits, to prevent damage to the cable. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

Following grade of the pipe fill shall be used for sizing the pipe size:

a) 1 cable in pipe - 53% full
b) 2 cables in pipe - 31% full
c) 3 or more cables - 43% full
d) Multiple cables - 40% full

After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/ ‘PUTTI’ for sealing purpose. Alternatively G.I. Lidsor PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to have been included in the installation of G.I. Pipe and no separate payment shall be allowed.

5.11 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures, the electrical contractor shall determine their location and obtain approval of the Engineer-in-Charge before cutting is done.

5.12 At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.
5.13 Drum number of each cable from which it is taken shall be recorded against the cable number in the cable schedule.

5.14 Cables installed above grade shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel or at right angles to beams, walls or columns.

Cables shall be so routed that they will not be subjected to heat from adjacent hot piping or vessels.

5.15 Individual cables or small groups which run along structures/walls etc. will be clamped by means of 10 SWG GI saddles on 25x6 mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables and no separate payment shall be made on this account. Alternatively small group of cables can be taken through 100 mm slotted channel/ISMC 100.

They shall be rightly supported on structural steel and masonry, individual or in groups as required, if drilling of steel must be resorted to, approval must be secured and steel must be drilled where the minimum weakening of the structure will result.

Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300 mm for cables up to 25 mm diameter and maximum 450 mm for cables larger than 25 mm dia.

5.16 All G.I. Pipes shall be laid as per layout drawings and site requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the contractor), all the burrs from the pipes shall be removed. GI Pipes with bends shall be buried in soil/concrete in such way that the bends shall be totally concealed. For G.I. Pipes buried in soil, bitumen coating shall be applied on the buried lengths. Installation of G.I. Pipes shall be undertaken well before paving is completed and necessary co-ordination with paving agency shall be the responsibility of Electrical Contractor. The open ends of pipes shall be suitably plugged with G.I. Plugs after they are laid in final position. The Contractor at no extra cost shall supply G.I. Plugs.

5.17 Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable trays shall be suitably clamped by means of G.I. Saddles/Clamps, whereas cable in horizontal run of cable trays shall be tied by means of nylon cords.

5.18 Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint unless otherwise specified.
6.0 TERMINATION

6.1 All PVC cables up to 1.1 KV grade shall be terminated at the equipments by means of double compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.

All Cable entries shall be through bottom only and top entry terminations are made only after getting approval of Engineer-in-Charge.

6.2 Power cables wherever colour coding is not available shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections is made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.

6.3 In case of control cables all cables shall be identified at both ends by their terminal numbers by means of PVC ferrules or Self-sticking cable markers. Wire numbers shall be as per schematic/wiring/inter-connection diagram. Bidders shall have the samples of PVC ferrules/cable markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends.

6.4 Where threaded cable gland is screwed into threaded opening of different size, suitable galvanized threaded reducing bushing shall be used of approved type, at no extra cost. All switchgear and control panels shall have undrilled gland plate.

Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables.

6.5 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom close fit hole should be drilled in the bottom plate for all the cables in one line, then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.
6.6 Cable leads shall be terminated at the equipment terminals, by means of crimped type solder less connector as manufactured by M/s. Dowell Electro works or approved equivalent.

Crimping shall be done by hand crimping hydraulically operated tool and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

6.7 Cable accessories for H.V. Systems

6.7.1 The 11, skilled and experienced jointers duly approved by the Engineer-in-Charge shall do 6.6 and 3.3 KV cables terminations joints. Termination including supplying of jointing kit shall be threaded in Contractor scope unless specified otherwise.

6.7.2 The termination and straight thro' joint kit. For use on high voltage system shall be suitable for the type of cables red by the contractor or the type of cables issued by owner for installation. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fitting and consumables items. An installation instruction shall be included in each sheet.

