Vadodara Smart City Development Ltd.

Section-6.20 : Detailed Technical Specifications

Vol-3 (Part III) – Technical Bid

BIDDING DOCUMENT

for the

" Work for 24 x 7 Water Supply System under Smart City Mission in ABD area of VMC including Refurbishment of existing network in part area and New Distribution Network in Part area. The works also includes Civil, Electromechanical, Instrumentation, SCADA, Household connections, Consumer water meter fittings and Operation and Maintenance for a period of 10 years "

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6.20 DETAILED TECHNICAL SPECIFICATIONS

6.20.1 PREAMBLE

1. In the specification “as directed” / “approved” shall be taken to mean, “as directed / approved by the Engineer-in-charge”.

2. Wherever a reference to any Indian Standard appears in the specifications, it shall be taken to mean as a reference to the latest edition of the same in force on the date of agreement.

3. In “Mode of Measurement” in the specification wherever a dispute arises in the absence of specific mention of a particular point or aspect, the provisions on these particular point or aspects in the relevant Indian Standards shall be referred to.

4. All measurements and computations, unless otherwise specified, shall be carried out nearest to the following limits.

(i)	Length, width and depth (height)	..	0.01Mt.
(ii)	Areas	..	0.01Sq.mt
(iii)	Cubic Contents	..	0.01Cu.mt.

In recording dimensions of work the sequence of length, width and height (depth) or thickness shall be followed.

5. The distance, which constitutes lead, shall be determined along the shortest practical route and not necessarily the route actually taken. The decision of the Engineer-in-charge in this regard shall be taken as final.

6. Where no lead is specified, it shall mean “all leads”.

7. Definite particulars covered in the items of work, though not mentioned or elucidated in its specifications shall be deemed to be included therein.

8. Any material specified in detailed specification of items shall be of quality and property as mentioned in the respective general specifications of materials mentioned in this tender.

9. Approval of the samples of various materials given by the Engineer-in-charge shall not absolve the Contractor from the responsibility of replacing defective material brought on site or materials used in the work found defective at a later date. The Contractor shall have no claim to any payment or compensation whatsoever on account of any such materials being rejected by the Engineer-in-charge.

10. The contract rate of the item of work shall be for the work completed in all respects.

11. No collection of materials shall be made before it is got approved from the Engineer-in-charge.

    Collection of approved materials shall be done at site of work in a systematic manner. Materials shall be stored in such a manner as to prevent damage deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work.

12. Materials, if and when rejected by the Engineer-in-charge, shall be immediately removed from the site of work.

13. No materials shall be stored prior to, during and after execution of a structure in such am way as to cause or lead to damage on overloading of the various components of the structure.

14. All work shall be carried out in a workmanlike manner as per the best techniques for the particular item.

15. All tools, templates, machineries and equipments for correct execution of the work as well as for checking lines, levels, alignment of the works during execution shall be kept in sufficient numbers and in good working condition on the site of work.

16. The mode, procedure and manner of, execution shall be such that it does not cause damage or over-loading of the various components of the structure during execution and after completion of the structure.

17. Special modes of construction not adopted in general Engineering practice, if proposed to be adopted by the Contractor, shall be considered only if the Contractor provides satisfactory evidence that such special mode of construction is safe, sound and helps in strength and quality. Acceptance of the same by the Engineer-in-charge shall not, however, absolve the Contractor of the responsibility of any adverse effects and consequences of adopting the same in the course of execution of completion of the work.

18. All installations pertaining to water supply and fixtures thereof as well as drainage lines and sanitary fittings shall be deemed to be completed only after giving satisfactory tests by the Contractor.

19. The Contractor shall be responsible for observing the rules and regulations imposed under the “Minor Minerals Act” and such other laws and rules prescribed by Government from time to time.

20. All necessary safety measures and precautions (including those laid down in the various relevant Indian Standards) shall be taken as also of the work itself.

21. The testing charges of all materials shall be borne by the Contractor.

22. Approval to any of the executed items for the work does not in any way relieve the Contractor of his responsibility for the correctness, soundness and strength of the structure as per the drawings and specifications.

23. All works shall be carried out strictly as per detailed technical specification provided in the tender. If not specified, the work shall be executed according to relevant applicable IS codes and standard engineering practice. In such case decision of the Engineer-in-charge shall be final and binding to the Contractor and in no case the Contractor will claim any extra for the same.

24. If Tenderer feels that detailed technical specifications for item mentioned in Schedule “B” are not provided with the tender, he will raise such points before quoting rates and submitting the tender. No claim on the basis of such argument shall be entertained during the course of work.

25. All measurements shall be considered as mentioned in the drawings / schedule / detailed specifications.

26. If Tenderers need any clarifications, they should obtain the same in writing from Owner / Engineer-in-charge.

Mm	Millimetres
Cm	Centimetres
Mt.	Metres
Km.	Kilometres
Sq.mt.	Square Metres
Cu.mt.	Cubic Metres
R.Mt.	Running Metres
No.	Numbers
C.I.	Cast Iron
R.C.C.	Reinforced Cement Concrete
Wt.	Weight
Kg.	Kilogram
M.T.	Metric Tonne
M.D.	Metre Depth
M.S.	Mild Steel
I.S.	Indian Standard
D.I.	Ductile Iron

EXECUTIVE ENGINEER
VADODARA MUNICIPAL CORPORATION

SIGNATURE AND SEAL OF THE CONTRACTOR:

NAME AND ADDRESS:

DATE:

6.20.2
GENERAL SPECIFICATIONS OF MATERIALS

6.20.2 GENERAL SPECIFICATIONS OF MATERIALS

M-1 WATER

1.1 Water shall not be salty or brackish and shall be clean, reasonably clear and free from objectionable quantities of silt and traces of oil and injurious alkalis, salts, organic matter and other deleterious material which will either weaken the mortar or concrete or cause efflorescence or attack the steel in R.C.C. Container for transport, storage and handling of water shall be clean. Water shall conform to the standards specified in I.S. 456-2000.

1.2 If required by the Engineer-in-charge it shall be tested by comparison with distilled water. Comparison shall be made by means of standard cement tests for soundness, time of setting and mortar strength as specified in I.S. 269 –1976. Any indication of unsoundness, change in time of setting by 30 minutes or more or decrease of more than 10 percent in strength of mortar prepared with water sample when compared with the results obtained with mortar prepared with distilled water shall be sufficient cause for rejection of water under test.

1.3 Water for curing mortar, concrete or masonry should not be too acidic or too alkaline. It shall be free of elements which significantly affect the hydration reaction or otherwise interfere with the hardening of mortar or concrete during curing or those which produce objectionable stains or other unsightly deposits on concrete or mortar surfaces.

1.4 Hard and bitter water shall not be used for curing.

1.5 Potable water shall generally be found suitable for curing mortar or concrete.

M-2 LIME:

2.1 Lime shall be hydraulic lime as per I.S. 712-1973. Necessary tests shall be carried out as per I.S. 6932 (Parts I to X) 1973.

2.2 The following field tests for limes are to carried out –

a) A very rough idea can be formed about the type of lime by its visual examination. I.e. fat lime bears pure white colour. Lime in form of porous lumps of dirty white colour, indicates quick lime, and solid lumps indicate the unburnt lime stone.
b) Acid tests for determining the carbonate content in lime. Excessive amount of impurities and rough determination of class of lime.

2.3 Storage shall comply with I.S. 712-1973. The slaked lime, if stored, shall be kept in a weather proof and damp proof shed with impervious floor and sides to protect it against rain, moisture, weather and extraneous materials mixing with it. All lime that has been damaged in any way shall be rejected and all rejected materials shall be removed from site of work.

2.4 Field testing shall be done according to I.S. 162-1974 to show the acceptability of materials.

M-3 CEMENT

3.1 Cement shall be ordinary Portland cement **as per latest amendment of I.S. 12269 of 53/43 grade** or Portland slag cement as per I.S. 455 –1989.

M-4 WHITE CEMENT:

4.1 The white cement shall conform to I.S. 8042-1978.

M-5 SAND:

5.1 Sand shall be natural sand, clean, well graded, strong, durable and gritty particles free from injurious amounts of dust, clay, kankar nodules, soft or flaky particles, shale, alkali, salts, organic matter, loam, mica or other deleterious substances and shall be got approved from the Engineer-in-charge. The sand shall not contain more than 8% of silt as determined by field tests. If necessary the sand shall be washed to make it clean.

5.2 Coarse Sand : The fineness modulus of coarse sand shall not be less than 2.5 and shall not exceed 3.0. The sieve analysis of coarse shall be as under:

I.S. Sieve Designation	% by weight passing sieve	I.S. Sieve Designation	% by weight passing sieve
4.75 mm	100	600 Micron	30 – 100
2.36 mm	90 – 100	300 Micron	5 – 70
1.18 mm	70 – 100	150 Micron	0 – 50

5.3 Fine Sand : The finess modulus shall not exceed 1.0. The sieve analysis of fine sand shall be as under –

I.S. Sieve Designation	% by weight passing thru	I.S. Sieve Designation	% by weight passing thru.
4.75 mm	100	600 Micron	40 – 85
2.36 mm	100	300 Micron	5 – 50
1.18 mm	75-100	150 Micron	0 - 10

M-6 STONE GRIT:

6.1 Grit shall consist of crushed or broken stone and be hard, strong, dense, durable, clean, of proper gradation and free from skin or coating likely to prevent proper adhesion of mortar. Grit shall generally be cubical in shape and as far as possible flaky elongated pieces shall be avoided. It shall generally comply with the provisions of I.S. 383-1970.

Unless a special stone of a particularly quarry is mentioned, grit shall be obtained from the best black trap or equivalent hard stone as approved by the Engineer-in-charge. The grit shall have not deleterious reaction with cement.

6.2 The grit shall conform to the following gradation as per sieve analysis:

I.S. Sieve Designation	% passing thru' sieve	I.S. Sieve Designation	% passing thru' sieve
12.50 mm	100%	4.75 mm	0-20%
10.00 mm	85-100%	2.36 mm	0-25%

6.3 The crushing strength of grit will be such as to allow the concrete in which it is used to built-up the specified strength of concrete.

6.4 The necessary tests for grid shall be carried out as per the requirements of I.S. 2386 (Parts I to VIII) 1963, as per instruction of the Engineer-in-charge. The necessity of test will be decided by the Engineering–in-charge.

M-7 LIME MORTAR:

7.1 LIME: Shall conform to specification M-2. WATER: water shall conform to specification M-1. SAND: Sand shall conform to specification M-5.

7.2 PROPORTION OF MIX: Mortar shall consist of such proportions of slaked lime and sand as may be specified in the item. The slaked lime and sand shall be measured by volume.

7.3 PREPARATION OF MORTAR : Lime mortar shall be prepared by wet process as per I.S. 1625-1971. Power driven mill shall be used for preparation of lime mortar. The slaked lime shall be placed in the mill in an even layer and ground for 180 revolutions with sufficient water. Water shall be added as required during grinding (care being taken not to add more water) that will bring the mixed material to a consistency of stiff paste. Thoroughly wetted sand shall then be added evenly and the mixture ground for another 180 revolutions.

7.4 STORAGE: Mortar shall always be kept damp, protected from sun and rain till used up, covering it by tarpaulin or open sheds.

7.5 USE: All mortar shall be used as soon as possible after grinding. It should be used on the day on which it is prepared. But in no case mortar made earlier than 36 hours shall be permitted for use.

M-8 CEMENT MORTAR:

8.1 Water shall conform to specification M-1. Cement shall conform to specification M-3. Sand shall conform to M-5.

8.2 PROPORTION OF MIX: Cement and sand shall be mixed to specified proportions, sand being measured by measuring boxes. The proportion of cement shall be by volume on the basis of 50 Kg./bag of cement being equal to 0.0342 cu.m. The mortar may be hand mixed or machine mixed as directed.

8.3 PREPARATION OF MORTAR: In hand mixed mortar, cement and sand in the specified proportions shall be thoroughly mixed dry on a clean impervious platform by turning over at least 3 times or more till a homogeneous mixture of uniform colour is obtained. Mixing platform shall be so arranged that no deleterious extraneous material shall get mixed with mortar or mortar shall flow out. While mixing, the water shall be gradually added and thoroughly mixed to form a stiff plastic mass of uniform colour so that each particle of sand shall be completely covered with a film of wet cement. The water cement ratio shall be adopted as directed.

8.4 The mortar so prepared shall be used within 30 minutes of adding water. Only such quantity of mortar shall be prepared as can be used within 30 minutes.

M-9 STONE COARSE AGGREGATE FOR NOMINAL MIX:

9.1 Coarse aggregate shall be of machine crushed stone of black trap or equivalent and be hard, strong, dense, durable, clean and free from skin and coating likely to prevent proper adhesion of mortar.

9.2 The aggregate shall generally be cubical in shape. Unless special stones of particular quarries are mentioned aggregates shall be machine crushed from the best black trap or equivalent hard stone as approved. Aggregate shall have no deleterious reaction with cement. The size of the coarse aggregate for plain cement concrete and ordinary reinforced cement concrete shall generally be as per the table given below. However, in case of reinforced cement concrete the maximum limit may be restricted to 6 mm. less than the minimum lateral clear distance between bars or 6 mm. less than the cover whichever is smaller.

TABLE

I.S. Sieve Designation	Percentage passing for single sized aggregates of Nominal size			I.S. Sieve Designation	Percentage passing for single sized aggregates of Normal size		
	40 mm	20 mm	16 mm		40 mm	20 mm	16 mm
80 mm	-	-	-	12.5 mm	-	-	-
63 mm	100	-	-	10.00 mm	0-5	0-20	0-30
40 mm	85-100	100	-	4.75 mm	-	0-50	0-50
20 mm	0-20	85-100	100	2.36 mm	-	-	-
16 mm	-	-	85-100				

NOTE: This percentage may be varied somewhat by the Engineer-in-charge when considered necessary for obtaining better density and strength of concrete.

9.3 The grading test shall be taken in the beginning and at the change of source of materials. The necessary tests indicated in I.S. 383-1970 and I.S. 456-2000 shall have to be carried out to ensure the acceptability. The arrangement shall be stored separately and handled in such a manner as to prevent the intermixing of different aggregates. If the aggregates are covered with dust, they shall be washed with water to make, them clean.

M-10 BLACK TRAP OR EQUIVALENT HARD STONE COARSE:

10.1 Aggregate for Design Mix concrete : Coarse aggregate shall be of machine crushed stone of black trap or equivalent hard stone and be hard, strong, dense, durable, clean and free from skin and coating likely to prevent proper adhesion of mortar.

10.2 The aggregates shall generally be cubical in shape, unless special stones of particular quarries are mentioned, aggregates shall be machine crushed from the best, black trap or equivalent hard stones as approved. Aggregate shall have no deleterious reaction with cement.

10.3 The necessary tests indicated in I.S. 383-1970 and I.S. 456-2000 shall have to be carried out to ensure the acceptability of the material.

10.4 If aggregate is covered with dust it shall be washed with water to make it clean.

M-11 BRICK BATS AGGREGATE:

11.1 Brick bat aggregates shall be broken from well burnt or slightly over burnt and dense bricks. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt of any other foreign material. The brickbats shall be of 40 mm to 50 mm size unless otherwise specified in the item. The under burnt or over burnt brick shall not be allowed.

11.2 The brick bats shall be measured by volume by suitable boxes as directed.

M-12 BRICKS:

12.1 The bricks shall be hand or machine molded and made from suitable soils and kiln burnt. They shall be free from cracks and flaws not nodules of free lime. They shall have smooth rectangular faces with sharp corners and shall be of uniform colour. The bricks shall be molded with a frog of 100 mm x 40 mm and 10 mm to 20 mm deep on one of its flat sides. The bricks shall not break when dropped on the ground from a height of 600 mm.

12.2 The size of modular bricks shall be 190 mm x 90 mm x 90 mm.

12.3 The size of conventional bricks shall be as under:
225 x 110 x 75 mm .

12.4 Only bricks of one standard size shall be used on one work. The following ipsnces shall be permitted in the conventional size adopted in a particular work.

Length	:	3.00 mm
Width	:	1.50 mm
Height	:	1.50 mm

12.5 The crushing strength of the bricks shall not be less than 35 kg./Sq.cm. The average water absorption shall not be more than 20% by weight. Necessary tests for crushing strength and water absorption etc. shall be carried out as per I.S. 3495 (Part I to IV) – 1976.

M-12A FLYASH BUILDING BRICKS

The flyash building bricks shall confirm to IS-13757, IS-5454, IS-12894, IS-3495, IS-3812.
The frog of 80 to 100 mm X 40 mm X 10 to 20 mm size
The size of modular bricks shall be 190 mm X 90 mm X 90 mm.
The size of conventional brick shall be 230 mm X 110 mm X 70 mm.
Only bricks of one standards size shall used on one work. The following tolerances shall permitted in the conventional size adopted in a particular work:

Length	:	±3 mm
Width	:	±2 mm
Height	:	±2 mm

The physical characteristic of bricks shall be as follows –
The minimum compressive strength of Burnt Clay Flyash building bricks shall not be less than 70 kg/sq. cm. And the test shall be conform to IS-3495 (Part-I)
The average water absorption shall not be more than 20 percentage by weight and the test shall confirm to IS-3495 (Part – 3). Sampling of flyash building bricks and criteria for conformity shall be as per IS:5454

M-13 STONE:

13.1 The stone shall be of the specified variety such as Granite / Trap stone/Quarzite or any other type of good hard stones. The stones shall be obtained only from the approved quarry and shall be hard, sound, durable and free from defects like cavities, cracks, sand holes, flaws, injurious veins, patches of loose or soft materials etc. and weathered portions and other structural defects and strength. The stone with round surface shall not be more than 5% of dry weight. When tested in accordance with I.S. 1134 – 1974. The minimum crushing of the strength of the stone shall be 200 Kg./Sq.cm. unless otherwise specified.

13.2 The samples of the stone to be used shall be got approved before the work is started.

13.3 The Khanki facing stone shall be dressed by chisel as specified in the item for khanki facing in required shape and size. The face of the stone shall be so dressed that the bushing on the exposed face shall not project by more than 40mm. from the general wall surface and on face to be plastered it shall not project by more than 19 mm nor shall it have depressions more than 10 mm from the average wall surface.

M-14 MILD STEEL BARS:

14.1 Mild steel bars reinforcement for R.C.C. work shall conform to I.S. 432 (Part-I) – 1982 and shall be of tested quality. It shall also comply with the relevant part of I.S. 456-2000.

14.2 All the reinforcement shall be clean and free from dirt, paint, grease, mill scale or loose or thick rust at the time of placing.

14.3 For the purpose of payment, the bar shall be measured correct upto 10 mm length and weight payable worked out as per the rate specified below:

i)6 mm	0.22 Kg/Rmt.	viii)	20 mm	2.47 Kg/Rmt.
ii)8 mm	0.39 Kg/Rmt	ix)	22mm	2.98 Kg/Rmt.
iii)10mm	0.62 Kg/Rmt.	x)	25 mm	3.85 Kg/Rmt.
iv)12 mm	0.89 Kg/Rmt.	xi)	28 mm	4.83 Kg/Rmt.
v)14 mm	1.21 Kg/Rmt.	xii)	32 mm	6.31 Kg/Rmt.
vi)16 mm	1.58 Kg/Rmt.	xiii)	36 mm	7.31 Kg/Rmt
vii)18 mm	2.00 Kg/Rmt.	xiv)	40 mm	9.86 Kg/Rmt

M-15 HIGH YIELD STRENGTH STEEL DEFORMED BARS (CRS – Corrosion Resistant Steel and TMT):

15.1 High yield strength steel deformed bars shall be either cold twisted or hot rolled and shall conform to I.S. 1786-1985.

15.2 Other provision and requirements shall conform to specification No. M-14 for Mild Steel bars.

M-16 HIGH TENSILE STEEL WIRES:

16.1 The high tensile wires for use in pre-stressed concrete shall conform to I.S. 2090-1962.

16.2 The tensile strength of the high tensile steel bars shall be as specified in the item. In absence of the given strength, minimum strength shall be taken as per para. 6-1 or the I.S. 1785-1962. Testing shall be dome as per I.S. requirements.

16.3 The high tensile steel shall be free from loose mill scale, rust, oil, grease or any other harmful matter. Cleaning of steel bars may be carried out by immersion in solvent solution, wire brushing or passing through a pressure box containing carborundum.

16.4 The high tensile wire shall be obtained from manufacturers in coils having diameter not less than 350 times the diameter of wire itself so that wire springs back straight on being uncoiled.

M-17 MILD STEEL BINDING WIRE:

17.1 The mild steel wire shall be of 1.63 mm or 1.22 mm (16 or 18 gauge) diameter and shall conform to I.S. 280 –1972).

17.2 The use of black wire will be permitted for binding reinforcement bars. It shall be free from rust, oil, paint, grease, loose mill scale or any other undesirable coating which may prevent adhesion of cement mortar.

M-18 STRUCTURAL STEEL:

18.1 All structural steel shall conform to I.S. 226 – 1965. The steel shall be free from the defects mentioned in I.S. 226 –1975 and shall have a smooth finish. The material shall be free from loose mill scale, rust pits or other defects affecting the strength and durability. Rivet bars shall conform to I.S. 1148-1973.

18.2 When the steel is supplied by the Contractor. Test certificates of the manufacturers shall be obtained according to I.S. 226-1975 and other relevant Indian Standards.

M-19 SHUTTERING:

1.1 The shuttering shall be either of wooden planking of 30 mm minimum thickness with or without steel lining or of steel plates stiffened by steel angles. The shuttering shall be supported on battens and beams and props of vertical ballies properly cross braced together so as to make the centering rigid. In places of ballie props, bricks pillar of adequate section built in mud mortar may be used.

1.2 The form work shall be sufficiently strong and shall have camber, so that it assumes correct shape after deposition of the concrete and shall be able to resist forces caused by vibration of concrete, live load of men, working with it and other incidental loads associated with it. The shuttering shall have smooth and even surface and its joints shall not permit leakages of cement grout.

1.3 If at any stage of work during or after placing concrete in the structure, the form work sags or bulges out beyond the required shape of the structure, the concrete shall be removed and work redone with fresh concrete and adequately rigid form work. The complete form work shall be got inspected by and approved from Engineer-in-charge, before the reinforcement bars are placed in position.