6.7.3 The termination kits shall be suitable for termination of the cables to indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer motor. The terminating kits shall preferably be of the following types:

a) TAPLEX' of M-seal make using non-linear resistance material fortress grading.

b) ‘PUSH-ON' type of CCI make using factory - moulded silicone rubber insulators.

c) ‘TROPOLINK' type of CCI makes.

d) Heat-shrinkable sleeve type of M/s. Raychem.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.
6.7.4 The straight thro jointing kits shall be suitable for underground-buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types.

a) 'TAPLEX' of M-seal make

b) 'TROPOLINK' type of CCI make

c) Heat-shrinkable sleeve type of M/s. Raychem.

6.7.5 Makes of kits other than those specified in 6.7.3 and 6.7.4 may be considered provided the Contractor furnishes type test certificates, along with the offer.

6.7.6 Type tests are to be carried out at manufacturer's works to prove the general qualities and design of a given type of termination/jointing system. The type tests shall include the following tests conforming to the latest IEC 502.2, 466 and VDE 0278 specifications. The Contractor along with the offer for the jointing system considered shall submit the type test certificates.

a) A.C. Voltage withstand dry test for 1 minute

b) Partial discharge test - Discharge magnitude small be less than 20 p.c.

c) Impulse voltage withstand test with 10 impulses of each polarity.

d) A.C. high voltage test following load cycling test with conductor temperature at 95°C.

e) Thermal short circuit test of 250°C for 1 second.

f) DC Voltage withstand test for 30 minutes.

g) Humidity test.

h) Dynamic short circuit test.

i) Salt log test

j) Impact test
7.0 TESTING:

7.1 Before energizing, the insulation resistance of every circuit shall be measured from phase to phase and from phase to ground.

7.2 Where splices or termination are required in circuits rated above 600 volts, measure insulation resistance of each length of cable before splicing and or/terminating. Repeat measurement after splices and/or terminations are completed.

7.3 Measure the insulation resistance of directly buried cable circuits before cable trenches are back-filled. Repeat measurement after back-filling.

For cables up to 1.1 KV grade, 1KV Megger and for H.V. Cables 2.5 KV/5 KV, 2.4 KV/4.9 KV Megger shall be used

7.4 D.C. High Voltage Test shall be conducted after installation on the following and test results are recorded.

a) All 1000volts grade cables in which straight through joints have been made.

b) All cables above 1100 V grade.

For record purposes test data shall include the measure values of leakage current versus time.

The D.C. High Voltage test shall be performed as detailed below in the presence of the Engineer-in-Charge or his authorized representative only.

Cables shall be installed in final position with the entire straight through joints complete. Terminations shall be kept unfinished so that motors, switchgears, transformers etc. are not subjected to test voltage.

The test voltage shall be as under:

i) For cables 3.3 KV grade 5.4 KV DC

ii) For cables 6.6 KV grade 10.8 KV DC

iii) For cables 11 KV grade 18 KV DC
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<tr>
<th>TITLE</th>
<th>CABLING MEC/S/05/E5/021</th>
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<tr>
<td>7.5</td>
<td>All cables shall be tested as per standard test Performa available with site engineer.</td>
</tr>
<tr>
<td>7.6</td>
<td>Cable schedule and layout drawings must be marked for AS BUILT conditions during the installation work and shall be approved by Site Engineer.</td>
</tr>
</tbody>
</table>
TENDER PURPOSE DRAWINGS (CIVIL)
SECTION A-A

PAVEMENT TYPE - I

PIPE SUPPORT

RCC (M-25)

PCC 100 THK. (M-10)

200THK COMPACTED SAND

WELL COMPACTED EARTH

SECTION B-B

PAVEMENT TYPE - I

METERING SKID/VALVE SUPPORT

RCC (M-25)

PCC 100 THK. (M-10)

200THK COMPACTED SAND

WELL COMPACTED EARTH

SECTION C-C

PAVEMENT TYPE - II

RCC (M-25)

PCC 100 THK. (M-10)