1.4 The props shall consists of bullies having 100 mm minimum diameter measured at mid length and 80 mm at the end and shall be placed as per design requirement. These shall rest squarely on wooden sole plates 40 mm. thick and minimum bearing area of 0-10 sq.m. laid on sufficiently hard base.

1.5 Double wedges shall further be provided between the sole plate and wooden props so as to facilitate tightening and easing of shuttering without jerking the concrete.

1.6 The timber used in shuttering shall not be so dry so as to absorb water from concrete and swell or bulge nor so green or wet so as to shrink after erection. The timber shall be properly swan and planed on the sides and the surface coming in contact with concrete. Wooden form work with metal sheet lining or steel plates stiffened by steel angles shall be permitted.

1.7 As far as practicable, clamps shall be used to hold the forms together and use of nails and spikes avoided.

1.8 The surface of timber shuttering that would come in contact with concrete shall be well wetted and coated with soap solution before the concreting is done. Alternatively coat of raw linseed oil or oil of approved manufacture may be applied in place of soap solution. In case of steel shuttering either soap solution or raw linseed oil shall be applied after thoroughly cleaning the surface. Under no circumstances black or burnt oil shall be permitted.

1.9 The shuttering for beams and slabs shall have camber of 4 mm per metre (1 in 250) or as directed by the Engineer-in-charge so as to offset the subsequent deflection. For cantilevers, the camber at free end shall be 1/50 of the projected length or as directed by the Engineer-in-charge.

M-20 TEAK WOOD:

20.1 The teak wood shall be of good quality as required for the item to be executed. When the kind of wood is not specifically mentioned, good Indian teak wood as approved shall be used.

20.2 Teak wood shall generally be free from large, loose, dead or cluster knots, flaws, warps, twists, shakes, bends or any other defects. It shall generally be uniform in substance and of straight fibers as far as possible. It shall be free from rot, decay, harmful fungi and other defects of harmful nature, which will affect the strength, durability or its usefulness for the purpose for which it is required. The colour shall be uniform as far as possible. Any effort like painting, using any adhesive or resinous materials made to hide the defects shall render the pieces liable to rejection by the Engineer-in-charge.

20.3 All scantlings, planks etc. shall be sawn in straight lines and planes in the direction of grains and of uniform thickness.

20.4 The tolerances in the dimensions shall be allowed at the rate of 1.5 mm per face to be planed.

20.5 First Class Teak Wood:

First class teak wood shall have no individual hard and sound knots, more than 6 sq.cm. in size and the aggregate area of such knots shall not be more than 1% of area of piece. The timber shall be closed grained.

20.6 Second Class Teak Wood:

No individual hard and sound knots shall be more than 15 sq.cm. in size and aggregate area of such knots shall not exceed 2% of the area of piece.

M-21 NON-TEAK WOOD:

The non teak wood shall be chemically treated, seasoned as per I.S. Specifications and of good quality. The type of wood shall be got approved before collecting the same on site. Fabrication of wooden members shall be started only after approval. For this purpose wood of Bio, Kalai, Sires, Saded, Behda, Jamun, Sisoo will be used for door frames whereas only Kalai, Siras, Halda, Kalam etc. will be permitted for shutters after proper seasoning and chemical treatment.
The non teak wood shall be free from large, loose dead of cluster knots, flaws, shakes, warps, bends, or any other defect. It shall be uniform in substance and of straight fibres

as far as possible. It shall be free from rots, decay, harmful fungi and other defects of similar nature which will affect the strength, durability or its usefulness for the purpose for which it is required. The colour of the wood shall be uniform as far as possible. The scantlings, planks etc. shall be sawn in straight lines and planes in the direction of grain and of uniform thickness.
The department will use the Agency to produce a certificate from the Forest Department in the event of a dispute and the decision of the Department shall be final and binding to the Contractor.

M-22 WOODN FLUSH DOOR SHUTTERS (SOLID CORE):

22.1 The solid core type flush door shutters shall be of decorative or non –decorative type as specified in the drawing. The size and thickness of the shutter shall be as specified in drawings or as directed. The timber species for core shall be used as per I.S. 2202- (Part-I) – 1980. The timber shall be free from decay and insect attack. Knots and knot holes less than half the width of cross-section of the members, pitch streaks and harmless pin holes shall be permissible except in the exposed edges of the core members. The commercial plywood, cross bands shall conform to I.S. 303-1275.

22.2 The face panel of the shutters shall be formed by gluing by the hot press process on both faces of the core with either plywood or coarse bands, and face veneers. The lipping, rebating, opening of glazing, venation etc. shall be provided if specified in the drawing.

22.3 All edges of the door shutters shall be square. The shutters shall be free form twist or warp in its plane. Both faces of the shutters shall be sand papered to smooth even texture.

22.4 The shutters shall be tested for ----

i) End Immersion Test : The test shall be carried out as per I.S. 2202 (Part-I) 1980. There shall be no delamination at the end of the test.

ii) Knife Test : The face panel when tested in accordance with I.S. 1659 – 1979 shall pass the test.

iii) Glue Adhesion Test : The flush door shall be tested for glue adhesive test in accordance with I.S. 2202 (Part-I) – 1980. The shutters all be considered to have passed the test if no delamination occurs in the glue lines in the plywood and if no single delamination more than 80 mm. in length and more than 3 mm. in depth has occurred in the assembly glue lines between the plywood face and the style and rail. Delamination at the corner shall be measured continuously around the corner.

Delamination at the knots knot, hole and other permissible wood defects shall not be considered in assessing the sample.

22.5 The tolerance in size of solid core type flush door as under –

In nominal thickness # 1.2 mm. In nominal height # 3 mm. The thickness of the shutters shall be uniform throughout with a permissible variation of not more than 0.8 mm. when measured at any two points.

M-23 ROLLING SHUTTERS:

23.1 The rolling shutters shall conform to I.S. 6248-1979. Rolling shutters shall be supplied of specified type with accessories. The size of the rolling shutters shall be specified in the drawings. The shutters shall be constructed with interlocking lath sections formed from

cold rolled steel strips not less than 0.9 mm. thick and 80 mm. wide for shutters up to 3.5 m. width not less than 1.25 mm. thick and 80 mm. wide for shutters 3.5 m. in width and above unless otherwise specified.

23.2 Guide channels shall be of mild steel deep channel section and of rolled pressed or built up (fabricated) joint less construction. The thickness of sheet used shall not be less than 3.15 mm.

23.3 Hood covers shall be made of M.S. sheets not less than 0.92 mm. thick. For shutters having width 3.5 mts. and above, the thickness of M.S. sheet for the hood covers shall be not less than 1.25 mm.

23.4 The spring shall be of best quality and shall be manufactured from tested high tensile spring steel wire or strip of adequate strength to balance the shutters in position. The spring pipe shaft etc. shall be supported on strong M.S. or malleable C.I. brackets. The brackets shall be fixed on the or under the lintel as specified with rawl plugs and screws bolts etc.

23.5 The rolling shutters shall be of self rolling type upto 8 sq.m. clear area without ball bearing and upto 12 sq.m. clear area with ball bearing. If the rolling shutters are of larger then gear operated type shutters shall be used.

23.6 The locking arrangement shall be provided at the bottom of shutter at both ends. The shutters shall be opened from outside.

23.7 The shutters shall be completed within door suspension, shafts, locking arrangements, pulling hooks, handles and other accessories.

M-24 COLLAPSIBLE STEEL GATE:

24.1 The collapsible steel gate shall be in one or two leaves and size as per approved drawings or as specified. The gate shall be fabricated from best quality mild steel channels, plates etc. Either steel pulleys or ball bearings shall be provided in every double channel. Unless otherwise specified the particulars of collapsible gate shall be as under..

i) Pickets : These shall be of 20 mm. M.S. channels of heavy sections unless otherwise shown on drawings. The distance center to center of pickets shall be 12 cms. with an opening of 10 cms.
ii) Pivoted M.S. flats shall be 20 mm. x 6 mm.
iii) Top and bottom guides shall be from tee or flat iron of approved size.
iv) The fittings like stoppers, fixing hold fasts, locking cleats, brass handles and cast iron rollers shall be of approved design and size.

M-25 GLASS :

25.1 All glass shall be of the best quality, free from specks, bubbles, smokes, veins, air holes blisters and other defects. The kind of glass to be used shall be as mentioned in the item or specification or in the special provisions or as shown in detailed drawings. Thickness of glass panes shall be uniform. The specifications for different kinds of glass shall be as under-

Sheet Glass:

In the absence of any specified thickness or weight in the item or detailed specifications of the item of work, sheet glass shall be weighing 7.5 Kg./Sq.m. for panes upto 600 mm x 600 mm.

For panes larger than 600 mm. x 600 mm. and upto 800 mm. x 800 mm. glass weighing not less than 8.75 Kg. / Sq.m. shall be used. For bigger panes upto 900 mm. x 900 mm. glass weighing not less than 11.25 Kg./Sq.m. shall be used.
Sheet glass shall be patent flattened glass of best quality and for glazing and framing purposes shall conform to I.S. 761-1960. Sheet glass of the specified colours shall be used, if so shown on detailed drawings or so specified. For important buildings and for panes with any dimensions over 900 mm. plate glass of specified thickness shall be used.
Plate Glass:
When plate glass is specified it shall be "Polished Patent Plate Glass" of best quality. It shall have both the surface ground flat and parallel and polished to obtain clear undisturbed vision and reflection. The plate glass shall be of the thickness mentioned in the item or as shown in the detailed drawing or as specified. In the absence of any specified thickness, the thickness of plate glass to be supplied shall be 6 mm. and a tolerance of 0.20 mm. shall be admissible.
Obscured Glass:
This type of glass transmits light so that vision is partially or almost completely obscured. Glass shall be plain rolled, figured, ribbed or fluted, or frosted glass as may be specified as required. The thickness and type of glass shall be as per details on drawings or as specified or as directed.
Wired Glass :
Glass shall be with wire netting embedded in a sheet of plane glass. Electrically welded 13 mm. Georgain square mesh shall be used. Thickness of glass shall not be less than 6 mm. wired glass shall be of type and thickness as specified.

M-26 FIXTURES & FASTENINGS:

General

i) The fixtures and fastenings, that is, butt, hinges, tee and strap hinges, sliding door bolts, tower bolts, door latch, bath room latch, handles, door stoppers, casement window fasteners, casement stays and ventilator catch shall be made of the metal as specified in the item or its specifications.

ii) They shall be of iron, brass, aluminium, chromium plated iron, chromium plated brass, copper oxidized iron, copper oxidized brass or anodized aluminium as specified.

iii) The fixtures shall be heavy, medium or light type. The fixtures and fastenings shall be smooth finished and shall be such as will ensure ease of operation.

iv) The samples of fixtures and fastenings shall be got approved as regards quality and shape before providing them in position.

v) Brass and anodized aluminium fixtures and fastenings shall be bright finished.

Holdfasts:

i) Holdfasts shall be made from mild steel flat 30 cm. Length and one of the holdfasts shall be bent at right angle and two nos. of 6 mm. dia. holes shall be made in it for fixing it to the frame with screws. At the other end, the holdfast shall be forked and bent at right angles in opposite directions.

Butt Hinges:

i) Railway standard heavy type butt hinges shall be used when so specified.

ii) Tee and strap hinges shall be manufactured from M.S. sheet.

Sliding Door Bolts (Aldrops) :

i) The aldrops as specified in the item shall be used and shall be got approved.

Tower Bolts (Barrel Type):

i) Tower bolts as specified in the item shall be used and shall be got approved.

Door Latch

i) The size of door latch shall be taken as the length of latch.

Bathroom Latch:

i) Bathroom latch shall be similar to tower bolt.

Handle:

i) The size of the handles shall be determined by the inside grip length of the handles. Handles shall have a base plate of length 50 mm. More than the size of the handle.

Door Stoppers:

i) Door stoppers shall be either floor door stopper type or door catch type. Floor stopper shall be of overall size as specified and shall have a runner cushion.

Door Catch :

i) Door catch shall be fixed at a height of about 900 mm. from the floor level such that one part of the catch is fitted on the inside of the shutter and other part is fixed in the wall with necessary wooden plug arrangements for appropriate fixity. The catch shall be fixed 20 mm. inside the face of the door for easy operation of catch.

Wooden Door Stop with Hinges:

i) Wooden door stop of size 100 mm. x 60 mm x 40 mm shall be fixed on the door frame with a hinge of 75 mm. size and at a height of 900 mm. from the floor level. The wooden door stop shall be provided with 3 coats of approved oil paint.

Casement window Fastner:

Casement window fastener for single lead window shutter shall be left or right handed as directed.

Casement Stays (Straight Peg.Stay):

i) The stays shall be made from a channel section having three holes at appropriate position so that the window can be opened either fully or partially as difected.

Size of the stay shall be 250 mm to 300 mm. as directed.

Ventilation Catch:

i) The pattern and shape of the catch shall be as approved.

Pivot:

i) The base and socket plate shall be made from minimum 3 mm. thick plate, and projected pivot shall not be less than 12 mm. dia. and 12 mm. length and shall be firmly riveted to the base plate case of iron pivot and in single piece base in the case of brass pivot.

M – 27 PAINTS:

27.1 Oil Paints:

Oil paints shall be of the specified colour and shade, and as approved. The ready mixed paints shall only be used.

However, if ready mixed paint of specified shade or tint is not available white ready mixed paint with approved strainer will be allowed. In such a case, the Contractor shall ensure that the shade of the paint so allowed shall be uniform.

All the paints shall need with the following general requirements –

i) Paint shall not show excessive setting in a freshly opened full can and shall easily be re-dispressed with paddle to a smooth homogeneous state. The paint shall show no curling, levering, caking or colour separation and shall be free from lumps and skins.

ii) The paint as received shall brush easily, possess good leveling properties and show no running or sagging tendencies.

iii) The paint shall not skin within 48 hours in a three quarters filled closed container.

iv) The paint shall dry to a smooth uniform finish free from roughness, grit unevenness and other imperfections.

Ready mixed paid shall be used exactly as received from the manufacturers and according to their instructions and without any admixtures whatsoever.

27.2 Enamel Paints

The enamel paint shall satisfy in general requirements as mentioned in specification of oil paints. Enamel paints shall conform to I.S. 2933-1975.

M-28 FRENCH POLISH:

The French polish of required tint and shade shall be prepared with the below mentioned ingredients and other necessary materials.

i) Denatured spirit of approved quality.
ii) Shellac
iii) Chandras
iv) Pigment

M-29 MARBLE CHIPS FOR MARBLE MOSAIC TERRAZZO:

29.1 The marble chips shall be of approved quality and shade. It shall be hard, sound, dense and homogeneous in texture with crystalline and coarse grains. It shall be uniform in colour and free from stains, cracks, decay and weathering.

29.2 The size of various colours of marble chips ranging from the smallest upto 20 mm. Shall be used where the thickness of top wearing layers is 6 mm. in size. The marble chips of approved quality and colours only as per grading as decided by the quality and colours as decided by the Engineer-in-charge shall be used for marble mosaic tiles or works.

29.3 The marble chips shall be machine crushed. They shall be free from foreign matter, dust etc. Except as above the chips shall conform to I.S. 2114-1962.

M-30 FLOORING TILES:

A Plain Cement tiles:

30.1.1 The plain cement tiles shall be of general purpose type. These are the tiles in the manufacture of which no pigments are used. Cement used in the manufacture of tiles shall be as per Indian Standards.

30.1.2 The tiles shall be manufactured from a mixture of cement and natural aggregates by pressure process. During manufacture, the tiles shall be subjected to a pressure of not less than 140 kg/sq.cm. The proportion of cement to aggregate in the backing of the tiles shall be not leaner than 1:3 by weight. The wearing face, though the tiles are of plain cement, shall be provided with stone chips of 1 to 2 mm in size. The proportion of cement to the marble chips aggregate in the wearing layer of the tiles shall be three parts of cement to one part of chips by weight. The minimum thickness of wearing layer shall be 3 mm. The colour and texture of wearing layer shall be uniform throughout in face and thickness. On removal from mould, the tiles shall be kept in moist condition continuously atleast for seven days and subsequently, for such long period as would ensure their conformity to requirements of I.S. 1237-1980 requiring resistance to wear and water absorption.

30.1.3 The wearing face of the tiles shall be plain, free from projections, depressions and cracks and shall be reasonably parallel to the back face of the tile. All angles shall be right angle and all edges shall be sharp and true.

30.1.4 The tile sizes shall generally be square shape 24.85 cm. X 24.85 cm. or 25 cm x 25 cm. The thickness of the tiles shall be 20 mm.

30.1.5 The tolerance for length and breadth shall be plus or minus 1 mm. the tolerance on thickness shall be plus 5 mm.

30.1.6 The tiles shall satisfy the tests as regards transverse strength, resistance to wear and water absorption as per I.S. 1237 – 1980.

B Plain Coloured Tiles:

30.2.1 These tiles shall have the same specifications as for plain cement tiles as per (A) above except that they shall have a plain wearing surface wherein pigments are used. They shall conform to I.S. 1237-1980.

30.2.2 The pigment used for colouring cement shall not exceed 10% by weight of cement used in the mix. The pigments, synthetic or otherwise, used for flouring tiles shall have permanent colour and shall not contain materials detrimental to concrete.

30.2.3 The colour of the tiles shall be specified in the item or as directed.

C Marble Mosaic Tiles:

30.2.4 These tiles have the same specifications as per plain cement tiles except the requirements as stated below-

30.2.5 The marble mosaic tiles shall conform to I.S. 1237 – 1980. The wearing face of the tiles shall be mechanically ground and filled. The wearing face of tiles shall be free of projections, depressions and cracks and shall be reasonably parallel to the back face of the tiles. All angles shall be right angles and all edges shall be sharp and true.

30.2.6 The tiles shall be prepared from cement conforming to Indian Standards or coloured Portland cement generally depnding upon the colour of tiles to be used or as directed.

D Chequered Tiles

30.4.1 Chequered tiles shall be plain cement tiles or marble mosaic tiles. The former shall have the same specification as per (A) above and the latter as per marble mosaic tiles as per (C) except as mentioned below.

30.4.2 The tiles shall be of nominal size of 250 mm. x 250 mm. or as specified. The center to center distance of the chequer shall not be less than 25 mm. and not more than 50 mm. The overall thickness of the tile shall be 22 mm.

30.4.3 The grooves in the chequers shall be uniform and straight. The depth of the grooves shall not be less than 3 mm. The chequered tiles shall be plain, coloured or mosaic as specified. The thickness of the upper layer measured from the top of the chequers shall not be less than 6 mm. The tiles shall be given the first grinding with machine before delivery to site.

30.4.4 Tiles shall conform to relevant I.S. 1237-1980.

E Chequered Tiles for Staircases:

30.5.1 The requirements of these tiles shall be the same as chequered tiles as per (D) above except in following respects:

i) the length of a tile including nose shall be 330 mm.
ii) The minimum thickness shall be 28 mm.
iii) The nosing shall have the same wearing layer at the top.
iv) The nosing edge shall be rounded.
v) The front portion of the tile for a minimum length of 75 mm. from and including the nosing shall have grooves running parallel to nosing and at centers not exceeding 25 mm. Beyond that the tiles shall have normal chequered pattern.

M31 ROUGH KOTAH STONE:

31.1 The kotah stones shall be hard, even, sound and regular in shape and generally uniform in colour. The colour of the stone shall generally be green. Brown coloured stones shall not be allowed for use. They shall be without any soft veins, cracks or flaws.

31.2 The size of the stones to be used for flooring shall be of size 600 mm. x 600 mm. and / or size 600 mm. x 450 mm as directed. However, smaller sizes will be allowed to be used to the extent of maintaining the required pattern. Thickness shall be as specified.

31.3 Tolerance of minus 30 mm. on account of chisel dressing of edges shall be permitted for length as well as breadth. Tolerance in thickness shall be plus 3 mm.

31.4 The edges of stones shall be truly chiseled and table rubbed with coarse sand before paving. All angles and edges of the stone shall be true, square and free from chipping and the surface shall be true and plain.

31.5 When machine cut edges are specified, the exposed edges and the edges at joints shall be machine cut. The thickness of the exposed machine cut edges shall be uniform.

M-32 POLISHED KOTAH STONES:

32.1 Polish kotah stone shall have the same specifications as per rough kotah stone except as mentioned below:

The stone shall have machine polished smooth surface. When brought on site, the stones shall be single polished or double polished depending upon its use. The stones for paving shall generally be single polished, the stones to be used for dado, skirting, platforms sink, veneering, sills, steps etc. where machine polishing after the stones are fixed in situ is not possible shall be double polished.

M-33 WHITE GLAZED TILES:

33.1 The tiles shall be of best quality as approved by the Engineering-in-charge. They shall be flat and true to shape. They shall be free from cracks, crazing, spots, chipped edges and corners. The glazing shall be of uniform shade.

33.2 The tiles shall be of nominal size of 150 mm. x 150 mm. unless otherwise specified. The maximum variation from the stated sizes, other than the thickness of tile, shall be plus or minus 1.5 mm. The thickness of the tile shall be 6 mm. except as above the tiles shall conform to I.S. 777-1970.

M-34 GALVANISED IRON PIPES AND FITTINGS:

Galvanized iron pipe shall be of the medium type and of required diameter and shall comply with I.S. 1239-1979. The specified diameter of the pipes shall refer to the inside diameter of the bore. Clamps, screw and all galvanized iron fittings shall be of the standard “R” or equivalent make.

M-35 BIB COCK AND STOP COCK:

35.1 A bib cock is a draw off tap with a horizontal inlet and a free outlet. A stop cock is a valve with a suitable means of connection for insertion in a pipe line for controlling or stopping the flow.

35.2 They shall be of screw down type and or brass chromium plated and of diameter as specified in the description of the item. They shall conform to I.S. 781 – 1977 and they shall be of best Indian make. They shall be polished bright.

35.3 The minimum finished weight of bib cock and stop cock shall be as given below –

Dia.	Bib cock	Stop cock	Dia.	Bib cock	Stop cock
8mm	0.25 kg.	0.25 kg.	15mm	0.40 kg	0.40 kg
10mm	0.30 kg.	0.35 kg.	20mm	0.75 kg.	0.75 kg.