200THK COMPACTED SAND

WELL COMPACTED EARTH

B - TO BE MEASURED AND PAID UNDER ITEM "REINFORCEMENT CONCRETE-SUPER STRUCTURE" IN SOR
C - TO BE MEASURED AND PAID UNDER ITEM "REINFORCED CEMENT CONCRETE" IN SUB STRUCTURE
D (01+02) - TO BE MEASURED AND PAID UNDER ITEM "CONCRETE PAVEMENT"
E - TO BE MEASURED AND PAID UNDER ITEM "CONCRETE PAVEMENT"

NOTES:-

1. CASTING OF PAVEMENT TO BE DONE IN PANELS ( >3x3m ) & JOINTS
   
   BE FILLED WITH APPROVED GR. BITUMINOUS FILLER COMPOUND.

2. PAVEMENT TYPE-I TO BE USED IN EQUIPMENT/ PIPE SUPPORTS AREA.

3. PAVEMENT TYPE-II TO BE USED FOR WALKWAY.

FOR TENDER PURPOSE ONLY

MECON LIMITED

TYPICAL DETAILS OF

RCC PAVEMENT & PEEDESTALS

CIVIL STANDARD FOR Terminals

MECON LIMITED

SCALE : NTS

SMT NO. MEC/05/11/STD/Terminal/002

48601906
LONGITUDINAL SECTION

NOTES:

1. ALL DIMENSIONS ARE IN mm
2. ALL P.C.C. WORKS SHALL BE OF M-10 GRADE UNLESS OTHERWISE STATED.
3. HEAVY DUTY R.C.C. NON-PRESSURE PIPE OF CLASS NP-3 CONFORMING TO IS:458 LATEST. SHALL BE USED FOR THE CULVERTS, UNLESS OTHERWISE STATED.
4. FOR DETAILS OF DIAMETER OFPIPES, INVERT LEVELS OF DRAINS, DETAILS OF ROAD AND EMBANKMENT etc., REFER TO RELEVANT DRAINAGE DRAWING.
5. ANY FILLING BELOW CULVERT, FOUNDATIONS, etc. SHALL BE DONE WITH WELL COMPACTED SAND.

PLAN
(TWO PIPES)

PLAN
(ONE PIPE)

TYPICAL SECTION
(TWO PIPES)

TYPICAL SECTION
(ONE PIPE)
NOTES:–

1. ALL DIMENSIONS AND LEVELS ARE IN MILLIMETERS.
2. ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED, DRAWING SHALL NOT BE SCALLED.
4. ALL R/F STEEL SHALL BE HYSD (Fe 415) CONFORMING TO IS: 1786.
5. LAP LENGTH SHALL NOT BE LESS THAN 50XDia. OF BAR/LAPS SHALL BE STAGGERED.
6. CLEAR COVER TO MAIN R/F SHALL BE AS FOLLOWS:
   a) ROOF BEAM=25mm  b) ROOF SLAB=25mm
7. FOR REINF. DETAIL REFER SEPARATE DRAWING.
8. BACK FILLING SHALL BE DONE IN LAYERS (MIN. 300mm THK).

FOR TENDER PURPOSE ONLY.
# List of Material

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1-1/2" FLANGED NOZZLE

THERMOWELL

------------ - INSTRUMENTATION SCOPE
------------- - PIPING SCOPE

NOTES:

1) PIPING SCOPE INCLUDES SUPPLY & INSTALLATION OF 1-1/2" SOCK-O-LET 1-1/2" NOZZLE, 1-1/2" FLANGE ALONG WITH GASKET, STUD & NUTS.