M-36 GUN METAL WHEEL VALVE:

36.1 The gun metal wheel valve shall be of approved quality. These shall be of gun metal fitted with wheel and shall be of gate valve opening full way and of the size as specified. These shall conform to I.S. 778-1971.

M-37 WHITE GLAZED PORCELAIN WASH BASIN:

37.1 Wash basin shall be of white porcelain first quality best Indian make and it shall conform to I.S. 2556 (Part – IV) 1972 and I.S. 771-1979. The size of the wash basin shall be as specified in the item. The wash basin shall be of one piece construction with continued over-flow arrangements. All internal angles shall be designed so as to facilitate cleaning. Wash basin shall have single tap hole or two holes as specified. Each basin shall have a circular waste hole which is either rebated or beveled internally with 65 mm. dia. to top and 10 mm. depth to suit the waste fitting. The necessary stud slot to receive the bracket on the under side of the basin shall be provided. Basin shall have an internal soap holder recess which shall fully drain into the bowl.

37.2 White glazed pedestal of the quality and colour as that of the basin shall be provided where specified in the item. It shall be completely recessed at the back for reception of supply and water pipe. It shall be capable of supporting the basin rigidly and adequately and shall be so designed as to make the height form the floor to top of the rim of basin 750 mm. to 800 mm. as directed.

M-38 CAST IRON PIPES AND FITTINGS:

38.1 All soil, waste, vent and antisyphonage pipes and fittings shall conform to I.S. 1729-1964. the pipes shall have spigot and socket ends with head on spigot end. The pipes and fittings shall be true to shape, smooth, cylindrical their inner and outer surfaces being as nearly as practicable concentric. They shall be sound and nicely cast and shall be free from cracks, laps, pin holes or other imperfections and shall be neatly dressed and carefully fettled.

38.2 The end of pipes and fittings shall be reasonably square to their axis.

38.3 The sand cast iron pipes shall be of the diameter as specified in the description and shall be in length of 1.5 M., 1.8 M. & 2.0 M. including socket ends of the pipe unless shorter length are either specified or required at junction etc. The pipes and fittings shall be supplied without ears unless specified or directed otherwise.

38.4 Tolerances : The standard weights and thickness of pipes shall be as shown in the table below. A tolerance upto minus 10% may however be allowed against these standard weight.

Sr. No	Nominal Dia	Overall Thickness	Weight of Pipe Excluding Ears		
			1.5M.long	1.8M long	2M. long 1
1.	75 mm.	5.0 mm.	12.83 Kg.	16.52 kg.	18.37 kg.
2.	100 mm.	5.0 mm.	18.14 kg.	21.67 kg.	24.15 kg.
3.	150 mm				
4.	250 mm				

A tolerance upto minus 15% in thickness and 20 mm. in length will be allowed. For fittings tolerance in lengths shall be plus 25 mm. and minus 10 mm.

The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions specified for the corresponding sizes of straight pipes. The tolerance in weights and thickness shall be the same as for straight pipes.

M-39 ASBESTOS CEMENT PIPE (A.C. PIPE):

39.1 The asbestos cement pipe of diameter as specified in the description of the item shall conform to I.S. 1926-1980. Special like bends, shoes cowls, etc. shall conform to relevant Indian Standards. The interior of pipe shall have a smooth finish, regular, surface and regular internal diameter. The tolerance in all dimensions shall be as per I.S. 1926- Part-I-1980.

M-40 BITUMEN FELT FOR WATER PROOFING AND DAMP PROOFING:

40.1 Bitumen felt shall be on the Hessian bases and shall be of type 3, self finished felt grader and shall conform to I.S. 1322-1970.

M-41 SELECTED EARTH:

41.1 The selected earth shall be that obtained from excavated material or shall have to be brought from outside as indicated in the item. If item does not indicate anything, the selected earth shall have to be brought from outside.

41.2 The selected earth shall be good yellow soil and shall be got approved from the Engineer-in-charge. In no case black cotton soil or similar expansive and shrinkable soil shall be used. It shall be clean and free from all rubbish and perishable materials, stones or brick bats. The clods shall be broken to a size of 50 mm. or less. Contractor shall make his own arrangements at his own costs for land for borrowing selected earth. The stacking of materials shall be done as directed by the Engineer-in-charge in such a way as not to interfere with any constructional activities and in proper stacks.

41.3 When excavated material is to be used, only selected, stuff got approved from the Engineer-in-charge shall be used. It shall be stacked separately and shall comply with all the requirements of selected earth mentioned above.

M-42 MARBLE SLAB:

Marble slabs shall be white or of other colour and of best quality as approved by the Engineer-in-charge. Slab shall be bard, close, uniform and in texture. They shall also be free of defects and cracks. The surface shall be machine polished to an even and perfectly plane surface and the edges machine cut true and square. The rear face shall be rough enough to provide key for the mortar.

Marble slabs with natural veins, if selected shall have to be laid as per the pattern given by the Engineer-in-charge. Size of the slabs shall be minimum 450 mm x 450 mm. and preferably 600 mm x 600 mm. However, smaller sizes will be allowed to be used to the extent of maintaining required pattern.

The slab shall not be thinner than the specified thickness at its thinnest part. A few specimen of finished to be used shall be deposited by the Contractor in the office for reference.

Except as above, the marble slabs shall conform to I.S. 1130 –1969 or as revised from time to time.

M-43 INDIAN TYPE WATER CLOSET:

The Indian type white glazed water closet of first class quality, size as specified in the item and conforming to I.S. 771-1979 and I.S. 2556- (Part-II) – 1981. Each pan shall have integral flushing ring of suitable type with adequate number of holes all around as directed to have satisfactory flushing. It shall also have an inlet at back of front for connecting flush pipe as directed. The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth. Pan

shall be provide with 100 mm. diameter “p” or “S” trap with approximately 50 mm. water seal and 50 mm. diameter vent horn.
FOOT RESTS:
A pair of white glazed earthen ware rectangular foot rests of minimum size 250 mm x 130 mm. shall be provided with the water closet.

M-44 GLAZED EARTHEN WARE SINK:

The glazed earthenware sink shall be of specified size, colour and quality. The sink shall conform to I.S. 771- Part-II-1979. The brackets for sinks shall conform to I.S. 775-1970. The pipes shall conform to I.S. 1239- Part-I-1973 and I.S. 404-1962 for steel and lead pipes respectively. 32 mm brass waste coupling of standard pattern with brass chain and rubber plug shall be provided with sink.

M-45 GLAZED EARTHEN WARE LIPPED TYPE FLAT BACK URINAL / CORNER TYPE URINAL.

The lipped type urinal shall be flat back or corner type as specified in the item and shall conform to I.S. 771-1979.
It shall be of best Indian make and size as specified and approved by the Engineer-in-charge. The flat back or corner type urinal must be of first class quality, free from any defects, cracks etc.

M-46 FLUSH COCK:

Half turn flush cock (heavy weight) shall be of gun metal chromium plated of diameter as specified in the description of the item. The flush cock shall conform to relevant Indian Standards.

M-47 NAHNI TRAP:

Nahni trap shall be of cast iron and shall be sound and free from porosity or other defects which affect serviceability. The thickness of the base metal shall not be less than 6.5 mm. The surface shall be smooth and free form crack, chips and other flaws or any other kind of defects which affect serviceability. The size of nahni trap shall be as specified and shall be of self cleansing design.
The nahni trap shall be of quality approved by the Engineer-in=charge and shall generally conform to the relevant Indian Standards.
The nahni trap provided shall be with deep seal, minimum 50 mm. except at places where trap with deep seal can not be accommodated. The cover shall be cast iron, Perforated cover shall be provided on the trap of appropriate size.

M-48 GULLY TRAP:

Gully trap shall conform to I.S. 651-1960. It shall be sound, free from defects such as fire cracks or hair cracks. The glaze of the traps shall be free from crazing.
They shall give a sharp clear note when struck with light hammer. There shall be no broken blisters.
The size of the gully trap shall be as specified in the item.
Each qully trap shall have one C.I. grating of square size corresponding to the dimensions, of inlet of gully trap. It will also have a water tight C.I. cover with frame inside dimensions 300 mm x 300 mm. The cover weighing not less than 4,53 Kg. and the frame not less than 2.72 Kg. The grating cover and frame shall be of sound and good casting and shall have truly square machined seating faces.

M-49 GLAZED STONE WARE PIPE AND FITTINGS:

The pipes and fittings shall be of best quality as approved by the Engineer-in-charge. The pipe shall be of best quality manufactured from stone-ware of fire clay, salt glazed thoroughly burnt throughout the whole thickness, of a close even texture, free from air blows, fire blisters, cracks and other imperfections, which affect the serviceability. The inner and outer surfaces shall be smooth and perfectly glazed. The pipe shall be capable to withstand pressure of 1.5 m. lead without showing signs of leakage. The thickness of the wall shall not be less than $1/12^{th}$ of the internal dia. The depth of socket shall not be less than 38 mm. The socket shall be sufficiently large to allow a joint of 6 mm. around the pipe. The pipes shall generally conform to relevant I.S. 651-1980.

M-50 CRYDON BALL VALVE:

Ball valve of screwed type including polythene float and necessary lever etc. shall be of the size as mentioned in the description of item and shall conform to I.S. 1703-1977.

M-51 CRACKSEAL:

Crackseal manufactured by Chemistic / Chemisol Indian Ltd., is an acrylic base ready application compound.

M-52 COLOURED CEMENT

52.1 Coloured cement shall be with white or gray Portland cement as specified in the item of the work.

52.2 The pigments used for coloured cement shall be of approved quality and shell not exceed 10% of cement used in the mix. The mixture of pigments and cement has such properties as to provide for durability under exposure to sunlight and weather.

M-53 STONE DUST:

53.1 This shall be obtained from crushing hard black tray or equivalent, it shall not contain more than 8% of silt as determined by field test with measuring cylinder. The method of determining silt contents by field test is given as under:

53.2.1 A sample of stone dust to be tested shall be placed without drying in 200 mm measuring cylinder. The quantity of the sample shall be such that it fills the cylinder upto 100-mm mark. Clean water shall be added upto 150 mm mark. The mixture shall be stirred vigorously and the content allowed to settle for 3 hours.

53.3 The height of silt visible as settled layer above the stone dust shall be expressed as percentage of the height of the stone dust below. The stone dust containing more than 8% silt shall be washed so as to bring the silt content within the allowable limit.

53.4 The fineness modulus of stone dust shall not be less than 1.80.

M-54 CINDER:

54.1 Cinder is well burnt furnace residue which has been fused or sintered into lumps of varying sizes.

54.2 Cinder aggregates shall be well burnt furnace residue obtained from furnace using coal fuel only. It shall be sound clean and free clay, dirt, ash or other deleterious matter.

54.3 The average grading for cinder aggregates shall be as mentioned below.

20 mm	100
10 mm	86
5.75 mm	70
2.36mm	52

M-55 GALVANIZED IRON SHEETS:

55.1 The galvanized iron sheets shall be plain or corrugated sheets of gauge as specified in item. The G.I. sheets shall conform to IS: 277-1977. The sheets shall be undamaged in carriage and handling either by rubbing off of zinc coating or otherwise. They shall have clean and bright surface and shall be free from dents, bends, holes, rust or white powdery deposit.

55.2 The length and width of G.I. sheets shall be as directed as per site condition.

M55-A G.I. VALLEYS GUTTER, RIDGES:

55-A.1 The G.I. ridges and hips shall be of plain galvanized sheet class-3 of the thickness as specified in item. These shall be 600-mm width and properly bent up to shape without damage to the sheets in process of bending.

55-A.2 Valley gutters and flashing shall be also of galvanized sheet of thickness as specified in item. Valleys shall be 900 mm wide over all and flashing shall be 380 mm, wide over all. They shall be bent to the required shape without damage to the sheet in the process of bending.

M-56 ALUMINIUM DOORS, WINDOWS, VENTILATORS:

56.1 Aluminium alloy used in the manufacture of extruded window sections shall conform to IS designation HEA-WP of IS:733-1975 and also to IS:Designation WVG-WP OF IS: 1285-1975. The sections shall be as specified in the drawing and design. The fabrication shall be done as directed.

56.2 The hinges shall be cast or excluded aluminium hinges of same type as in window but of large size.

56.3 The hinges shall normally be of 50 mm projecting types non-projecting type of hinges may also be used if directed. The handles of door shall be of specified design. A suitable lock for the door operable either from outside shall be provided. In double shutter door, the first closing shall have a concealed aluminium alloy bolt at top and bottom.

M-57 PLYWOOD

57.1 The plywood for general purpose shall conform to IS:303-1975. Plywood is made by cementing together thin boards or sheets of wood into panels. There are always an odd number of layers 3,5,7,9 ply etc. The piles are placed so that the grain of each layer is at right angles to the grain in the adjacent layers.

57.2 The chief advantage of plywood over a single board of the same thickness is the more uniform strength of the plywood along the length and width of the plywood and greater resistance to cracking and slitting with change in moisture content.

57.3 Usually synthetic resins are used for gluing. Phenolic resins are usually cured in a hot press which compresses and simultaneously heats the piles between hot plates which maintain a temperature of 90 – degree C. to 140 degree C. and a pressure of 11 to 14 kg./sq.cm. on the wood. The time of heating may be any thing from 2 to 60 minutes depending upon thickness.

57.4 When water glue are used the wood absorbs so much water that the finished plywood must be dried carefully. When synthetic resins are used as adhesive, the finished plywood must be exposed to atmosphere of controlled humidity until the proper amount of moisture has been absorbed.

57.5 According to IS:303-1975 the plywood for general purpose shall be of three grades namely BWR, WWR and CWR depending upon the adhesives used for bonding the veneers and it will be further classified into six types namely AA, AB, AC, BB, BC and CC based on the quality of the two faces, each being of three kinds namely A, B and C. After pressing, the finished plywood should be reconditioned to a moisture content not less than 8 percent and not more than 16 percent.

57.6 THICKNESS OF PLYWOOD BOARDS

Board	**Thickness**
3 ply	3mm
	4mm
	5mm
	6mm
5 ply	5mm
	6mm
	8mm
	9mm
7 ply	9mm
	13mm
	16mm
9 ply	13mm
	16mm
	19mm
11 ply	19mm
	22mm
	25mm

M-58 FLUSH COCK:

Half turn flush cock (heavy weight) shall be of gun metal chromium plated of diameter as specified in the description of the item. The flush cock shall conform to relevant Indian Standards.

HYDRAULIC ENGINEER
VADODARA MUNICIPAL CORPORATION.

SIGNATURE AND SEAL OF THE CONTRACTOR:

NAME AND ADDRESS:

DATE:

6.20.5
DETAILED TECHNICAL SPECIFICATIONS FOR RCC ESR (3 NOS.), RCC GSR (2 NOS.), PUMP HOUSE (2 NOS.) AND OFFICE BUILDING

6.20.5 DETAILED TECHNICAL SPECIFICATIONS OF RCC ESR (3 NOS.), GSR (2 NOS.) AND PUMP HOUSE (3 NOS)

CONCRETE & ALLIED WORKS

1 SCOPE

This Specification covers the general requirements for ready mixed concrete and for concrete using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing, transporting, placing, curing, protecting, repairing, finishing and testing of concrete; formwork; requirements in regard to the quality, storage, bending and fixing of reinforcement; grouting as well as mode of measurement and payment for completed works.

It shall be very clearly understood that the specifications given herein are brief and do not cover minute details. However, all works shall have to be carried out in accordance with the relevant standards and codes of practices or in their absence in accordance with the best accepted current engineering practices or as directed by ENGINEER from time to time. The decision of ENGINEER as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on CONTRACTOR and no claim whatsoever will be entertained on this account.

2 APPLICABLE CODES AND SPECIFICATIONS

The following specifications, standards and codes, including all official amendments/revisions and other specifications & codes referred to therein, should be considered a part of this specification. In all cases the latest issue/edition/revision shall apply. In case of discrepancy between this specification and those referred to herein below or other specifications forming a part of this bid document, this specification shall govern.

2.1 MATERIALS

IS:269	Specification for 33 grade ordinary portland cement.
IS:455	Specification for Portland slag cement.
IS:1489	Specification for Portland pozzolana cement(Parts 1 & 2)
IS:8112	Specification for 43 grade ordinary portland cement.
IS:12330	Specification for sulphate resisting Portland Cement.
IS:383	Specification for coarse and fine aggregates from natural sources for concrete.
IS:432	Specification for mild steel and medium tensile (Parts steel bars and hard drawn steel wires for 1 & 2) concrete reinforcement.
IS:1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
IS:1566	Specification for hard drawn steel wire fabric for (Parts II) concrete reinforcement.

IS:9103	Specification for admixtures for concrete.
IS:2645	Specification for integral cement waterproofing compounds.
IS:4900	Specification for plywood for concrete shuttering work.
IS:4926	Ready mixed concrete
IS:12269	Specification for 53 grade ordinary portland cement.
IS:8041	Specification for rapid hardening cement.
IS:12600	Specification for low heat cement.
IS:6909	Specification for supersulphated cement.
IS:12089	Specification for granulated ground blast furnace slag.
BS:6699	Specification for granulated ground blast furnace slag.
BS:6073	Specifications for precast concrete masonry units (Part 1) Methods for specifying precast concrete masonry (Part 2)

2.2 MATERIAL TESTING

IS:4031	Methods of physical tests for hydraulic cement. (Parts 1 to 15)
IS:4032	Method of chemical analysis of hydraulic cement.
IS:650	Specification for standard sand for testing of cement.
IS:2430	Methods for sampling of aggregates for concrete.
IS:2386	Methods of test for aggregates for concrete (Parts 1 to 8)
IS:3025	Methods of sampling and test (physical and chemical) water used in industry.(Part 1 to 51)
IS:6925	Methods of test for determination of water soluble chlorides in concrete admixtures.

2.3 MATERIAL STORAGE

IS:4082	Recommendations on stacking and storing of construction materials at site.

2.4 CONCRETE MIX DESIGN

IS:10262	Recommended guidelines for Concrete Mix Design.
SP:23	Handbook on Concrete Mixes.

2.5 CONCRETE TESTING

IS:1199	Method of sampling and analysis of concrete.
IS:516	Method of test for strength of concrete.
IS:9013	Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
IS:8142	Method of test for determining setting time of concrete by penetration resistance.
IS:9284	Method of test for abrasion resistance of concrete.
IS:2770	Methods of testing bond in reinforced concrete.

2.6 EQUIPMENT

IS:1791	Specification for batch type concrete mixers.
IS:2438	Specification for roller pan mixer.
IS:4925	Specification for concrete batching and mixing plant.
IS:5892	Specification for concrete transit mixer and agitator.
IS:7242	Specification for concrete spreaders.
IS:2505	General Requirements for concrete vibrators: Immersion type.
IS:2506	General Requirements for screed board concrete vibrators.
IS:2514	Specification for concrete vibrating tables.
IS:3366	Specification for pan vibrators.
IS:4656	Specification for form vibrators for concrete.
IS:11993	Code of practice for use of screed board concrete vibrators.
IS:7251	Specification for concrete finishers.
IS:2722	Specification for portable swing weigh batchers for concrete (single and double bucket type).
IS:2750	Specifications for steel scaffoldings.

2.7 CODES OF PRACTICE

IS:456	Code of practice for plain and reinforced concrete.
IS:457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
IS:3370	Code of practice for concrete structures for storage of liquids (Parts 1 to 4)

IS:3935	Code of practice for composite construction.
IS:2204	Code of practice for construction of reinforced concrete shell roof.
IS:2210	Criteria for the design of reinforced concrete shell structures and folded plates.
IS:2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS:5525	Recommendation for detailing of reinforcement in reinforced concrete works.
IS:2751	Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
IS:9417	Specification for welding cold worked bars for reinforced concrete construction.
IS:3558	Code of practice for use of immersion vibrators for consolidating concrete.
IS:3414	Code of practice for design and installation of joints in buildings.
IS:4326	Code of practice for earthquake resistant design and construction of buildings.
IS:4014	Code of practice for steel tubular scaffolding. (Parts 1 & 2)
IS:2571	Code of practice for laying in situ cement concrete flooring
IS:7861	Part1 - Recommended practice for hot weather concreting Part2 – Recommended practice for cold weather concreting
IS:3370	Code of practice for concrete structures for the storage of liquid (Part I to IV)

2.8 CONSTRUCTION SAFETY

IS:3696	Safety code for scaffolds and ladders.(Parts 1 & 2)
IS:7969	Safety code for handling and storage of building materials.
IS:8989	Safety code for erection of concrete framed structures.

2.9 MEASUREMENT

IS:1200 (Part 1 to 12)	Method of measurement of building and engineering works (Part 2 and 5)

3 GENERAL

ENGINEER shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and ENGINEER's approval obtained, prior to starting of concrete work. This shall, however, not relieve CONTRACTOR of any of his responsibilities. All materials, which do not conform to this specification, shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/standards shall only be used. Other materials may be used after approval of the ENGINEER and after establishing their performance suitability based on previous data, experience or tests.

4 MATERIALS

4.1 CEMENT

Unless otherwise specified or called for by ENGINEER/OWNER, cement shall be ordinary Portland cement conforming to IS: 269, IS: 8112 or IS: 12269.

The Portland pozzolana cement shall conform to IS: 1489 and it shall be used as directed by ENGINEER. Where Portland pozzolana or slag cements are used, it shall be ensured that consistency of quality is maintained and there will be no adverse interactions between the materials and the finish specified is not marred.

Only one type of cement shall be used in any one mix unless specifically approved by ENGINEER. The source of supply, type or brand of cement within the same structure or portion thereof shall be approved from ENGINEER prior to its use.

Cement, which is not used within 90 days from its date of manufacture, shall be tested at a laboratory approved by ENGINEER and until the results of such tests are found satisfactory, it shall not be used in any work.

4.2 AGGREGATES

Aggregates shall consist of naturally occurring stones and gravel (crushed or uncrushed) and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/organic impurities/deleterious materials and conform to IS: 383. Aggregates such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used.

Aggregates shall be washed and screened before use where necessary or if directed by the ENGINEER.

Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse affect on strength, durability and finish, including long term effects, on the concrete.

The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2. If use of sand having fineness modulus more than 3.2 is unavoidable then it shall be suitable blended with crusher stone dust.

The maximum size of coarse aggregate shall be as stated on the drawings, but in no case greater than 1/4 of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. For most work 20mm aggregate is suitable. Where there is no restriction to the flow of concrete into sections, 40mm or larger size is permitted.

In concrete elements with thin sections, closely spaced reinforcements or small cover, consideration should be given to the use of 10mm nominal maximum size.

Plums 160 mm and above of a reasonable size may be used where directed. Plums shall not constitute more than 20% by volume of concrete unless specified by ENGINEER.

4.3 WATER

Water used for both mixing and curing shall conform to IS:456. Potable water is generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.

The pH value of water shall not be less than 6.

Seawater shall not be used for concrete mixing and curing.

The proposed admixtures shall comply with requirements of TCE.M4-403-02.

4.4 REINFORCEMENT

Reinforcement bars shall conform to IS:432 and/ or IS:1786 and welded wire fabric to IS:1566 as shown on the drawing.

All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill scales, rust, dirt, dust or any other substance that will destroy or reduce bond.

Special precaution like coating of reinforcement may be provided with the prior approval of ENGINEER.

4.5 WASTAGE

Wastage allowance for cement and steel (supplied by OWNER) shall be as specified under Instruction to Bidders.

4.6 SAMPLES AND TESTS

All materials used for the works shall be tested before use. The frequency of such confirmatory tests shall be decided by ENGINEER.

Manufacturer's test certificate shall be furnished for each batch of cement/steel and when directed by ENGINEER samples shall also be got tested by the CONTRACTOR in a laboratory approved by ENGINEER at no extra cost to OWNER. However, where material is supplied by OWNER, all testing charges shall be borne by OWNER, but transportation and preparation of material samples for the laboratory shall be done by CONTRACTOR at no extra cost.

Sampling and testing of aggregates shall be as per IS:2386 under the supervision of ENGINEER. The cost of all tests, sampling, etc. shall be borne by CONTRACTOR. For coarse aggregate crushing value shall be tested.

Water to be used shall be tested to comply with clause 5.4 of IS:456.

CONTRACTOR shall furnish manufacturer's test certificates and technical literature for the admixture proposed to be used. If directed, the admixture shall be got tested at an approved laboratory at no extra cost.

4.7 STORING OF MATERIALS

All material shall be stored in a manner so as to prevent its deterioration and contamination, which would preclude its use in the works. Requirements of IS:4082 shall be complied with.

CONTRACTOR will have to make his own arrangements for the storage of adequate quantity of cement even if cement is supplied by OWNER. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cost of such rejected cement, where cement is supplied by OWNER, shall be recovered at issue rate or open market rate which ever is higher. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15 bags shall be stacked in any tier. Storage arrangement shall be approved by ENGINEER. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt. CONTRACTOR shall maintain record of receipt and consumption of cement.

Each size of coarse and fine aggregates shall be stacked separately and shall be protected from dropping leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.

CONTRACTOR shall make his own arrangements for storing water at site in tanks of approved capacity. The tanks shall be cleaned at least once a week to prevent contamination.

The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground/ water. Each type and size shall be stacked separately.

4.8 CONCRETE

4.8.1. General

Concrete grade shall be as designated on drawings. Concrete in the works shall be “DESIGN MIX CONCRETE” OR “NOMINAL MIX CONCRETE”. All concrete works of upto grade M15 shall be NOMINAL MIX CONCRETE whereas all other grades, M20 and above, shall be DESIGN MIX CONCRETE.

4.8.2. Design Mix Concrete

Design Mix Concrete are classified in three categories, viz. "Normal Concrete (M)", "Heavy Concrete (H)", "Super Heavy Concrete (SH)". Each class of concrete shall be identified by a prefix and two numbers. Prefix "M" would denote Normal Concrete, prefix "H" would denote heavy concrete and prefix "SH" would denote super heavy concrete. The two numbers e.g. 25 - 40 would denote the crushing strength of cube at 28 days in N/sq.mm and maximum size of the coarse aggregates in millimetres respectively.

Normal concrete shall have a net dry unit weight of not less than 25 kN/cum, for the finished structure after curing, Heavy concrete shall have a net dry unit weight of not less than 36.30 kN/cum, for the finished structure after curing and special heavy concrete shall have a net dry unit weight of not less than 41 kN/cum for the finished structure after curing.

4.8.3. Mix Design & Testing

For Design Mix Concrete, the mix shall be designed as per any of four methods given in SP: 23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS: 456. The design mix shall in addition be such that it is cohesive and does not segregate during placement and should result in a dense and durable concrete capable of giving the specified finish. For liquid retaining structures, the mix shall also result in watertight concrete. The CONTRACTOR shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

The minimum grade of concrete shall be as per Table 5 of IS: 456 for various exposure conditions of concrete. For various environmental conditions, refer Table 3 of IS: 456.

The minimum cement content for Design Mix Concrete shall be as per Table 5 of IS: 456 or as given below, whichever is higher.

Grade of Concrete	**Minimum Cement Content in kg/cum. of Concrete**
M 20	300
M 25	320
M 30	340
M 35	360
M 40	360
M 45	400

The minimum cement content stipulated above shall be adopted irrespective of whether the CONTRACTOR achieves the desired strength with less quantity of cement. The CONTRACTOR’s quoted rates for concrete shall provide for the above eventuality and nothing extra shall become payable to the CONTRACTOR on this account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the CONTRACTOR.

It shall be CONTRACTOR’s sole responsibility to carry out the mix designs at his own cost. He shall furnish to ENGINEER for approval at least 30 days before concreting

operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS:516 shall comply with the requirements of IS:456.

Grade of Concrete M	**Minimum Compressive Strength N/Sq.mm at 7 days**	**Specified Characteristic compressive strength N/sq.mm at 28 days**
15	10.0	15.0
20	13.5	20.0
25	17.0	25.0
30	20.0	30.0
35	23.5	35.0
40	27.0	40.0
45	30.0	45.0

A range of slumps recommended for various types of construction, unless otherwise instructed by the ENGINEER, shall be as given below:

Structure/Member	**Slump in millimeters**	
	Maximum	**Minimum**
Reinforced foundation walls and footings	75	25
Plain footings, caissons and substructure walls	75	25
T. G. and massive compressor foundations	50	25
Slabs, Beams and reinforced walls	50	25
Pumps & miscellaneous Equipment Foundations	75	25
Building columns	50	25
Pavements	50	25
Heavy mass construction	50	25
Liquid retaining/ conveying structures	50	25

(NOTE: These values are not meant for pumped concrete placed using slip formed technique.)

Where single size graded coarse aggregate are not available, aggregates of different sizes shall be properly combined. The contractors mix design shall show that combined grading of coarse aggregate meets the requirements of Table 2 of IS: 383 for graded

aggregates.

4.8.4. Batching & Mixing of Concrete

Proportions of aggregates and cement, as per approved concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within ±2% for cement and ±3% for aggregate. The batching equipment shall be calibrated at the frequency decided by ENGINEER.

Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water- cement ratio specified for use by ENGINEER shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional sand and cement to allow for sticking in the drum.

Arrangement should be made by CONTRACTOR to have the cubes tested at his own expense in an approved laboratory or in field with prior consent of ENGINEER. Sampling and testing of strength and workability of concrete shall be as per IS:1199, IS:516 and IS:456.It is preferable to cast additional cubes (minimum 3 specimen) for testing at 7 days and 14 days.

4.9 NOMINAL MIX CONCRETE

4.9.1. Mix Design & Testing

Mix Design and preliminary tests are not necessary for Nominal Mix Concrete. However works tests shall be carried out as per IS:456. Proportions for Nominal Mix Concrete and w/c ratio may be adopted as per Table 9 of IS:456. However, it will be CONTRACTOR's sole responsibility to adopt appropriate nominal mix proportions to achieve the specified characteristic strength.

4.9.2. Batching & Mixing of Concrete

Based on the adopted nominal mixes, aggregates shall be measured by volume. However cement shall be by weight only. Appropriate correction shall be made for bulking of sand after testing.

4.10 READY MIXED CONCRETE

All specification as per IS:4926 – "Specification for ready mixed concrete" shall be used.

The Contractor shall identify at least two sources of ready mix concrete supplier and get it approved by ENGINEER prior to start of the Works. Any change in the source of the RMC, shall be got approved by the ENGINEER.

The design mix prepared by the RMC supplier shall be the responsibility of the Contractor. The testing of concrete as per Codal provisions and the specifications shall be done by the Contractor same as the normal concreting works.

4.11 PRECAST CONCRETE

4.11.1. General

Precast concrete shall comply with the preceding Sections relating to Concrete as far as they are applicable. Precast concrete blocks shall comply with the requirements and recommendations of BS 6073.

4.11.2. Precasting bed

All precast units shall be cast on, or their shutters supported from a suitably prepared level unyielding paved area.

4.11.3. Marking

All units shall be suitably marked in a clean and legible manner with a reference number and the date of casting, which information shall be clearly visible when units are stacked. Reinforced precast members shall be clearly marked to indicate the upper face.

4.11.4. Formwork

The formwork shall be either steel or lined with steel, waterproof / laminated board or such other material as directed and approved by the ENGINEER. Forms shall be strongly constructed, closely jointed and smooth and shall be such as to ensure true sharp arises and a perfect surface. Forms shall be so designed that they can be taken apart and reassembled readily.

4.11.5. Casting tolerance

The casting tolerance, unless otherwise ordered or directed, shall be within +3mm of true dimensions.

4.11.6. Striking forms

The method and time of striking the side shutters after casting the units will normally be left to the discretion of the CONTRACTOR, but the ENGINEER may specify minimum time in which case the CONTRACTOR must comply with the ENGINEER'S directions. In the event of any damage resulting from premature removal of shutters, or from any other cause, the unit will be liable to rejection and replacement by the Contractor at his own cost, whether the Engineer has specified a minimum striking time or not.

4.11.7. Lifting, stacking and removal

Precast units shall not be lifted, transported or used in the Works until they are sufficiently mature. The crushing tests on the test cubes, which are to be kept along with relevant the precast units, will be used to assess the maturity of the units.

Lifting, stacking and removal of precast units shall be undertaken without causing shock, vibration or undue stress to or in the units. The CONTRACTOR shall satisfy the ENGINEER that the methods he proposes for lifting, transporting and setting precast units will not overstress or damage the units in any way. In the event of overstress or damage due to whatever cause, the unit or units concerned will be liable to rejection. Rejected units shall be immediately broken up and removed from the site. The CONTRACTOR shall replace such rejected units at his own cost.

4.11.8. Curing

The top and sides of all precast units shall be kept covered constantly and in a damp condition with clean, potable fresh water for at least seven days after casting or for such further period as the ENGINEER may direct. It is preferable to have a curing pond for this purpose.

4.11.9. Precasting records

Complete records shall be maintained of all precast work. Every unit shall have a reference number, date of casting, date of removal from bed and date and position of placing shall be recorded together with corresponding test cube reference number and results.

CONTRACTOR shall submit a method statement to ENGINEER for approval, furnishing details of each stage of operation.

4.12 FORMWORK

Formwork shall be all inclusive and shall consist of but not limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs, etc. including ties, anchors, hangers, inserts, false work, wedges, etc.

The design and engineering of the formwork as well as its construction shall be the responsibility of CONTRACTOR. However, if so directed by ENGINEER, the drawings and calculations for the design of the formwork shall be submitted to ENGINEER for approval.

Formwork shall be designed to fulfil the following requirements:

Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.

Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.

Capable of withstanding without deflection the worst combination of selfweight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.

Capable of easily striking without shock, disturbance or damage to the concrete

Soffit forms capable of imparting a camber if required.

Soffit forms and supports capable of being left in position if required.

Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

The formwork may be of lined timber, waterproof / plastic coated plywood, steel, plastic depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of ENGINEER. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structure shall be sufficiently tight to prevent loss of slurry from concrete using foam and rubber seals.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces, dust etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of ENGINEER. CONTRACTOR shall equip himself with enough quantity of shuttering to allow for wastage so as to complete the job in time.

Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves may be used. Formwork spacers left in situ shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

For liquid retaining structures sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

Where specified or shown on drawings all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size.

Forms for substructure may be omitted when, in the opinion of ENGINEER, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavation shall be slightly larger, as directed by ENGINEER, than that required as per drawing to compensate for irregularities in excavation.

CONTRACTOR shall provide adequate props of adjustable steel pipes carried down to a firm bearing without overloading any of the structures.

The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.5 m or as directed by ENGINEER. CONTRACTOR shall temporarily and securely fix items to be cast (embedment/inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

Formwork showing excessive distortion, during any stage of construction, shall be removed. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at CONTRACTOR's cost.

The striking time for formwork shall be determined based on the following requirements:

a) Development of adequate concrete strength;

b) Permissible deflection at time of striking form work;

c) Curing procedure employed - its efficiency and effectiveness;

d) Subsequent surface treatment to be done;

e) Prevention of thermal cracking at re-entrant angles;

f) Ambient temperatures; and Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

Before removing formwork of soffit of slabs/ beams compressive strength at 7/14/21 days shall be checked.

Under normal circumstances (generally where temperatures are above 20 Deg. C) forms may be struck after expiry of the period given in IS: 456 unless directed otherwise by ENGINEER. For Portland Pozzolona/slag cement the stripping time shall be suitably modified as directed by the ENGINEER. It is the CONTRACTOR's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resists surface damage and any stresses arising during the construction period.

4.13 REINFORCEMENT FABRICATION AND PLACEMENT

Reinforcing bars supplied in the form of bent coils shall be straightened cold without damage at no extra cost. No bending shall be done when ambient temperature is below 5 Deg.C. Suitable preheating may be permitted if steel bar bending is to be done at below 0 Deg.C. Bars supplied in bent coils shall be straightened only by machine.

All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as directed by ENGINEER. Bar bending machines shall be used to achieve desired accuracy.

Re-bending or straightening incorrectly bent bars shall not be done without approval of ENGINEER.

Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire, etc. to prevent displacement during placing and compaction of concrete. The tied inplace reinforcement shall be approved by ENGINEER prior to concrete placement. Spacers (PVC or Concrete) shall be of such material and design as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.

Binding wire shall be 16 gauge soft annealed wire. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.

Substitution of reinforcement, laps/splices not shown on drawing shall be proposed by CONTRACTOR and approved by ENGINEER.

If permitted by ENGINEER, welding of reinforcement shall be done in accordance with IS: 2751, IS: 9417 and SP: 34 as applicable.

Tolerance on placement of reinforcement shall be as per Cl. 12.3 of IS: 456.

4.14 TOLERANCES

Tolerance for formed and concrete dimensions shall be as per IS: 456 and/ or ACI-117-90, ACI-347 unless specified otherwise.

Tolerance specified for horizontal or vertical building lines or footings shall not be construed to permit encroachment beyond the legal boundaries.

Tolerance for top of concrete of equipments and structural steel foundations shall be as under:

a) Where grout thickness is less than or equal to 25mm: +5mm and –10mm.

b) Where grout thickness is more than 25mm: ±15mm.

4.15 PREPARATION PRIOR TO CONCRETE PLACEMENT

Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

All arrangements-formwork, equipment and proposed procedure, shall be approved by ENGINEER. CONTRACTOR shall maintain separate Pour Card for each pour as per the format enclosed.

4.16 TRANSPORTING, PLACING AND COMPACTING CONCRETE

Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.

In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms, CONTRACTOR shall provide suitable drops and “Elephant Trunks”. Concrete shall not be dropped form a height of more than 1.5 m.

Concrete shall not be placed in flowing water. Under water concrete shall be placed in position by tremie or by pipeline from the mixer and shall never be allowed to fall freely through the water.

While placing concrete the CONTRACTOR shall proceed as specified below and also ensure the following:

a) Continuously between construction joints and predetermined abutments.

b) Without disturbance to forms or reinforcement.

c) Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits, etc.

d) Without dropping in a manner that could cause segregation or shock.

e) In deep pours only when the concrete and formwork is designed for this purpose and by using suitable chutes or pipes.

f) Do not place if the workability is such that full compaction cannot be achieved.

g) Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations, withdraw the linings progressively as concrete is placed.

h) If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.

i) Ensure that there is no damage or displacement to sheet membranes.

j) Record the time and location of placing structural concrete.

Concrete shall normally be compacted in its final position within thirty minutes (Initial setting time) of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids, thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set. Over-vibration leads to segregation and shall be avoided.

Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by ENGINEER. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

CONTRACTOR shall submit a method statement to ENGINEER for approval, furnishing details of pour sequence, thickness of each layer, mixing and conveying equipments proposed etc. preferably with a sketch.

Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as determined by ENGINEER. Concrete shall be protected against damage until final acceptance.

4.17 ADMIXTURES

The use of poor aggregate grading or aggregate with continuous change in overall grading of the 'combinations' during concreting operation will make special admixtures quite useful in overcoming the main difficulty like blockage in pumping. These admixtures shall be incorporated in pumpable concrete to aim the following.

- Increase in the range of mix designs which may be successfully pumped using water reducing admixtures/Super plasticizers with the approval of the Engineer.
- Reducing the risk of pipeline blockages by preventing segregation of concrete mix.
- To have satisfactory/specified performance both in fresh and hardened state.

Any admixture that increases workability in normal weight concrete may usually improve pumpability. The choice of type of admixture and the advantage gained from its use in concrete to be pumped will depend on the characteristics of the pump mix and will be finally decided by the Engineer in consultation with the admixture manufacturer.

For improvement of pumpability the following admixtures are generally recommended. Such admixtures used shall conform to ASTM C-494/IS 9103.

a) Water Reducing Admixtures/Super Plasticizers

These cause reduction in water requirements at constant slump or an increase in slump at constant water-cement ratio. They can be designed to have no apparent effect on setting time, or alternately to achieve varying degrees of acceleration or retardation in rate of hardening of the mixture. Most water reducing admixtures increase the pumpabillity of the concrete mix through plasticising action.

b) Air Entraining Admixtures

Air entrained concrete is considerably plastic and more workable than non air entrained concrete. It can be pumped with less coarse aggregate segregation and has fewer tendencies for concrete to bleed. Start-up after shut down is also generally easier due to reduced bleeding. For pumped concrete these limits shall be obtained at the point of placement in the structure. To compensate for air content loss in the air entrained concrete higher entrainment of air may be required at the batching plant. The required adjustment of admixture dose shall be carried out by the Engineer after carrying out necessary air loss tests. An air content in the range of 3 to 5 % shall be preferred as higher ranges reduces the delivery capacity of pump systems due to increased compressibility of the concrete and also reduces strength of concrete.

If air-entraining plasticizer is used, typically 13 % minimum water reduction is possible. Therefore, strength loss due to air entrainment will be compensated by using such air-entraining plasticizer.

c) Finely Divided Mineral Admixtures

Contractor, if specifically approved by the engineer, can use mineral admixture. In concrete mixtures, deficient in fines, the addition of a finely divided inert mineral admixture generally improves workability, pumpability, reduces the amount of bleeding and increases the strength. The effect on strength depends on the type of mineral admixture used, conditions under which the concrete is cured, and the amount of admixture used. Water soluble polymers obtained from cellulose derivations may also be used as an admixture with a small dose of 60 to 150 gms/cu.m to increase viscosity of the mixing water and reduce the frictional resistance to flow and bleeding in the pipe system.

4.18 TRIAL MIXES

The trial mixes for pumping shall be prepared and tested in the Site laboratory by contractor in accordance with clause 4.19 of this specification. The ingredients, particularly the coarse and fine aggregates shall also be checked for the conformance to the desired properties described, by the contractor. Table –10 may be used to select the volume of coarse aggregate per cu. m. of concrete. In using this table it is recommended that the highest probable fineness modulus of sand be used rather than the average fineness modulus to ensure consistent performance during pumping. For additional plasticity, 10 % reduction in coarse aggregate quantities shall be considered. Experience with the use of local aggregate and their uniformity shall also be considered in the proportioning concepts.

4.19 MIX DESIGN FOR PUMPABLE CONCRETE

Taking the above factors into account, the concrete shall first be designed for normal placement conditions and then modified as necessary to suit pumping. The following procedure shall be adopted:

a) Design the mix for specified characteristic strength and workability.

b) Check and ensure combined grading of aggregates i.e. as uniform grading as possible. This requirement is vital as gaps or partial gaps are the basic reasons for poor water retention property and segregation under pressure.

c) Determine the optimum sand content for the required workability and increase sand content by reducing volume of coarse aggregate per unit volume of concrete by about 10 % as a degree of protection against under sanding due to batch variations.

d) Recheck the minimum cement content for durability.

e) Examine the total fines content i.e. cement and fine aggregates passing through 300 micron sieve and readjust the mix, if necessary. A very rich mix with fine sand will be as problematic as coarse sand with lean mix.

f) Re-appraise the grading if the particle shape of any particular fraction is such as may cause excessive voids. Re-adjust as required, if necessary examining the void ratio of various combinations, using void meter to achieve minimum voids at the expense of 'sufficient fines' content.

g) If dissatisfied with (a) to (f) as above, consider what remedial action may be taken to overcome the troublesome factor. For example, the following two situations may occur :

h) If the sand has more coarser fraction it is worth considering the addition of a proportion of finer sand, or alternately if the sand has finer fraction, the addition of coarse fraction may be considered. Addition or reduction of cement may help, but the correct solution is to overcome the gap in overall grading as stated above.

i) In a 20 mm aggregate max size, if there is an excess of 10 to 4.75 mm fraction, and this fraction is flaky with unduly large surface area, either increase the sand content to reduce the possibility of segregation and to reduce the inter-practical stresses, or (better) re-grade using single sized aggregates.

j) At the trial mix stage small variations can be made preferably in the light of the pressures registered and observed performances through the pump. In certain cases admixtures may be economically and beneficially used to improve or eliminate circumstances that cannot readily be overcome by other means

4.20 MASS CONCRETE WORKS

Sequence of pouring for mass concrete works shall be as approved by ENGINEER. CONTRACTOR shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

4.28.1. Placing temperature of concrete

Placing temperature of concrete should be maintained as specified in Bill of Quantities or as directed by ENGINEER, to avoid shrinkage cracking

Mixing water shall be kept cool by storing it under cover. Chilled water or crushed ice as part of the mixing water to achieve the specified placing temperature shall be used. For chilled water, it is recommended that the contractor install and maintain refrigeration facility of required capacity. The contractor shall also build and maintain well insulated adequate capacity storage tank for cold water with insulated connected piping. To supplement this refrigeration facility, the contractor will have to have ice plant or use commercial ice subject to approval of the ENGINEER. The full quantity of crushed ice shall be stored in cold storage 24 hours in advance of the start of concreting. The temperature in cold storage shall not be more than –2oc. The contractor should study the placing temperature condition and work out plant capacity commenVadodarae with the construction schedule requirements and submit his scheme along with the tender.