2) INSTRUMENTATION SCOPE INCLUDES SUPPLY OF FLANGED THERMOWELL ALONG WITH THE INSTRUMENT.
WELD
NO WELD MATERIAL PROJECTION BEYOND RF
OD 22 mm
ID 11 mm
BORE TO BE CONCENTRIC WITH OD WITHIN 10% OF WALL THICKNESS

4 mm
ø 16 mm
ø 34 mm
ø 1/2' NPT
45 mm
1 1/2' FLANGE
6 R
LENGTH 1'
TAPERING UPTO 150 mm
WELD

NO WELD MATERIAL PROJECTION BEYOND RF

OD 22 mm

1 1/2" FLANGE

TAPERING UPTO 150 mm

45 mm

ID 11 mm

BORE TO BE CONCENTRIC
WITH OD WITHIN 10% OF WALL THICKNESS

6 R

4 mm

φ 16 mm

φ 34 mm

φ 1/2" NPT
CABLE SHALL BE LOOLED BEFORE CONNECTION
LENGTH OF WI CABLE

1) ABOVE GROUND = 1.0M
2) BURRIED LINE = 3.0M

NOTE:-- RTD HEAD TO BE MOUNT ON SEPERATE SUPPORT
NOTES:

1. ALL DIMENSIONS ARE IN mm.
2. CLAMP MULTICABLE ON ANGLE WITH 25mm WIDE PVC COVERED ALUMINIUM STRIP.
3. ADD 50mm WHEREEVER FIRE INSULATION IS PROVIDED.

* DIMENSIONS 'A AND B' TO SUIT JUNCTION BOX.
TYTE 15  STEEL COLUMN MOUNTING [FLANGE FACE]

SIDE VIEW
FRONT VIEW

TYTE 16  STEEL COLUMN MOUNTING [WEB FACE]

SIDE VIEW
FRONT VIEW

TYTE 17  PIPE BRACKET MOUNTING

TYTE 17-1  [VERTICAL PIPE]

VIEW A-A

FRONT VIEW
SIDE VIEW

TYTE 17-2  [HORIZONTAL PIPE]

NOTES:-
1. ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE SPECIFIED.
2. PIPE MATERIAL SHALL BE IS:239 HEAVY GRADE AS A MINIMUM.
3. 6mm DIA WEEP HOLE SHALL BE PROVIDED AT LOW POINT.
4. U-BOLT ASSEMBLY SHALL BE OF MIN. M12 SIZE WITH NUT AND SPRING WASHERS.
5. ALL WELD SHALL BE 3mm FILLET WELD FULL STRENGTH.
6. ADD 30mm WHEREEVER ARE INSULATION IS PROVIDED.
7. BOLT SHALL BE TURNED FROM MS ROUNDS CONFIRMING TO IS : 432 GRADE 1.
8. NUTS AND WASHERS SHALL CONFIRM TO IS : 1363 AND IS : 3138.
NOTES:

1. ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE SPECIFIED.
2. PIPE MATERIAL SHALL BE IS:1239 HEAVY GRADE AS A MINIMUM.
3. 6mm DIA WEEP HOLE SHALL BE PROVIDED AT LOW POINT.
4. U-BOLT ASSEMBLY SHALL BE OF MIN. M12 SIZE WITH NUT AND SPRING WASHERS.
5. ALL WELD SHALL BE 3mm FILLET WELD FULL STRENGTH.
6. ADD 50mm WHERE–EVER INSULATION IS PROVIDED.
7. BOLT SHALL BE TURNED FROM MS ROUNDS CONFIRMING TO IS: 432 GRADE 1.
8. NUTS AND WASHERS SHALL CONFIRM TO IS: 1363 AND IS: 3138.
NOTES:
1. ALL DIMENSIONS ARE IN mm.
2. *—TO SUIT INSTRUMENT DIMENSIONS.
3. HINGES SHALL BE OF STAINLESS STEEL.
4. A MINIMUM OF TWO COATS PAINTING SHALL BE CARRIED OUT AFTER
   A MINIMUM OF ONE COAT OF RED OXIDE ZINC CHROMATE PRIMER.
   THE COLOUR OF THE PAINT SHALL BE AS PER IS—5.