Ice when used as replacement for a portion or all the mixing water shall be produced from water which meets the requirements of clause 4.3. Ice when used shall be in flakes of size 3mm or below or crushed condition and the crushed ice shall be such as to pass completely, 10mm sieve.

4.28.2. Curing

Curing and protection shall start immediately after the compaction of the concrete to protect it from:

a) Premature drying out, particularly by solar radiation and wind;

b) leaching out by rain and flowing water;

c) rapid cooling during the first few days after placing;

d) high internal thermal gradients;

e) low temperature or frost;

f) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

All concrete, unless directed otherwise by ENGINEER, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessian or other absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.

Where a curing membrane is directed to be used by the ENGINEER, the same shall be of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be got approved from the ENGINEER before use and shall be applied with spraying equipment capable of a smooth, even textured coat.

Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.

Extra precautions shall be exercised in curing concrete during cold and hot weather as per Clause no. 8.3 of IS: 7861(Part II) and Clause no. 8.2 of IS:7861(Part I) respectively.

Curing arrangement shall be subjected to ENGINEER’s approval.

4.28.3. Construction Joints And Keys

Construction joints (location and type) shall be as shown on the drawing or as approved by ENGINEER. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of ENGINEER.

Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the drawings or as directed by ENGINEER.

Before resuming concreting on a surface which has hardened all laitance and loose aggregates shall be thoroughly removed by wire brushing and/ or hacking, the surface washed with high pressure water jet and treated with thin layer of cement slurry for vertical joints and a 15 mm thick layer of cement sand mortar for horizontal joints, the ratio of cement and sand being the same as in the concrete mix.

When concreting is to be resumed on a surface, which has not fully hardened, all laitence shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

Approved epoxy Bonding agent, for bond between old (say 28 days or more) and new concrete may also be used as per manufacturer's specifications.

4.28.4. Foundation Bedding

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy area shall be cleaned out and back filled with either soil-cement mixture, lean concrete or clean sand compacted as directed by ENGINEER. The surfaces of absorptive soils shall be moistened.

Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

4.28.5. Base Concrete

The thickness and grade of concrete and reinforcement shall be as specified in the item of work.

Before placing the blinding concrete of 1:4:8 mix, 50/75mm thick as per the item of work, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

4.28.6. Measurement

Measurement shall be in sq.m correct to two places of decimal. This work could be either separate or combined along with the floor finish as indicated in the respective items of work.

4.21 FINISHES

4.29.1. General

The formwork for concrete works shall be such as to give the finish as specified. The CONTRACTOR shall make good as directed any unavoidable defects consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g.

damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. CONTRACTOR shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

4.29.2. Integral Cement Finish On Concrete Floor

In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded off to proper level and tamped with tamper having conical projections so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener of appropriate thickness as approved by the ENGINEER shall be supplied and used as recommended by the manufacturer.

4.29.3. Repair And Replacement Of Unsatisfactory Concrete

Immediately after the shuttering is removed, all the defective areas such as honeycombed surfaces, rough patches, etc. shall be brought to the notice of ENGINEER who may permit patching of the defective areas or reject the concrete work. ENGINEER'S decision on rejection of concrete work shall be final.

All through holes for shuttering shall be filled with cement mortar for full depth and neatly plugged flush with surface.

Rejected concrete shall be removed and replaced by CONTRACTOR at no additional cost to OWNER.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared as directed by the ENGINEER.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the ENGINEER as to be the method of repairs to be adopted shall be final and binding on the CONTRACTOR and no extra claim shall be entertained on this account. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as directed by ENGINEER.

CONTRACTOR shall submit a method statement for such repairs to ENGINEER for approval.

4.22 VACUUM DEWATERING OF SLABS

Where specified floor slabs, either on grade or suspended, shall be finished by vacuum dewatering including all operations such as poker vibration, surface vibration, vacuum processing, floating and trowelling as per equipment manufacturer's recommendation. The equipment to be used shall be subject to ENGINEER'S approval.

4.23 HOT WEATHER REQUIREMENT

Concreting during hot weather shall be carried out as per IS:7861 (Part I).

Adequate provisions shall be made to lower concrete temperatures which shall not exceed 40 °C at the time of placement of fresh concrete.

Where directed by ENGINEER, CONTRACTOR shall spray non-wax based curing compound on unformed concrete surface at no extra costs.

4.24 COLD WEATHER REQUIRMENTS

Concreting during cold weather shall be carried out as per IS:7861 (PART 2).

The ambient temperature during placement and upto final set shall not fall below 5 deg.c. Approved anti-freeze/accelerating additive shall be used where directed.

For major and large scale concreting works the temperature of concrete at times of mixing and placing, the thermal conductivity of the formwork and its insulation and stripping period shall be closely monitored.

4.25 LIQUID RETAINING STRUCTURES

The CONTRACTOR shall take special care for concrete of liquid retaining structures, underground structures and those other specifically called for to guarantee the finish and water tightness.

The minimum level of surface finish for liquid retaining structures shall be of smooth type. All such structures shall be hydro-tested.

The CONTRACTOR shall include in his price hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipe lines, etc.

Any temporary arrangements that may have to be made to ensure stability of the structures shall also be considered to have been taken into account while quoting the rates.

Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guniting or such other method as may be approved by the ENGINEER. All such rectification shall be done by the CONTRACTOR to the entire satisfaction of the OWNER/ENGINEER at no extra cost to the OWNER.

4.26 TESTING CONCRETE STRUCTURES FOR LEAKAGE

Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by ENGINEER, as described below:

In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.

In the case of structures whose external faces are submerged and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling; the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hrs over period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period for seven days shall be taken as an indication of the water tightness of the structure. The ENGINEER shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.

Each compartment/segment of the structure shall be tested individually and then all together.

For structures such as pipes, tunnels, etc. the hydrostatic test shall be carried out by filling with water, after curing as specified, and subjecting to the specified test pressure for specified period. If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

4.27 OPTIONAL TESTS

If ENGINEER feels that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the ENGINEER, as per relevant IS Codes. OWNER shall pay only for the testing of material supplied by the OWNER; otherwise CONTRACTOR shall have to pay for the tests. Transporting of all material to the laboratory shall however be done by the CONTRACTOR at no extra cost to OWNER.

In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strength, ENGINEER reserves the right to order the CONTRACTOR to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, as per relevant IS specifications. All these tests shall be carried out by CONTRACTOR at no extra cost to the OWNER. Alternately ENGINEER also reserves the right to ask the CONTRACTOR to dismantle and re-do such unacceptable work at the cost of CONTRACTOR.

If the structure is certified by ENGINEER as having failed, the cost of the test and subsequent dismantling/reconstruction shall be borne by CONTRACTOR.

The quoted unit rates/prices of concrete shall deemed to provide for all tests mentioned above.

4.28 GROUTING

4.36.1. Quality Control

a) TCE Consulting Engineers have over the years developed in house quality control formats for concrete works. CONTRACTOR shall note that it required adopting all such formats. A copy of formats shall be furnished to CONTRACTOR by ENGINEER/ OWNER after the contract is awarded.

b) Alternatively, if CONTRACTOR has his own QC formats he may adopt them subjected to such modifications considered necessary by ENGINEER.

c) In either case CONTRACTOR shall submit his detailed Quality Assurance Plan along with the bid. This would be reviewed, appropriately modified and approved by CONSULTANT after the award of contract.

4.36.2. Inspection

All materials, workmanship and finished construction shall be subject to continuous inspection and approval of ENGINEER. Materials rejected by ENGINEER shall be expressly removed from site within 3 working days and shall be replaced by CONTRACTOR immediately at no extra cost to OWNER.

4.36.3. Clean-Up

Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and any debris, scraps of wood, etc. resulting from the work shall be removed and the premises left clean.

4.36.4. Acceptance Criteria

Any concrete work shall satisfy the requirements given below individually and collectively for it to be acceptable.

a) properties of constituent materials;

b) characteristic compressive strength;

c) specified mix proportions;

d) minimum cement content;

e) maximum free-water/cement ratio;

f) workability;

g) temperature of fresh concrete;

h) density of fully compacted concrete;

i) cover to embedded steel;

j) curing;

k) tolerances in dimensions;

l) tolerances in levels;

m) durability;

n) surface finishes;

o) special requirements such as :

i. Water tightness

ii. resistance to aggressive chemicals

iii. resistance to freezing and thawing

iv. very high strength

v. improved fire resistance

vi. wear resistance

vii. resistance to early thermal cracking

ENGINEER's decision as to the acceptability or otherwise of any concrete work shall be final and binding on the CONTRACTOR.

For work not accepted, ENGINEER may review and decide whether remedial measures are feasible so as to render the work acceptable. ENGINEER shall in that case direct the CONTRACTOR to undertake the remedial measures. These shall be expeditiously and effectively implemented by CONTRACTOR. Nothing extra shall become payable to CONTRACTOR by OWNER for executing remedial measures.

4.36.5. Mode of Measurement and Payment

The unit rate for concrete work under various categories shall be all inclusive and no claims for extra payment on account of such items and leaving holes, embedding inserts, etc. shall be entertained unless separately provided for in the Schedule of Quantities. No extra claim shall also be entertained due to change in the number, position and/or dimensions of holes, slots or openings, sleeves, inserts or on account of any increased lift, lead of scaffolding etc. All these factors shall be taken into consideration while quoting the unit rates. Unless provided for in the schedule of Quantities the rates shall also include fixing inserts in all concrete work, whenever required.

Payments for concrete will be made on the basis of unit rates quoted for the respective items in the Schedule of Quantities. No deduction in the concrete quantity will be made for reinforcements, inserts etc. and opening less than 0.100 Sq.m, in areas where concrete is measured in sq.m and 0.010 cum. where concrete is measured in cubic metres. Where no such deduction for concrete is made, payment for shuttering work provided for such holes, pockets, etc. will not be made. Similarly, the unit rates for concrete work shall be inclusive or exclusive of shuttering as provided for in the

Schedule of Quantities.

Payment for beams will be made for the quantity based on the depth being reckoned from the underside of the slabs and length measured as the clear distance between supports. Payment for columns shall be made for the quantity based on height reckoned upto the underside of slabs.

The unit rate for precast concrete members shall include formwork, mouldings, finishing, hoisting and setting in position including setting mortar, provision of lifting arrangement etc. complete. Reinforcement and inserts shall be measured and paid for separately under respective item rates.

Only the actual quantity of steel embedded in concrete including laps as shown on drawings or as approved by ENGINEER shall be measured and paid for, irrespective of the level or height at which the work is done. The unit rate for reinforcement shall include all wastage, binding wires, chairs, spacer bars etc. for which no separate payment shall be made.

Where the formwork is paid for separately, it shall be very clearly understood that payment for formwork in inclusive of formwork, shuttering, shoring, propping, scaffolding, deshuttering etc. complete. Only the net area of concrete formed (shuttered) shall be measured for payment.

Where reinforcement is supplied by OWNER, the quantity of chairs and spacer bars shall be measured for accounting wastage only.

CONCRETE POUR CARD

a) CLIENT: DATE: POUR NO:

b) PROJECT: : STRUCTURE :

c) CONTRACTOR :

d) MAX AGGREGATE SIZE mm SLUMP : mm

e) DRG. NO.

f) START TIME/COMPLETION TIME:

g) CONCETE GRADE/QUANTITY : M / M^3 MIXING TIME :

SR. NO.	**ITEM**			**CONTRACTOR'S REP. SIGNATURE**	**ENGINEER'S SIGNATURE**	**REMARKS**
1.	BEFORE CONCRETING	CENTERLINES CHECKED				
2.		FORMWORK AND STAGING CHECKED				
3.		REINFORCEMENT CHECKED				
4.		COVER0000000 TO REINFORCEMENT CHECKED				
5.		VERFIED TEST CERTIFICATE FOR CEMENT /STELL		YES/NO	YES/NO	
6.		ADEQUENCY OF MATERIALS/EQUIPMENT FOR POUR		YES/NO	YES/NO	
7.		EMBEDED PARTS CHECKED (LOCATION & PLUMB)	CIVIL			
			MECHANICAL			
			ELECTRICAL			
POUR AUTHORISED SITE ENGINEER						
8.	SOFFIT(S) AND POUR TOP(T) LEVELS CHECKED BEFORE(B) AND AFTER(A) FROM REMOVAL (ONLY OF BEAMS OF OVER 10 M SPAN & IMPORTANT STRUCTURES LIKE T.G. ETC.)			S(B) T(B) S(A) T(A)		

SR. NO.	ITEM	CONTRACTOR'S REP. SIGNATURE	ENGINEER'S SIGNATURE	REMARKS
9.	CONSTRUCTION JOINT LOCATION & TIME (IF NOT AS PER DRAWING)			
10.	CEMENT CONSUMPTION IN kg.			
11.	NUMBER OF CUBES AND IDENTIFICATION MARK			
12.	TEST CUBE RESULTS (7 DAYS/ 28 DAYS)	/ / /		
13.	CONCRETE CONDITION ON FORM REMOVAL	V.GOOD/GOOD/FAIR/POOR		
SITE-IN-CHARGE				

NOTES:

a) EACH ITEM TO BE CHECKED & SIGNED BY THE RESPECTIVE ENGINEERS.

b) ITEMS 8 TO 13 (BOTH INCLUSIVE) TO BE FILLED BY ONLY TCE ENGINEER.

c) EACH POUR TO HAVE SEPARATE CARDS, IN TRIPILCATE ONE EACH FOR CLIENT, TCE & SITE OFFICE. FORM 279

d) UNDER REMARKS INDICATE DEVIATIONS FROM DWGS & SPECIFICATIONS, CONGESTION IN REINFORCEMENT IF ANY, UNUSUAL OCCURENCES, SUCH AS FAILURE OF EQUIPMENT'S, SINKING OF SUPPORTS/PROPS, HEAVY RAINS AFFECTING CONCRETEING, POOR COMPACTION, IMPROPER CURING, OTHER DEFICIENCIES, OBSERVATION ETC.

5 BRICKWORK

5.1. MATERIALS

Bricks used in the works shall conform to the requirements laid down in IS: 1077. The class of the bricks shall be as specifically indicated in the respective items of work.

The nominal size of the modular brick shall be 200 mm x 100 mm x 100 mm with the permissible tolerances over the actual size of 190 mm x 90 mm x 90 mm as per IS: 1077. The nominal thickness of one brick and half brick walls using modular bricks shall be considered as 200 mm and 100 mm respectively. In the event of use of traditional bricks of nominal size 230 mm x 115 mm x 75 mm with tolerance up to ±3 mm in each dimension, one brick and half brick walls shall be considered as 230 mm and 115 mm respectively.

Bricks shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified, hand/ machine moulded, deep red, cherry or copper coloured, of regular shape and size and shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 5 N/mm2 unless otherwise specified in the items of work.

The average water absorption shall not be more than 20% by weight up to class 12.5 and 15% by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works.

Sample bricks shall be submitted to the Engineer for approval and bricks supplied shall conform to approved samples. If demanded by Engineer, brick samples shall be got tested as per IS: 3495 by Contractor. Bricks rejected by Engineer shall be removed from the site of works within 24 hours.

Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS: 2250. Mix shall be in the proportion of 1:5 for brickwork of thickness one brick or above and 1:4 for brickwork of thickness half brick or below, unless otherwise specified in the respective items of work. Sand for masonry mortar shall conform to IS: 2116. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by Engineer. If so directed by the Engineer, sand shall be screened and washed till it satisfies the limits of deleterious materials.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by the Engineer. The mortar thus mixed shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. In case, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only up to 30 minutes from the time of initial mixing of water to cement. Any mortar, which is partially set shall be rejected and shall be removed forthwith from the site. Droppings of mortar shall not be re-used under any circumstances.

The Contractor shall arrange for test on mortar samples if so directed by the Engineer.

5.2. WORKMANSHIP

Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work. Brick work 200 mm/ 230 mm/ 250 mm thick and over shall be laid in English Bond unless otherwise specified. 100 mm/ 115 mm/ 125 mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full size bricks shall be used for the works and cut bricks utilised only to make up required wall length or for bonding. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, at least one face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 450. But in no case the level difference between adjoining walls shall exceed one metre. Brick work shall not be raised more than one metre per day.

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10 mm/ 15 mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering/ pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.

During inclement weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.

Brickwork shall be kept constantly moist on all the faces for at least seven days after 24 hrs of laying. The arrangement for curing shall be got approved from the Engineer.

Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS: 2750 and IS: 3696 (Part I). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the Engineer. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/ pointing.

In the event of usage of traditional bricks of size 230 mm x 115 mm x 75 mm or local bricks of size 250 mm x 125 mm x 75 mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/ floor slabs and at the top of the parapet shall be laid with bricks on edge.

A rendering of cement mortar 1:4 rough coat plaster shall be applied on Reinforced Cement Concrete (RCC) surfaces, which are in contact with masonry before starting masonry. All brickwork shall be built tightly against columns, floor slabs or other structural members.

To overcome the possibility of development of cracks in the brick masonry following measures shall be adopted.

RCC/ steel beams resting on masonry wall shall be provided with reinforced concrete bed blocks of 50 mm thickness, projecting 50 mm on either sides of the beam, duly finished on top with 2 layers of Kraft paper Grade 1 as per IS: 1397 or 2 layers of 50 micron thick polyethylene sheets.

PVC mesh fabric shall be provided at the junction of brick masonry and concrete before taking up plastering work.

Bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is taken up for execution. Further, the top most course of half or full brick walls abutting against either a deshuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

Reinforced cement concrete transoms and mullions of dimensions as indicated in the construction drawings are generally required to be provided in the half brick partition walls.

Where the drawings indicate that structural steel sections are to be encased in brickwork, the brick masonry shall be built closely against the steel section, ensuring a minimum of 20 mm thick cement-sand mortar 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.

Contractor shall note that the unit rates quoted for the masonry work shall be deemed to include for the installation of miscellaneous inserts such as pipe sleeves, bolts, steel sections with anchors, etc. and provide pockets, leaving openings, cutting chases, etc. in accordance with the construction drawings. Miscellaneous inserts shall be either supplied free by the Owner or to be furnished by the Contractor as per item description or as shown in drawings. Any of the miscellaneous inserts which are required to be fabricated and supplied by the Contractor and cement concrete to be provided in the pockets for holdfasts of door/ window frames, etc. shall however, be measured and paid for separately under the respective items of work.

Facing bricks of the type specified conforming to IS: 2691 shall be laid in the positions indicated on the drawings and all facing brickwork shall be well bonded to the backing bricks/ RCC surfaces. The level of execution of the facing brick work shall at any time be lower by at least 600 mm below the level of the backing brickwork.

Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of pointing to be carried out shall be as specified in the item of works. The pattern of laying the bricks shall be as specifically indicated in the drawings.

For facing brickwork, double scaffolding shall be used.

Faced works shall be kept clean and free from damage, discoloration, etc., at all times.

5.3. MEASUREMENT

Measurement shall be in cum correct to two places of decimal for brickwork of thickness one brick i.e. 200 mm/ 230 mm/ 250 mm and above. Measurement shall be in sqm correct to two places decimal for facing brickwork and brickwork of thickness half brick i.e. 100mm/ 115mm/ 125 mm and below. Measurement shall be for the quantities as actually executed duly deducting for openings, lintels, transoms/ mullions, etc. All concrete works shall be measured and paid for separately under the respective items of work.

Rate shall include the following:

(a) Making openings for pipes, conduits, ducts etc. and closing the same after completion of such works and finishing as directed.

(b) Providing openings at exact locations and exact sizes.

(c) Making one layer of masonry layout and obtaining Engineer's approval before proceeding with further layer.

(d) M20 RCC Patli beam including shuttering for 75 mm/ 115 mm brick work.

6 RUBBLE SUB-BASE

6.1. MATERIALS

Stones used for rubble packing under floors on grade, foundations, etc., shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects. Stones shall generally conform to the requirements stipulated in IS: 1597 (Part I).

Stones shall be as regular as can be obtained from quarries. Stones shall be of height equal to the thickness of the packing proposed with a tolerance of ±10 mm. Stones shall not have a base area neither less than 250 cm2 nor more than 500 cm2, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of the Engineer.

6.2. WORKMANSHIP

Stones shall be hand packed carefully and laid with their largest base downwards resting flat on the prepared sub-grade and with their height equal to the thickness of the packing. Stones shall be laid breaking joints and in close contact with each other. All interstices between the stones shall be wedged-in by small stones of suitable size, well driven in by crow bars and hammers to ensure tight packing and complete filling-in of the interstices. The wedging shall be carried out simultaneously with the placing in position of rubble packing and shall not lag behind. After this, any interstices between the smaller wedged stones shall be in filled with clean hard sand by brooming so as to fill the joints completely.

The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

6.3. MEASUREMENT

Measurement shall be in sqm correct to two places of decimal for the specified compacted thickness of rubble sub-base.

7 BASE CONCRETE

The thickness and grade of concrete and reinforcement shall be as specified in items of work.

Before placing the blinding concrete, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

7.1. MEASUREMENT

Measurement shall be in sqm correct to two places of decimal. This work could be either separate or combined along with the floor finish as indicated in the respective items of work.

8 CEMENT PLASTERING WORK

8.1 MATERIALS

The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand). Cement and sand shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS standards. The quality and grading of sand for plastering shall conform to IS: 1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Engineer. If so desired by the Engineer, the sand for internal and external plaster shall be machine washed to restrict silt content of sand to less than 2% by volume of sand to meet the Specifications. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required to restore consistency, but this will be permitted only up to 30 minutes from the time of initial mixing of water to cement. Any mortar, which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

8.2 WORKMANSHIP

Preparation of surfaces and application of plaster finishes shall generally conform to the requirements specified in IS: 1661 and IS: 2402.

Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/ window panels, pipes, conduits, etc. are completed.

All joints in masonry shall be raked as the work proceeds to a depth of 10 mm/ 20 mm for brick/ stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry surface to be rendered shall be washed with clean water to remove all dirt, loose materials, etc. Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. Hacking of concrete surfaces shall be about 144 hacks of 8-10 mm deep per square feet of surface area to be hacked. Excess bulges and uneven surfaces must be removed and chipped properly to line and level and no additional payment shall be made for this work. The masonry surfaces should not be too wet, but only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

Interior plain faced plaster - This plaster shall be laid in a single coat of 12 mm thickness. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface. Interior plaster shall be carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by the Engineer. In case more than 12 mm/ 10 mm thick plaster has to be rendered to the RCC surface then, the same has to be rendered in layers of maximum 15 mm thick each. This plaster has to be cured for at least 3 days before applying the subsequent or final neeru layer. Contractors quoted rate for plastering is deemed to include for above provision.

Plain Faced Ceiling plaster - This plaster shall be applied in a single coat of 6 mm thickness. Application of mortar shall be as stipulated in above paragraph.

Exterior plain faced plaster - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14 mm thick. The rendering coat shall be applied as stipulated above except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for at least two days and then allowed to dry. The second coat or finishing coat shall be 6 mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for at least 7 days.

Interior plain faced plaster 20 mm thick if specified for uneven faces of brick walls or for random/ coursed rubble masonry walls shall be executed in 2 coats similar to the procedure stipulated in above paragraph.

Exterior Sand Faced Plaster - This plaster shall be applied in 2 coats. The first coat shall be approximately 14 mm thick and the second coat shall be 6 mm thick. These coats shall be applied as stipulated above. However, only approved quality white sand shall be used for the second coat and for the finishing work. Sand for the finishing work shall be coarse and of even size and shall be dashed against the surface and sponged. The mortar proportions for the first and second coats shall be as specified in the respective items of work.

Wherever more than 20 mm thick plaster has been specified, which is intended for purposes of providing beading, bands, etc. this work shall be carried out in two or three coats as directed by the Engineer duly satisfying the requirements of curing each coat (rendering/ floating) for a minimum period of 2 days and curing the finished work for at least 7 days.

In the case of pebble faced finish plaster, pebbles of approved size and quality shall be dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by the Engineer.

Where specified in the drawings, rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition. Battens shall be carefully removed after the initial set of plaster and the broken edges and corners made good. All grooves shall be uniform in width and depth and shall be true to the lines and levels as per the drawings.

Curing of plaster shall be started as soon as the applied plaster has hardened sufficiently so as not to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.

For waterproofing plaster, the Contractor shall provide the water-proofing admixture as specified in manufacturer's instructions while preparing the cement mortar.

For external plaster, the plastering operations shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/ windows, etc. Ceiling plaster shall be completed first before commencing wall plastering.

Double scaffolding to be used shall be as specified in clause 2.2.

The finished plaster surface shall not show any deviation more than 4 mm when checked with a straight edge of 2 m length placed against the surface.

To overcome the possibility of development of cracks in the plastering work following measures shall be adopted:

(a) Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.

(b) PVC fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/ thermal movement.

(c) Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

8.3 MEASUREMENT

Measurement for plastering work shall be in sqm correct to two places of decimal. Unless a separate item is provided for grooves, mouldings, etc., these works are deemed to be included in the unit rates quoted for plastering work. The quantity of work to be paid for under these items shall be calculated by taking the projected surface of the areas plastered after making necessary deductions for openings for doors, windows, fan openings, etc. The actual plaster work carried out on jambs/ sills of windows, openings, etc. shall be measured for payment.

Rate shall include the following:

(a) Taking reference level pads in CM 1:4 for lines, plumb, right angles, etc. at all corners including edge of beams, columns, doors and window jambs. This level pad, required for accurate working, shall be taken at the skirting level height.

(b) Making and finishing the openings of electrical switch boxes, ceiling points, etc.

(c) Labour required for mixing additional admixture for the improvement of quality.

11.1. **CEMENT POINTING**

9.1 MATERIALS

The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to three parts of fine sand). Sand shall conform to IS: 1542 and shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by Engineer and if so directed it shall be washed/ screened to meet specification requirements.

9.2 WORKMANSHIP

Where pointing of joints in masonry work is specified, the joints shall be raked at least 15 mm/ 20 mm deep in brick/ stone masonry respectively as the work proceeds when the mortar is still green.

Any dust/ dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be specified in the respective items of work. No false joints shall be allowed.

The work shall be kept moist for at least 7 days after the pointing is completed. Whenever coloured pointing has to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the Engineer.

9.3 MEASUREMENT

The quantity of work to be paid for under this item shall be measured in sqm correct to two places of decimal by taking the projected surface of the area pointed after making necessary deductions for openings, etc.

6.20.6
ITEMWISE DETAILED TECHNICAL SPECIFICATIONS (IDTS) FOR RISING MAIN AND DISTRIBUTION NETWORK

6.20.6 ITEMWISE DETAILED TECHNICAL SPECIFICATIONS (IDTS) FOR RISING MAIN AND DISTRIBUTION NETWORK

DTS No. 1

Providing and supplying DI K-9 and K-7 pipes with EPDM Rubber Gasket for nominal bore diameter with internal cement mortar lining including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete. (IS 8329-2000)

(i) 150 mm dia.
(ii) 200 mm dia.
(iii) 250 mm dia.
(iv) 300 mm dia.
(v) 350 mm dia.
(vi) 400 mm dia.
(vii) 450 mm dia.
(viii) 500 mm dia.
(ix) 600 mm dia.

General : The specification pertains to ductile iron spigot and socket spun pipes (suitable for jointing with rubber gaskets) with ISI make and in standard length and of classes mentioned in the bill of quantities confirming to IS 8329/ISO 2531 with all upto date amendments and revision inclusive of all taxes, transportation loading, unloading from the railway wagons, carting to site of work, stacking at site of work (F.O.R.) site of work including all the taxes and duties. Ductile Iron pipe manufacturer must have ISI licence for the entire range of DI pipes required for this tender as on date of submission oftender.

Material : The material shall confirm IS 1387 of 1993 (second revision) for General requirements for supply of metallurgical materials.

Manufacture : The Ductile iron pipes shall be manufactured disconfirming the procedure laid down in clause 7 of IS 8329-2000.

Mechanical test : Shall confirm clause10 J IS: 8329-2000

Hydraulic test : Shall confirm clause 10 J IS: 8329-2000

Cement motor lining : Shall confirm Annex B of IS: 8329-2000

Rubber gasket : Rubber gasket used for jointing shall be of EPDM Rubber gasket and physical properties of gasket material shall confirmed to IS: 5382-1985.

Test Reports : The contractor shall have to produce the original copy of manufacturer's test certificate & third party inspection certificate from organisation agency authorized by VMC for quality and strength of D.I pipes.

Stacking Pipes :þ All pipes shall be stacked as per manufacturer's recommendations unless otherwise directed by the Engineer.

Transportation of Pipes at Site: After pipes, fittings and valves will be delivered to and off-loaded at temporary stores/ godown, the Contractor shall make all arrangements for subsequent transport and handling on or about the site to the point of installation, including where necessary any movement into and out of temporary storage.

The Contractor has to transport the pipes and other materials from manufacturers to the site of lying as indicated by the Engineer. Pipes should be handled with care to avoid damage to the surface and the socket and spigot ends, deformation or bending. Pipes shall not be dragged along the ground or the loading bed of a vehicle. Pipes shall be transported on flat bed vehicles/trailers. The bed shall be smooth and free from any sharp objects.

The transportation and handling of pipes shall be made as per IS: 12288. Handling instructions of the manufacturers of the pipes shall be followed. All precautions set out shall be taken to prevent damage to the protective coating, damage of the jointing surfaces or the ends of the pipes.

Loading & Unloading: Pipes shall be loaded and un-loaded manually or by suitable mechanical means without causing any damage to the stacked pipes.
Cranes or chain pulley block or other suitable handling and lifting equipment shall be used for loading and un-loading of heavy pipes. Where using crane hooks at sockets and spigot ends hooks shall be broad and protected by rubber or similar material, in order to avoid damage to pipe ends and lining. Damage to lining must be repaired before pipe laying according to the instructions of the pipe manufacturer. Pipes shall not be thrown directly on the ground or inside the trench.

When using mechanical handling equipment, it is necessary to employ sufficient personnel to carry out the operation efficiently ensuring safety. The pipes should be lifted smoothly without any jerking motion and pipe movement should be controlled by the use of guide ropes in order to prevent damage caused by pipes bumping together or against surrounding objects.
Rolling or dragging pipes along the ground or over other pipes already stacked shall be avoided.

Support of Pipe on Transit & Storage: The pipe should be given adequate support at all times. The pipes shall rests uniformly on the vehicle bed in their entire length during transportation. Whatever method and means of transportation is used, it is essential that the pipes are carefully placed and firmly secured against uncontrolled movement during transportation to the satisfaction of Engineer.
Stocking of Materials: -The Contractor shall remain responsible for the safe custody of all kinds of materials received by him till consumption of the same in the works. The materials must be stored in a protected temporary store near the site of work and shall not be removed without specific permission of the Engineer. Temporary stores shall be built by the Contractor at location as directed by the Engineer at the Contractor's cost.
A stock register shall be maintained by the Contractor and the day to day receipt, consumed and balance of such materials shall be recorded therein. This register shall be produced by the Contractor to the Engineer or his representative whenever required for verification of stock. The Engineer shall have free access to the temporary stores/go-down of the Contractor

at any time and without any prior intimation.

Materials supplied for a particular work or part thereof shall not be used elsewhere without permission from the Engineer.

Temporary Storage: The Contractor shall take into temporary protective storage all pipes and valves not required for immediate installation in the works. The Contractor shall provide proper and adequate storage facilities to protect all the materials and equipments against damage from any cause whatsoever and in case of any such damage/theft, the Contractor shall be held responsible. Pipe should be stored on a reasonably flat surface free from stones and sharp projections so that the pipe is supported throughout its length. In storage, pipe racks should provide continuous support and sharp corners of metal racks should be avoided. Pipes should not be stacked in large piles. Socket and Spigot pipes should be stacked in layer with sockets placed in alternate ends of the stack to avoid lop sided stacks. Pipes should not be stored inside another pipe. On no account the pipes should be stored in stressed or bent condition or near the sources of heat. Pipes should not be stacked more than 2 m high and pipes of different sizes and classes should be stacked separately. The ends of the pipes should be protected from abrasion. The pipes should be protected from excessive heat at all times. Their storage facility should be well ventilated. Valves shall be stored under cover until they are required for installation and particular care shall be taken for the protection of any associated mechanical equipment.

The period between taking delivery of pipe and the completion of its installation shall be kept to a minimum and generally, the pipes shall be laid within four weeks from the date of their dispatch from the manufacturer / store.

Any period during which the pipes are strung out along the pipeline or placed alongside the works awaiting installation shall also be kept to a minimum and if this period exceeds one month pipes shall be raised at least 75 mm from the ground on timber bearers. Jointing parts and materials shall in any case be stored under cover as for valves.

The contractor shall supply the required dia. of pipe at his cost. **The pipes shall be accepted after the third party inspection by agency authorized by VMC,** the charges for the same shall be **borne** by the contractor

Mode of Payment :

The payment shall be made on Running Meter basis.

DTS No. 2
Manufacture, Supply & Delivery of Ductile Iron Flange socket spigot bends, tees, reducers etc.

Specifications:

The DI specials shall be manufactured and tested in accordance with IS 9523 or BS 4772. The mechanical test and hydrostatic test shall confirm to clause 9 and clause 10 respectively of IS 9523. The tolerances on dimensions shall be as per IS 9523.

The manufacturer of the pipes shall supply the fittings. D.I. Specials shall confirm to relevant

IS codes of latest edition. Material should be procured from approved manufacturer with

manufacturers test certificate. At least 50% of the D.I. specials should be inspected by agency approved by the VMC. Inspection charges shall be borne by the contractor.

All the DI fittings shall be supplied with rubber rings for each socket. The rubber ring shall conform to IS 12820 and IS 5382. Flanged fittings shall be supplied with one rubber gasket per flange and the required number of nuts and bolts. Rubber Gaskets shall be as per IS specifications mentioned in the schedule.

Synthetic rubber ring dimension should be as per IS 12820 / 89 and quality should be as per I.S. 5382/1985 and suitable for jointing of D.I. pipes as per I.S. 8329-2000 or C.I. pipes as per I.S. 1536-2001. Mechanical joint Bends, Tees, Reducer, Adopter etc. shall be of exact size, dia degree and as per standard specifications.

The special shall be coated or protected from rusting and shall be suitable for D.I. pipes (as per IS 8329/2000)

Mechanical compression sealing flanged socket tail piece (Jiffy flange adopter) shall be of exact size and dia. to match D.I. pipes (IS 8329-2000). Mechanical Joint double socket reducer shall be as per IS 13382-1992 and suitable to D.I. pipes (IS 8329-2000) sealing gaskets of S.B.R. shall be as per IS 12820-1989.

This item includes providing of special, transporting the special to site and testing. It also includes cost of entire jointing material, cost of specials, and nut-bolts etc.

The contractor shall supply the required dia of special at his cost. **The Special shall be accepted after the third party inspection by agency authorized by VMC,** the charges for the same shall be **borne** by the contractor.

Mode of Payment :

The payment shall be made on kilogram basis.

DTS No. 3

Providing, supplying DI Resilient seated glandless Sluice / Scour valves conforming to IS 14846/ BS 5136/AWWA C 509 or its latest revision with Gear Box of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete.

150 mm dia Sluice Valve PN-1.0
200 mm dia Sluice Valve PN-1.0
250 mm dia Sluice Valve PN-1.0
300 mm dia Sluice Valve PN-1.0
350 mm dia Sluice Valve PN-1.0

DI RESILIENT (SOFT) SEATED GLANDLESS SLUICE VALVES

SPECIFICATION:-

(1) All Ductile Iron resilient seated sluice valves shall be manufactured strictly in accordance with and conforming to Indian Standard specification IS:14846/ BS:5163/ AWWA C 509 Or its latest amendments and detailed specification of V.M.C..

(2) The valves intended to be used in water supply systems up to $70^{O}C$ in vertical/ horizontal position. All the sluice valves shall be Double flanged of non-rising spindle type and shall be of PN1.0 type.

(3) The Material of Construction for different components, parts of sluice valves shall conform to requirements given in table below:

Sr.	Components	Material	Ref. to IS No.	Grade or Designation
1	Body and Bonnet	Ductile iron/ SG Iron	GGG-50/40 or 1865	500/7 or 400/15
2	Stem	Stainless steel	AISI 304 / 316	
3	Stem sealing	NBR wiper ring		NBR O-rings
4	Wedge	Ductile iron/ SG Iron	GGG-50/40 or 1865	500/7 or 400/15, core fully encapsulated with EPDM rubber with integral wedge nut
5	Bonnet bolts	Stainless steel	AISI 420	Sealed with hot melt
6	Bonnet gasket	EPDM rubber	WRAS or DVGW approved	EUW-70
7	Wedge Nut	Aluminum Bronze		
8	Coating	Electro statically applied epoxy powder coating	DIN 30677-2 or GSK guide lines	Internally and externally RAL Blue colour

Manufacturing:-

a) Dimensions of each part of the valve shall conform to IS:14846-2000/ BS:5163 / AWWA C 509 or Manufacturer's standard.
b) The valve shall be glandless and pocket less for smooth flow of water.
c) The valve shall be easy in operation having negligible head loss and it shall be maintenance free.
d) Resilient wedge with double sealing points provides absolute water tightness.
e) Ductile Iron wedge core is fully vulcanized with EPDM rubber on all sides.
f) The valve shall be open anticlockwise.

g) The flange of the valve shall conform to IS:1538-1993/ BS EN:1092-2 table-9 or its latest amendments.

h) Hand wheel:-All valve shall be provided with hand wheels as per required size. The direction of closing shall be indicated on the top of the hand wheel.

i) The supplier shall submit a detailed G.A. drawing which is to be approved by the V.M.C.. after awarding the work. The valves shall be manufactured and supplied according to this approved drawing.

Testing:-

The DI Sluice Valve shall be tested according to IS:14846-2000/ as per approved drawings in presence of representatives of VMC or / and V.M.C. appointed TPI consultant. Representative of VMC or / and V.M.C. appointed Third Party Inspection Consultant [TPI] may visit/inspect the worksite at any stage of manufacturing for inspection/testing and may reject any material which does not conform to the specified requirement. The supplier shall give at least 15 days notice period for the inspection/testing of the material. All the charges towards testing/ inspection including traveling charges of V.M.C. representatives shall be borne by the manufacturer. T.P.I. Charges shall be borne by V.M.C.

(7) All valves shall be provided with enclosed greased packed spur gear box (for 400 mm dia. and above size). The valves shall be vertically operated by removable key from top accordingly the design of the shaft and Gear box shall be done. The gear box essentially be of worm and worm wheel design, self locking type with or without additional Spur gear arrangement to ensure that the effort on hand wheel is limited to 180 N pull and Push. The gear box shall be invariably of Master gear/Auma/Limitorque/ Ameya/ Transpower/BEL-Bombay Engg. Ltd./Safex/New-Tech/Perfect Engg. only with operating torque as per AWWAC-504rating.

MARKING:-

The following information shall be cast/punched/painted on each valve body in raised letters.

(a) The manufacturer's name or trade mark.
(b) The nominal pressure of valve.
(c) The size and serial number of valve.
(d) Year of manufacturing.
(e) Heat number of cast.
(f) V.M.C../ or any other mark.

Packing:

All valves shall be supplied with the wedge closed. Valve of small diameter may be packed in wooden case parts liable to injury in trasit shall be wrapped with wood-wool or similar material as a protection.

The valve shall be of the following make only.

(1) Fouress Engg. (Ind.) Ltd., Banglore "FOURESS"
(2) Indian Valve International,Kolkata - "IVI"
(3) Kirloskar Bros. Ltd.,Mumbai-"KIRLOSKAR"
(4) Indian Valve Pvt. Ltd., Nasik-"IVC"

Mode of Measurement and payment:

The rate shall be paid in Nos. basis.

DTS No. 3A

Providing and supplying ISI mark DI BF of the following class and diameter including all taxes, insurance, transportation, freight charges, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. comp. D/F BF valves, of following class and diameters

(a) 400 mm dia B/F Valve PN-1.0
(b) 450 mm dia B/F Valve PN-1.0
(c) 500 mm dia B/F Valve PN-1.0
(d) 600 mm dia B/F Valve PN-1.0

1.0 Butterfly Valves as per IS 13095 with PN 1.0 - Gear operated

SCOPE – Fabricated valve will not be considered.

This standard cover double flanged and wafer type of metal seated, resilient seated cast iron, ductile iron, and carbon steel and lined butterfly valves for general purpose. Valves covered under this standard are manually, pneumatically, hydraulically or electrically

operated.

It covers valves of nominal pressure designations up to and including 4 Mpa. and class 300 with ends flanged in accordance with appropriate table of I.S 6418 : 1971 'Cast iron and malleable cast iron flanges for general engineering purpose' or wafer type valves with bodies designed to be accommodate between pipe work flanges in accordance with appropriate table of IS 6418 : 1971 or IS 6392 : 1971 'steel pipe flanges' in nominal size DN 40 to DN 2000. It also covers valves up to class 300 and flanges as per the pressure/temperature ratings given in IS 13159 (Part 1) : 1991 'steel pipe flanges and flanged fittings : part I dimensions' and IS 6418 : 1971 'cast iron and malleable cast iron flanges for general engineering purposes'.

2.0 REFERENCE

The Indian standards are necessary adjuncts to this standard.

3.0 TERMINOLOGY AND DEFINITIONS

Terminology and definition covered in IS 4854 (Part3) : 1974 are generally applicable.

4.0 VALVE END CONNECTIONS

Double flanged valves

A valve having flanged ends for connection to pipe flanges by individual bolting.

5.0 SERVICE APPLICATIONS

Valves shall be suitable for one or more of the following applications.

(a) Tight shut off - A valve having no visible leakage on the disc in closed position under test conditions.

(b) Regulating - A valve intended for regulating purpose and which may have a clearance between the disc and the body in close position.

(c) Low leakage - A valve which has specified maximum leakage rate on the disc in the closed position.

Vacuum Condition

Where valve are to be used under vacuum conditions, purchaser shall mention specifically and the detailed design provision shall be mutually agreed between the purchaser and the manufacturer.

6.0 NOMINAL SIZES

The range of nominal valve size (DN) in mm shall be as follows:

40, 50, 65, 80, 100, 150, 200, 250, 300, 350, 400, 450, 500, 600, 700, 750, 800, 900, 1000, 1200, 1400, 1600, 1800 and 2000

7.0 NOMINAL PRESSURES

Valve shall be designated by nominal pressure (PN) defined as the maximum permissible working pressure (Mpa) at 20 ^{0} C temperature as follows:
PN 0.25, PN0.6, PN1.0, PN 1.6, PN 1.25 and PN4.0

The class designation for valves specified by nominal pipe size shall be class 125, class 150 and class 300.

8.0 PRESSURE / TEMPERATURE RATINGS

Maximum permissible gauge working pressure and operating temperatures shall be in accordance with IS 6418 : 1971 and IS 13159 (Part I) : 1991 except that restriction on temperature may be placed by the manufacturer on valves in accordance with this standard by reason of valve type, trim materials or other factors. However, all valves shall be suitable for continuous use at their PN designation within the temperature range of –10 ^{0} c to 65 ^{0} c.

9.0 BODY ENDS

Double Flanged Body Ends

The dimensions of flanged body ends and drillings shall be in accordance with the requirement given in Annex B. Flanges as per any other specific requirements of the purchaser may also be given as agreed to between the manufacturer and the purchaser or as per I.S. 13159 (part I) : 1991.

Flanges shall be at right angles to the axis of the bore and concentric with the bore. Flanges shall be drilled unless otherwise specified and bolt holes shall be off centers. Tapped by the design of the valve

Wafer Body Ends

Body ends shall be capable of being fitted between the pipe flanges complying with the requirements of annex B flange drilling.

The joint faces shall be at right angles to the axis of the bore and concentric with the bore.

Holes may be provided, where required by the design, for the passage of the bolts securing the flanges and the valve. Where through bolting is not practicable due to the presence of valve shaft, bearing housing, tapped holes may be provided for individual bolting of each flange.

10.0 FACE TO FACE DIMENSIONS

Face to face dimensions of double flanged and wafer types of valve shall be as per Table 1.

Face to face dimensions given in Table 1 are exclusive of the sealing gaskets at both ends.

The manufacturer shall ensure that adequate space will be available between valve flanges for bolting when flanged valve with short body face to face to face or wafer long face to face are manufactured.

Tolerance on face to face dimension in Table 1 shall be as follow

Face to face dimension of Unlined valve MM		Tolerance MM
Over	Up to and Including	
0	250	$\pm$2
250	500	$\pm$3
500	800	$\pm$4
800	100	$\pm$5
1000	2400	$\pm$6

11.0 BODIES

Bodies end ports shall be circular and the numerical valves of the diameter shall be as close as possible to the valve of DN.

12.0 DISC AND SHAFT

The disc and shaft shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The shaft may be of one piece design or in two pieces separately attached to the disc. Any means of attachment between the shaft and the disc shall be such as to preclude components becoming loose in service.

13.0 SEATING AND LININGS

Non-integral seating, and lining shall be used, and their means of attachment shall be such as to preclude their becoming loose in service.

14.0 BEARINGS

14.1 The bearings shall be suitable for the maximum loads imposed by the shaft during testing and in service.

14.2 For valves DN 350 and above, a bearing shall be provided to take the axial thrust, spring retaining clips (circlips) shall not be used as thrust bearing.

14.3 Suitable sealing shall be provided for the shaft where it passes outside the pressure containing en closer.

15.0 MATERIAL OF CONSTRUCTION

This standard is based on materials specified in I.S.S. Unless otherwise agreed, the materials shall be of a grade equivalent to those given in I.S.S. or superior. Other material may be used as per agreement between the manufacturer and the purchaser. The material of construction shall be as per table given below

Sr. No.	Part Component	Pressure Rating (1 Bar + 1 atmosphere)
1.	Body	D.I. / S.G.IRON IS 1865 GR 400/12 or 500/7
2.	Disc	D.I. / S.G IRON IS 1865 GR 400/12 or 500/7
3.	Shaft (DE/NDE)	SS AISI 410
4.	Seal	EPDM Rubber having Properties equal or superior to the following. 1) Tensile strength Min. 130 Kg/cm2 2) Elongation at break: Min 375% 3) Tear resistance : Min.35 Kg/cm2 Compression set at 100ºC for 72 hours: Max. 20%.
5.	Seat ring / Retaining Ring	SS AISI 316
6.	Bearing	Steel backed PTFE
7.	Internal Hardware	SS AISI 316
8.	External Hardware	C S to IS 1367
9.	Hand wheel	M.S. round, Chrome Plated
10.	Cast Steel parts to be protected with coating suitable for tropics.	Clause 16 of B.S. 1218
11.	Drilling of valves flange	Drilling of the flange shall be as per Table of BS 4504 / IS 1538 and thickness of the flange as per the pressure rating of the valves.

The material of construction of Gear Box for valves shall be as per table given below

Sr. No.	Description	Materials
1.	Gear Case & Cover	Cast Steel ASTM A 216 Gr. WCB or S.G Iron to IS 1865 Gr. 400/15
2.	Sector Gear	D.I. / S.G.I. IS 1865 Gr. 600/3
3.	Worm / Shaft, spur Gear /pinion /shaft	BS 970 EN 19 / EN 24
4.	Fastners / Dowels	SS 316 / SS 304
5.	O – Rings	Nitrile Rubber with Shore hardness of 65 + 5
6.	Bearing for shaft	Ball / Roller bearing.

16.0 OPERATION

16.1 Manual Operation

All valves shall be capable of operated at a differential pressure across the disc as marked on the valve. Lever, worms gear / travelling nut type or any other suitable type of operator can be used.

16.1.1 Direction

Unless otherwise, specified manually operated valves shall be closed by turning hand wheel or lever in a clockwise direction when facing the hand wheel or lever. The design of lever when fitted shall be such that the lever may only be assembled to the valve so that it is parallel to the direction of flow when the valve is open.

16.1.2 All gear travelling nut operators shall be provided with suitable stops to prevent movement of the shaft beyond the limit corresponding to the fully closed position of the disc.

16.1.3 All gear travelling nut operators shall be packed with grease for life time operation. Gear / travelling nut operators shall be totally enclosed and weather proof for general application. For special applications such as marine, submerged service etc. the purchaser may specify special en-closer.

16.1.4 All gear / travelling nut operators shall be self locking type. All leaver operated valve shall be capable of being locked at least three intermediate position.

16.2 The operating hand-wheels shall be marked ‘CLOSE’ or ‘SHUT’ to indicate the direction of closer.

16.3 The operator shall be provided with arrangement to indicate the disc position.

17.0 TESTING

All valves shall hydrostatically tested by the manufacturer before dispatch. The pressure shall be obtained without any significant hydraulic shock. Testing shall be carried on

before application of paint or other similar treatment unless otherwise agreed between the purchaser and the manufacturer. There shall be no air entrapped within the part of the valves subjected to test pressure.

17.1 Performance Testing

Each valve shall be shop operated from fully closed to fully open position and reverse, under no pressure and no flow condition to demonstrate that the complete assembly is workable.

17.2 Body Test

Completely assembled valve shall be tested as follows:
'The body ends shall be blanked so that the valve is subjected to the full pressure in all directions include by the test pressure wafer valves may be tested in any suitable manner agreed between the purchaser and the manufacturer. The valve disc shall be in slightly open position and pressure equivalent to 1.5 times the maximum permissible working pressure shall be applied with water. The duration of this test shall be as in Table 3 below in Para 17.3.

17.3 Seat Test

The seating surface of the valve shall be cleaned unless a surface treatment forms an integral part of the design or the use of a temporary surface treatment has been agreed between the manufacturer and the purchaser to avoid the possibility of damage under the condition of the test.

NOMINAL DIA MM	MINIMUM TEST DURATIOIN IN MINUTES	
	BODY TEST	SEAT TEST WHEN APPLICABLE
Up to and including 50	0.25	0.25
65 to 150	1.00	1.00
200 to 300	2.00	2.00
350 to 1000	5.00	2.00
1200 to 2000	5.00	3.00

17.3.1 Each valve shall be shop tested for leaks in close position. The test shall be conducted with the body flanges in a horizontal position. Pressure shall be applied to the upstream end of the valve, the downstream being open to atmosphere. The duration of test shall be as per Table above. There shall be no indication of leakage past the valve disc during test and valves shall be drop tight. Seat test shall be carried out in both the direction of valve if agreed between the manufacturer and the purchaser. The seat pressure applied on upstream side shall be equivalent to 1.1 times the maximum permissible working pressure at 20^{0} c and shall be applied with water.

17.3.2 For regulating type valves seat test shall not be applicable.

17.4 Disc Strength Test

The test shall be conducted with the body flanges in horizontal position. The test pressure shall be 1.5 times the maximum permissible pressure at 20 0 C With disc in

closed position, hydro test pressure shall be applied to the lower face of the disc for duration as per table-3. There shall be no damage to the valve disc nor shall any part of valve or disc be permanently deformed by the test. The purpose of this test is to provide evidence of the adequacy and structural integrity of disc and body. Any leakage past the seat shall not be the criteria for rejection of the valve (Sampling test sample as per IS 2500). For regulating type valves, disc strength shall not be applicable.

17.5 Maximum permissible leakage shall be as given in Table in para 18.0.

18.0 TEST CERTIFICATES

When specified by the purchaser, the manufacturer shall issue a test certificate confirming that the valves have been tested in accordance with this standard and stating the actual pressures and medium used in the test.

VALVE TYPE	LEAKAGE RATE
Tight shut-of	No visible leakage for duration of test
Low leakage	0.1 mm^2 /s X DN (sec 5)
Regulating	Not specified. Outside the scope of this standard.

19.0 INSPECTION

The purchaser or his authorized representative shall have access to the manufacturer's works at all reasonable times to inspect assembled valve at factory. The bidder has to make necessary arrangements for testing facilities of the valves as per the relevant IS at factory.

20.0 WITNESSING OF TESTS

When the purchaser desires to witness the tests, this shall be specifically agreed in advance.

21.0 MARKING

Marking shall be cast integral on the body or on a plate securely attached to the body. The markings shall be in accordance with I.S. 9866: 1981.

22.0 PREPARTION FOR DISPATCH

(a) Valve shall be complete in all respect when dispatched. Each valve shall be drained, cleaned, prepared and suitable protected with 2 coats of red oxide on un machined surfaces and rust preventive coats on machined and flanged surfaces for dispatch in such a way as to minimize the possibility of damage and

deterioration during transit and storage. Painting other than specified on the finished valve shall be as per the agreement between the manufacturer and the purchaser.

(b) Disc shall be unseated when dispatched, but care shall be taken to ensure that there is no risk of damage to the disc.

(c) When specified, the body ends shall be suitably sealed to exclude foreign matter during transit and storage.

(d) Components shipped unattached shall be adequately protected and identified to permit correct field assembly.

23.0 APPROVED MAKE FOR BUTTERFLY VALVES

1. Kirloskar Brothers Limited
2. Fouress Engineering Limited
3. R & D Multiples
4. Indian Valve Company

24.0 MODE OF PAYMENT

The payment will be made on No. basis.

DTS No. 4

Providing and supplying CI temper proof Air valves conforming to IS 14845 with SS 304 float gun metal nozzle of approved make and quality of following class and diameter incluidng all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. comp.

Temper proof air valve with isolation sluice valve PN 1.0

(a) 150 mm dia

(b) 100 mm dia

(c) 80 mm dia

Tamper proof double acting Kinetic Air Valves

Tamper proof double acting Kinetic Air Valves are to be supplied which shall be designed as per IS 14845 / AWWA C512-92 standards.

1.0 GENERAL

The double air valves shall have two ball chambers, having one outlet of large capacity for admission and release of bulk volume of air during emptying and filling of the main and another having small outlet for escape of smaller quantities of entrapped air. This type of air valves shall be of flanged type with full conformation with IS:1538.

The ball sealed orifice always remains open while air is exhausting and is immediately closed when water rises in the chamber, lift the ball and seals the orifice. It shall also ensure that there are no recesses or pockets, sheltering, escaping air for the large orifice (low pressure) valve to drop into when the valve is open. Turbulent air at the time of

filling of pipe shall not circulate in such cavities and cause the ball to blown into when the valve is open. Turbulent air at the time of filling of pipe shall not circulate in such cavities and cause the ball blown into the discharging air streams, blowing the valve shut prematurely.

The cone angle of the lower pressure chamber shall be such that even at the critical velocity of air escape at 300 m/sec. The total impact force on the ebonite covered ball is less than the suction force on the angular area between the ball and the cone. The design of the valve should be such as to allow maximum free air discharge at various pressure differentials. The tenderer shall submit with the tender full set of curves showing discharge of free set of curves showing discharge of free air valves pressure differential for all sizes of valves offered by him.

Under no circumstances shall be large orifice ball blow shut prematurely.

The low pressure cover shall be massive and designed to withstand full operating thrust in working conditions.

Air valve shall be design to prevent premature closure prior to all air having been discharge from the line. The orifice shall be positively sealed in the close position but flot (Ball) shall only be rised by the liquid and not by mixer of air and liquid. The sealing shall be design to prevent the flots sricking after long period in the close position.

All branched outlets including outlets for Air valves will be with compensation pads (Dia of Main / For branch Dia ratio greater than 3). Diameter of compensation pad will not be less than 1.75 times thr O.D. of the branched outlet. Plate thickness for pads will be same that of the main.

For outlets with above ratio less than three, then the joints will be of plate reinforcement type.

All branched outlets including air valve tee's will be provided with one ½"BSP coupling duly plugged for measurement of pressure in due course. The closing plug will be in Stainless Steel (AISI 304 or equivalent) with Hex. Head and will be provided with copper washer for sealing.

The neoprene seat ring shall be held securely in place under the low pressure cover by a joint support ring to prevent it from sagging when the ball is not sealing the office.

The valve body, the orifice cover, cowl of the air valves shall be made of cast iron of glade 2 of IS:210.

Where tenderer considers necessary a suitable drain plug shall be provided.

2.0 HIGH PRESSURE ORIFICE

The high pressure orifice and the high pressure chamber shall be so designed that the orifice is effectively sealed in working conditions by "EPDM" coated float.

The material of the orifice shall be gunmetal. The orifice shall be of size not less than 3 mm and tapering to 100 mm suitable to release accumulated air within the pipe. The profile of the orifice shall be carefully chosen to avoid damage to the float surface. The orifice shall be protected by a suitable plug of stainless steel.

3.0 VALVE FLANGES

All valves flanges shall be designed to withstand the stresses to which they would be subjected under hydraulic tests. Flanges shall be machined flat. The flanges shall be drilled in accordance with IS:1538 (part – I to XXII) – 1976 (specifications for C. I. Fittings for pressure pipes for water etc.)

4.0 COATING

The casting shall be such that it shall not impart any taste or smell to water. The coating shall be smooth, glossy and tenacious, sufficiently hard so as not to flow when posed to a temperature of 770 C and not so brittle at a temperature of 150 C as to chip off when scratched lightly with the point of penknife.

Alternatively, two coats of black Japan conforming to type 8 of IS 341-1971 (Or latest edition) or paint conforming to type – 2 of IS 158-1969 (OR latest edition) shall be applied.

5.0 TAMPER PROOF AIR RELEASE VALVES

The bidder has to supply tamper proof Air Release Valves.
The valves shall be

(i) 100% tamper proof
(ii) Zero water leakage
(iii) Unaffected by strong air flow
(iv) Maintenance free

The tamper proof air release valve shall have following:

(i) Double orifice & double float.
(ii) Stainless steel large & small float.
(iii) Stainless steel guiding stem for large float shall give 100% perfect closing.
(iv) Aerodynamic bucket design for maximum airflow & which should restrict entry of foreign material.
(v) Integral vent welded to inverted cap made of MS should restrict tampering of Air Release Valve large orifice.
(vi) Small orifice automatic valve vertically assembled should discharge small quantity of dissolved air / air pockets automatically.
(vii) Design shall be as per AWWA C512-92 standards.
(viii) Air Release Tamper Proof Valves shall be tested as per IS 14845 – 2000.

6.0 MATERIAL OF CONSTRUCTION OF KINETIC AIR VALVES

Sr. No.	Kinetic Air Valves	Material Description PN 10, PN 16 / PN 25

1	Body	Ductile Ion DIN 1693-GG40/ Spheroidal Graphite Iron IS 1865 Gr 400/15
2	Float (Large)	Stainless Steel : ISI – 304 / 316 / 316L
3	Nozzle	Gun Metal : IS 318 LB2 / GM + Neoprene Rubber
4	Gasket	Rubber : Neoprene
5	Cover	Carbon Steel : Plate
6	Fasteners	Carbon Steel : IS 1363

7.0 TESTING

The air valves shall be tested as per IS 14845 – 2000. The air valves shall withstand 1.5 times the working pressure. The joints and air valve shall be water tight. During test if the joints of air valve are found leaking or the air valve is found not functioning properly then the same shall be got rectified or replaced by the contractor to the satisfaction of Engineer-in-charge.

8.0 APPROVED MAKE FOR KINETIC AIR VALVE – TAMPER PROOF

1. Indian Valve Company
2. Kirloskar Brothers Limited
3. Fouress Engineering Limited
4. R & D Multiples

9.0 MODE OF PAYMENT

The payment will be made on No. basis.

DTS No. 5

Excavation for pipeline trenches including all safety provision (barricadding, fencing etc.) using site rails with shoring, strutting and stacking the excavated stuff upto 90.00 mt. Cleaning the site etc.complete for lift and strata s specified. The excavation shall be carried out in stable slope for which no extra payment will be made. Rate is inclusive of backfilling the trenches with available excavated earth (excluding rock) in layer including ramming, watering, consolidation desposal surplus stuff as directed within a radius of 3 km.

(a) In all sorts of soil, soft murrum, hard murrum, soft rock, etc.

- 0 to 1.5 mt. Depth

- 1.5 mt. to 3.0 mt. Depth

The trench for laying the pipes shall be excavated true to lines, levels and grades as shown on the drawings or directed by the Engineer with the help of boning rods.

The depth shall be such that the pipe shall have a clear cover of at least 1.2 m. The trench shall be excavated through all strata met with.When it is necessary and ordered by the Engineer in writting, the sides shall be shored or sloped, otherwise they shall be as vertical as possible. The rates shall include shoringand provision ofslopes.

Various materials excavated shall be separated and stacked beyond one meter or more from the edge as may be necessary in the opinion of the Engineer to avoid provision ofslopes.

The bed shall be even and to the correct grade and line in all cases.

The trench shall be barrieaded and warning board fixed, Red lights shall be hung at night

time at sufficiently close intervals to indicate the danger and a chowkidar employed to see that the lights are properly burning. The contractor shall be solely responsible for any accidents, due to any default in barricading, sign posting or red lights and shall bear the consequences.

At all road crossing, the trench shall be excavated only for half the width of the road and pipe laid. The other half shall be excavated only after backfilling over the laid pipe and making it suitable for the traffic. At all road crossings, the pipes shall be sufficiently laid below the crust of the road.

All pipes, gas gline, cables service lines etc. met with during the excavation shall be carefully protected and supported. Any damage done shall be made good by the contractor at his own cost. For making end connection or branch connection it shall be the responsiblity of the contractor to excavate the trench in such manner so as to enable the fitter to make the connections conveninatly. At crossing of cross drains, sewer mains, old water main, drain connection, electric cable etc. it shall be to such a depth as to enable the fitter to take the pipe from, below above or through the cross drain or the cable etc as the case may be and as directed by the Hydraulic Engineer. No extra payment shall be made in above cases of excavation.In case contractor has laid the pipeline in the trench excavated less than above specified depth, contractor may be asked to lay the line after making proper depth as directed by the Hydraulic Engineer or his Authorised representative on site. The extra labour involved in such cases will have to borne by the contractor. If contractor, fails to carry out such direction, Hydraulic Engineer may give the reduced rates for portion of pipe line laid in the trench as he thinks fit or relay the line at the risk and cost of contractor as deemed fit, no measurement will be taken for joints pits as the same included in the item of lead jointing.

The contractor shall have to keep chowkidar and red lights (of a proper size) during night on open trenches during the progress of the work and until the trench or pit is completely refilled.Red flags road closing board etc. and such other precautionary measures shall have to taken by the contractor.If the contractor fails carry out the above precautionary measures, Hydraulic Engineer shall engage, even without giving a notice to the contractor wherever the situation demands quick action for the chowkidar, places, necessary red lights and manage to guard the trenches all the expenditures so incurred shall be recovered from the contractor form his bill or deposit.The contractor will have no right to dispute the action taken by the Hydraulic Engineer.

Excavated earth shall be used for refilling of trenches however, surplus excavated stuff will be the property of Contractor and Contractor may disposed off or stock the same at their own risk and cost.NO PAYMENT FOR THE CARTING OF SURPLUS EXCAVATED STUFF WILL BE MADE.

The earth to be used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken. As soon as the work in foundation has been completed and measured the site of foundation shall be cleared of all debris, brick bats, mortar dropping and filled with earth in layers not exceeding 20 cms. Layers shall be adequately, watered, rammed and

consolidated before the succeeding layer is laid. The earth shall be rammed with iron rammers where feasible and with the butt ends of crowbars where rammer cannot be used.

After compaction and consolidation, If any short fall of excavated stuff is found, than Contractor has to bring the soil of the required quantity in order to meet short fall at his own cost. Moreover, if any settlement of road after reinstatement or after first monsoon or during watering, contractor shall be fully responsible for the settlement of trenches. Patches / depression / settlement shall be repaired with chhara or soil at his own cost. Surplus excavated stuff shall be disposed off in such a way that it does not create any nuisance to the public or VMC's road surface.

Mode of measurement and payment:-

The depth of excavation shall be counted from the bottom of the base course of metal or asphalt road surface.

Payment shall be made on cubic meter basis.

DTS No. 6

Excavation of asphalt pavement of any thicknesetc.complete withs tacking the material as directed by the Engineer-in-charge (only carpet thickness shall be considered for calculation of quantity)

Item includes breaking and removing of the road surface upto the bottom of asphalt surface item also include stacking of useful material useful material upto lead of 90 meters.

Mode of measurement and payment:-
Payment shall be made on cubic meter basis.

DTS No. 7

Reinstatement of asphalt road / pavement using same material for soling and providing new soling and new metalling, grouting with tack coat etc. complete, as directed.

This work shall consist of necessary excavation prepared base, spreading metal using excavated useful material, new metal for second layer and grouting it with tack coat.

Necessary specifications of MoRTH & ULB are applied for specific layer.

The item should be measure in Square meter.

The unit rate shall include all the activities to complete above job including all materials, labours, machineries as directed by engineer in charge.

DTS No. 8

Providing bedding of average 15 CM thickness including ramming, watering, consolidating etc. complete.

Providing murum bedding under pipe of average 15 CM thickness including watering raming consolidating and dressing etc. complete as and where instructed by Engineer-in-charge

1. The murum to be use for filling shall be free from salts, organic or other foreign matter. All clods of sand shall be broken.

2. As the excavation of trench is done up to required depth and of required width, The murum is filled in trench with average thickness of 15 CM (compacted) in full width of trench before laying pipe. It is watered and rammed to required level so that the average thickness of sand bedding is 15 CM.

3. Mode of measurement and payment:-

The payment shall be made for filling murum as per drawings. No deduction shall be made for shrinkage or voids, if consolidated as instructed above.

The rate shall be for a unit of one cubic meter

DTS No. 9
Lowering, laying and jointing DI Pipes of various classes with specials of following diameters in proper position grade and alignment as directed by Engineer in charge.
(i) 150 mm dia.
(ii) 200 mm dia.
(iii) 250 mm dia.
(iv) 300 mm dia.
(v) 350 mm dia.
(vi) 400 mm dia.
(vii) 450 mm dia.
(viii) 500 mm dia.
(ix) 600 mm dia

The DI pipes will be transported to the site of work where actually they are to be laid and jointed. All necessary steps shall be taken to prevent damage to pipes during transport, loading, unloading, operations etc. Only approved method for conveyance loading and unloading, stacking operations etc. Only approved method for conveyance loading unloading, stacking operations such as winch and chain pulley block tripod, etc. may be adopted. The DI / C.I. pipe should be laid as per IS 12288 and as given below.

Laying of Pipes Under Ground :-

The pipes should be lowered into the trench with tackle suitable for weight of pipe. Either a well designed set of shear legs or mobile crane shall be used for lowering of pipe into the trench. When lifting gear is used the positioning of the sling to ensure proper balance should be checked when the pipe is just clear of the ground. The pipe should be clearly cleaned of any debris inside the pipe either before or just after joint is made. When the laying is not in progress the temporary end closure should be securely fitted to the open end of pipe line.

On gradient of 1:15 or steeper, precautions should be taken to ensure that the spigot of the pipe being laid does not move into or out of socket of the laid pipe during jointing operation. As soon as the joint assembly is completed. The pipe should be held in position while the trench is back filled over the barrel of pipe.

The designed anchorage shall be provided to resist the thrust developed by internal pressure at bends, tees and other specials etc. The cement concrete block should be casted in situ to resist the thrust designed taking into account the maximum pressure the main is to carry in service or on test and the safe bearing pressure of the surrounding soil.

Cutting and Chamfering to D.I. Pipes : -

This item shall be executed for use of cut pipes in required length only when directed by Engineer in charge and after obtaining the permission from him. The burn left after cutting should be trimmed off by light grinding or by filing method. The chamfering of pipes shall conform to IS 12288 — 1987.

The chamfering shall be suitable for push on joints / mechanical joint without damaging the rubber gasket. The pipe after chamfering should be so smooth that enables to push in gasket for push on jointing. This item includes cost of all labour and tools required for executing the complete item.

Jointing of Pipes :-

The DI pipes should be jointed either with flexible joints / SBR rubber gasket joints or by rigid flanged joints. The pipes shall be joined by the rubber gaskets (SBR) except where there are specials / valves to be jointed to the pipeline. The SBR rubber gasket of suitable size required for laying of CI pipes shall have to be procured by the contractor at his own cost. The SBR ring should confirm to IS 12820/1989.

Before assembling the joint the spigot of one pipe and the interior of the socket of the adjacent pipe should be thoroughly cleaned. The insertion of the gasket can be facilitated by the prior application of a thin film of lubricant to the bulb seating the inside the socket.

The rubber gasket should be wiped clean, flexed and then placed in the socket with the bulb towards the back of the socket. The groove in the gasket must be located in the retaining heel in the socket and the retaining heel of the gasket firmly embedded in its seating:

It is necessary to ensure that the SBR gasket fits evenly around the whole circumferences removing any bulges which prevent the proper entry of the spigot end. In the larger diameter this operation may be assisted by forming a second loop in the gasket opposite the first then pressing the loop flat one after the other.

A thin film of lubricant should be applied to the inside surface of the gasket which will be in contact with the entering spigot. In addition a thin film of lubricant may be applied to the

outside surface of the entering spigot for a distance of 25 cms from the spigot end.

The pipe to be jointed should be supported centrally by the tackle used for laying and balance just clear of the trench bottom. The spigot of the pipe must be aligned and entered carefully into the adjacent socket until it makes contact with the gasket. Finally assembly of the joint is completed from this position.

Joint assembly is completed by forcing the spigot end of the entering pipe through the gasket, which is thus compressed until the spigot end reached the total depth of the socket, if the assembly is not completed with the application of reasonable force, the spigot should be removed and the position of the gasket examined.

For joints 200 mm and above rack and level tackle may be used for completing assembly wherever found necessary at the cost of contractor.

The rack is placed on the socket with the hooked end of the rack extending over the spigot of the entering pipe. The tumble on the end of the 3.2 meters long socket rope is placed over the hook bolt on the rack, which should be in its lowest position, with nut of the top of the thread. The plain end of the rope is passed round the body of the pipe looped through the rope adjuster on the side of the rack housing, wedge inserted and the rope draw tight, this pulls the wedge home thus securing the rope. The tackle is then tamped firmly to the pipe by tightening the nut on the work bolt once the length of the rope is correctly set, it is not necessary to loosen the wedge adjuster for subsequent joints unless the diameter of pipes being jointed in change. The thimble secured to one end of 6.1 m. wire rope is not loosed over the hook at the end of rack and the free end carried to the socket end of the pipe to be jointed.

A special hook and rope adjuster is then fitted on to this rope and securely located in convenient position by means of the wedge. Once the position of the hook and rope adjuster has been thus set subsequent assembly of pipe of similar length should be subsequently jointed.

Backfilling

Pipe trenches shall be backfilled after completion and acceptance of field hydraulic tests and repair of coating as required and/or as directed. The work shall be done in accordance with IS: 12288.

Backfilling of trenches shall be done as specified below with watering and compacting in layers under "Optimum Moisture Content" conditions to achieve required density of refilling and strength after compaction. For the purpose of backfilling, 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 trench to the level of the centre line of the pipe	Backfilling by hand with sand, fine gravel or other approved material placed in layers of 150 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, specials and appurtenances simultaneously. Special care shall be taken to avoid damage of the pipe and the coating or movement of the pipe.
Zone B: From the level of the	Backfilling and compaction shall be done by hand or approved mechanical methods in layers of 150 mm, special

centre line of the pipe to a level 300 mm above the top of the pipe	coating or moving or moving of the pipe.
Zone C: From a level 300 mm above the pipe to the top of the trench.	Back-filling shall be done by hand or approved mechanical methods in 150 mm layers after compacting and carried to the level necessary to allow for the temporary restoration of road and path surfaces, and also for hard core (if and where ordered) on roads or to such level as will leave the requisite space for the top soil, road surface etc. to be reinstated as directed by the Engineer.

Where the excavation is made through permanent pavements, curbs, paved footpaths, or where such structures are undercut by the excavation, the entire back-fill to the sub-grade of the structures shall be made with sand in accordance with IS:12288.

The excavated material may be used for back-fill in the following cases, provided it complies with IS: 12288 Clause 4.11.1:

a) In Zone C: In cases where settlement is unimportant the back-fill shall be neatly rounded over the trench to a sufficient height to allow for settlement to the required level.
b) In any zone, when the type of back-fill material is not indicated or specified. Provided that such material consists of loam, clay, sand, fine gravel of other materials which are suitable for back-filling in the opinion of the Engineer.

All excavations shall be backfilled to the level of the original ground surfaces unless otherwise shown on the drawings or ordered by the Engineer, and in accordance with the requirements of the specification. The material used for backfill, the amount thereof and the manner of depositing and compacting shall be subject to the approval of the Engineer, but the Contractor will be held responsible for any displacement of pipe or other structures, any damage to their surfaces, or any instability of pipes and structures caused by improper depositing of backfill materials.

Trenches shall be backfilled with selected material placed in layers not exceeding 150 mm in thickness after compacting, wetted and compacted to a density of not less than 90 percent of the maximum dry density at optimum moisture content for zones A, B and C of the surrounding material. Any deficiency in the quantity of material for backfilling the trenches shall be supplied by the contractor at his expense. Water for compaction shall be arranged by the contractor at his cost.

The contractor shall at his expense make good any settlement of the trench backfill occurring after backfilling and until the expiry of the defects liability period.

On completion of pressure and leakage tests exposed joints shall be covered with approved selected backfill placed above the top of the pipe and joints in accordance with the requirements of the above specifications. The contractor shall not use backfilling for disposal of refuse or unsuitable soil.

Laying to Curves

Where flexible jointed pipes are to be laid to curves, the deflection at each joint shall not exceed 75% of the maximum allowable values as per the recommendations of the pipe manufacturer. For sharper curves made bevel pipes, bevel adopters and standard bends shall

be provided.

Anchor/Thrust Blocks

The contractor shall provide anchor/thrust blocks at all bends, at dead ends and at all other places both below and above ground as directed by the Engineer. Anchor blocks shall be in cement concrete
as per dimensions given in the approved drawings. The grade of concrete as specified in the relevant sections of the specification shall be strictly followed. Shuttering shall be as required and to the satisfaction of the Engineer.

The thrust faces of all blocks shall be placed directly against the undisturbed faces of excavations and the shape and size of the blocks shall be as shown on the drawings or as otherwise determined by the Engineer having regard to the nature of the ground and the load or thrust to be encountered. The concrete shall be placed around the fitting in such a way that the coupling are not covered or fixed by it to allow for flexibility and to provide access to the collars for replacing when necessary.

Before casting concrete, bituminous felt shall be wrapped around the fitting at the interface between concrete and fitting. Where required, anchor clamps shall be cast into the anchor blocks. **Hydraulic testing**

1. DI pipes and Fittings:

2. All the Pipes, specials and fitting of DI shall be supplied and tested as per relevant IS codes and specifications. The Following code shall be used for
   a. Factory Test Pressure: as per IS 8329
   b. Site Test Pressure: as per IS 8329

Suitable section as directed by the Engineer in charge shall be taken for such testing from time to time during progress of the work and satisfactory test given for that section. All testing apparatus, gauges, connections, etc. and water required for testing shall be arranged by the contractor at his cost. The TMC does not undertake any responsibility to supply water for testing which the contractor has to arrange by paying the required charges directly. The TMC shall have the right to recover such charges from his bills if complaints are received that contractor has not paid the charges thereof. If there is delay in testing, the contractor shall

refill the trenches for the time being and reopen them at time of testing at his own cost failure of which shall entitle the TMC to do the refilling and reopening of trenches at the risk and cost to the contractor. If the trenches are filled due to any reason whatsoever before testing, the contractor shall have to open them for testing at no extra cost.

1.0] Satisfactory hydraulic test shall be recorded when the section under test shall withstand the pressure as specified by the Engineer in charge for about 15 minutes without operating the test pump. The test pressure being maintained at the specified figures during that 15 minutes interval.

1.2] The field test pressure to be imposed should be not less than the maximum of following.

a) 1.5 times the maximum sustained operating pressure (with minimum design pressure as 6.0 kg/sqcm) in the pipeline.
b) 1.5 times the maximum static pressure (with minimum design pressure as 6.0 kg/sqcm) in the pipeline in the pipe line
c) Sum of maximum sustained operating pressure and maximum surge pressure.
d) Sum of maximum pipe line static pressure and maximum surge pressure,

The testing conditions for the pipelines are summarized as follows:

- Pre test and saturation period with addition of make-up water
  Pressure : Test pressure
  Duration : 24 hrs for DI pipes with cement mortar lining

- Pressure test with addition of make-up water
  Pressure : Test pressure
  Duration : 3 hrs

The pipeline shall be filled slowly from the lowest point in such a manner as to allow expulsion of air through air release valves at highest points. The following filling rates are recommended:

Size (mm)	100	150	200	250	300	400	500	600
Filling rate (l/sec)	0.3	0.7	1.5	2.0	3.0	6.0	9.0	14.0

After filling, the pipeline shall be pressurised to the specified operating pressure and left for a period of time to achieve stable conditions. The pipeline shall then be pressurized upto the full test pressure and the section under test completely closed off. Care shall be taken to ensure that the pipeline is free of air. For this if required or if asked by the Engineer, water release test shall be carried out. The hydraulic test shall be maintained for a period of not less than 10 minutes to reveal any defect in the pipes, joints and anchorages.

If the test is not satisfactory, the fault shall be found and rectified. In case fault cannot be identified easily, the section under test shall be sub-divided and each part tested separately.

If it is required to test a section of a pipe line with a free end, it is necessary to provide temporary support against the considerable end thrust development by the application of the test pressure. The end support can be provided by inserting a wooden beam or similar

strong material in a short trench excavated at right angle to the main trench and inserting suitable packing between the support and pipe end.

Leakage Test for DI/MS Pipeline

Test criteria for permissible losses in DI pipes shall be as under

Q = 1 litre per km per length per 10mm diameter of pipe per 30mtr test pressure per 24 hrs. All pressure testing at site should be carried out hydrostatically. The pipes shall be accepted to have passed the pressure test satisfactorily, if the quantity of water required to restore the test pressure does not exceed the amount 'Q' , calculated by the above formula.

If it is required to test a section of a pipeline with a free end, it is necessary to provide temporary support against the considerable end thrust developed by the application of the test pressure. The end support can be provided by inserting a wooden beam or similar strong material in a short trench excavated at right angle to the main trench and inserting suitable packing between the support and the pipe end.

No section of the pipe work shall be accepted by the Engineer until all requirements of the test have been obtained.

On completion of a satisfactory test any temporary anchor blocks shall be broken out and stop ends removed. Backfilling of the pipeline shall be completed.

During testing if any joints are found leaking they shall be repaired and / or redone by the contractor at his cost till the test is found satisfactory. Similarly, any pipes collars, specials, show hair cracks, leaks etc. during testing the contractor shall replace them with sound pipes and specials etc. free of cost. The hydraulic test shall be given in presence of the Engineer in Charge.

Cleaning Out after Testing

On completion of a satisfactory test any temporary anchor blocks shall be broken out and stop ends removed. Backfilling of the pipeline shall be completed.

All pipes or joints which are proved to be in any way defective shall be replaced or remade and re-tested as often as may be necessary until a satisfactory test shall have been obtained. Any work which fails or is proved by test to be unsatisfactory in any way shall be redone by the contractor.

After the completed pipeline is tested, approved, backfilled and the Contractor has removed all temporary works and has reconnected any parts temporarily removed from the pipeline, the Contractor shall finally clean out the whole pipeline and flush it through with water.

Disinfection

After cleaning out, disinfection shall be performed in the following manner: after flushing the pipes the system shall be drained completely, all valves shall be closed carefully and the system filled with a strong chlorine solution of about 50 ppm free chlorine. This solution shall

remain in the system for a period as directed but not exceeding 24 hours uninterruptedly. Chlorine residual tests shall be done at various points by an orthotolidine reagent with a colour scale. The disinfection process shall be repeated until the chlorine residual is not less than 10 ppm at all sampling points. After disinfection the entire pipeline shall be rinsed with potable water till the chlorine residual is less than
4 ppm at various points of testing. Contractor will not paid separately for this activity.

After completion of disinfection and rinsing the results shall be reported by the Contractor in writing and signed by the Contractor and the Engineer.

The Contractor shall provide at his own expense such sampling points as the Engineer may direct if permanent points are not available or suitably located.

Water for Testing and Cleaning
The Contractor shall provide all water required for testing, cleaning and disinfection of the pipeline at his own cost and shall use only potable water. Contractor shall also bear the cost of chemical required for disinfection.

Disposal of water after testing, disinfection and cleaning shall be arranged by the Contractor with prior approval from the Engineer. The disposal shall be done in such a manner as will not cause any harm to any standing crop, cultivated land, damage to roads or structures, cause submergence and/or nuisance to any public or vehicular traffic.

Mode of Payment :

The payment shall be made on running meter basis which is inclusive of lowering, laying and jointing of specials also.

DTS No. 10
Lowering, laying and jointing in position following BF valve, Sluice valves, Resilience seated SV including of all labour, jointing material, including nut bolts and giving satisfactory hydraulic testing etc. complete.

(a) 150 mm dia Sluice Valve PN-1.0
(b) 200 mm dia Sluice Valve PN-1.0
(c) 250 mm dia Sluice Valve PN-1.0
(d) 300 mm dia Sluice Valve PN-1.0
(e) 350 mm dia Sluice Valve PN-1.0
(f) 400 mm dia Sluice Valve PN-1.0
(g) 450 mm dia Sluice Valve PN-1.0
(h) 500 mm dia Sluice Valve PN-1.0
(i) 600 mm dia. - B/F Valve PN 1.0 class

Valves shall be lowered and fixed in proper position and right to the plump and flange joints with the sets of tail pieces shall be carried out perfectly water tight. Nut bolts, rubber insertion etc. required for jointing shall be provided by the Contractor.

Mode of the measurement and payment:-

The rate shall be for unit of one number.

DTS No. 10A
Lowering,laying and jointing in position following Air valves including of all labour,

jointing material, including nut bolts and giving satisfactory hydraulic testing etc. complete.

(a) 150 mm dia
(b) 100 mm dia
(c) 80 mm dia

Valves shall be lowered and fixed in proper position and right to the plump and flange joints with the sets of tail pieces shall be carried out perfectly water tight. Nut bolts,rubber inseration etc.required for jointing shall be provided by the Contractor.

Mode of the measurement and payment:-
The rate shall be for unit of one number.

DTS No. 11
Providing & laying Cement Concrete 1:3:6 (1 Cement, 3 Course sand, 6 graded stone aggregate 40 mm.Nominal size) with ramming, curing etc. complete including cost of form work

(a) For Pipe Encasing
(b) For foundation and plinth.
(c) For Thrust Block

1. Item shall be carried out in general and shall be as per IS 456:1984 or revised from time to time shall be followed.

1.1 The materials like cement, sand,coarse aggregates shall be as per the general specification of the materials and as per relevant IS.

2. Concrete Mix :
In ordinary concrete, the proportion of cement to fine aggregate to carse aggregates shall be 1:3:6 i.e. one part of cement and three parts of sand and six parts of coarse aggregates. The volumeof cement is considered to be 1.20 cft.

The crushing strength of 6 "square cube shall be as per Table No.1, I.S.456 i.e.for 7 days 105.5 Kg/cm2(1500 lb/Sq.In) and for 28 days 158.2 Kg/Cm2 (2250 lbs/Sq.in).

3. Water Contents :
The water contents for an ordinary concrete mix should generaly be equal to 27 to 35 litres per bag. Allowance for surface water present in aggregates shall be made when computing the water content.

Form work :

4. General :
The form work shall confirm to shape, lines and dimensions as shown on plan and be so constructed as to remain sufficiently rigid during the placing and compacting of concrete and shall be sufficiently tight to prevent lose of liquid from the concrete.

For form work constructions of plywood or steel plates will be used except for small junction and crossing.

Clearing of forms :

All rubbish, chipping shaving and saw dust shall be removed from the interior of forms before the concrete is placed and form work in context with concrete shall be cleaned thoroughly wetted or treated with the approved composition.

Stripping time :

The frame shall be structed after expiry of following period.

(a) Vertical sides of beams and columns, columns footing -48 Hours
(b) Bottom of slabs upto 4.6 M.Span. - 7 Days
(c) Bottom of slabs above 4.6 M.to 6.0 M.Span. -14 Days
(d) Removal of props under beam upto 6 M. Span. -14 Days
(e) Removal of props under beam above 6 M.Span. -21 Days

Procedure when removing the form work :

All form work shall be removed without such sock on vibration as would damge the reinforced concrete. The concrete should be sufficiently hardened before the so fits and props are removed proper precautions shall be taken in cold whether.

5. Centering :

The centering to be provided shall got approved from the Engineer-in-charge. It shall be sufficiently strong to ensure safety of the form work and concrete work before, during and after pouring concrete,watch shall be kept to see the behaviour of centring and form work satisfactory during the concreting. Erection shall also be such that it would allow the removal of forms in proper without damaging either concrete for forms to be removed.

The props of centering should be provided in on firm foundations or base of sufficient strength to carry the load without settlement. The props shall be strong durable and not less than 3" dia.If wooden pulling are used. In case of centering of slabs, the props shall be of 3" dia c/c for beams and shall be placed not more than 2 to 2'-3" c/c.

The cross horizontal struts shall be provided at every 8"to 10" height of props. The centering and form work will be inspected and approved by the Engineer- in-charge beofre concreting. But this will not relieve the contractor or responsibility for strength and safety of the form works and centering. If there is failure of form work or centering, contractor shall be responsibile for any damage to work, or injury to life and property.

6. Scaffolding :

All scaffolding and hoisting arrangements ladders etc., required for the concreting shall be provided and removed, on completion of the work by contractor at his own expense. The scaffolding, hoisting arrangements, ladders etc. shall be strong to withstand all the live, dead, and impact, load, expected to act and shall be subject to approval of the Engineer-in-charge. However the contractor shall be completely responsible for the work and workman etc.

7. Workmanship :

The quantity of cement shall be assumed to be per bag having volume 1.2 cft. The quantity of fine and coarse aggregates shall be measured in volumetric basis i.e.steel

phromes of 0.30 x 0.30 x 0.38 high.

8. Mixing :
Concrete shall be mixed in a mechanical mixer. Mixing shall be continued until there is a uniform distribution of the materials and mass is uniform in colour and consistency.

The case of failure of the mechinary, hand mixing shall be permitted but in such cases, 10% extra cement shall have to be used without any extra cost to the Corporation.

9. Transporting :
Concrete shall be handled from the place of mixing to the place of final deposit at regidle, as practicable by methods which will present the segregation or base any in gradients. During not or cold weather, concrete shall be transported in deep containers.

10. Placing and compacting :
Concrete shall be carried out continuously upto construction joints, the position and arrangements shall be determined by the department. When the work has to be resumed on the surface which are hardened such surface shall be roughned on before the new concrete is laid.

11. Compacting :
Concrete shall be thoroughly compacted during the operation of placing and thoroughly worked around the reinforcement and into corner of form work by means of mechanical vibrator and wooden screeds, so that whole mass becomes compact and homogenous and there is no air bubble or honey combing. At the time of concreting, proper care shall be taken, so that honey combing formation is minimum.

After the form work is removed, if any such honey combing etc. work is found, it shall be immediately finished with the cement mortar 1:1, so that the crevices are properly filled and no reinforcement is exposed. If however, the honey combing is found of any severe nature and is found through out the surface of concreting, exposing the reinforcement. The concrete work shall be rejected and redone without any extra cost.

12. The concrete shall be covered with a layer of stacking canvas hession or similar absorement materials and kept constant wet for 20 days from the date of placing of concrete for R.C.C. slab cement or lime mortar cykes 7 c.m. to 10 c.m.height shall be filled with water. If proper curing arrangement is not done by contractor the same shall be done by department at risk and cost of the contractor and the contractor shall be fully responsibility for the same.

13. Testing :
The work test concrete shall be carried out as per Appendix `E' of I.S.456. The size of cubes shall be 15 cm x 15 cm x 15 cm. The mould for test specimen shall be made of steel plated. They shall not very from the std. dimension by more than one percent.

The moulds shall be so constructed that there will not be leakage of water from the test specimen during moulding.

More samples of concrete consisting six cubes sizes 150 mm x 150 mm x 150 mm shall be taken for every 45 cms. or part there of concrete work. The conctractor may taken his own arrangement for taking samples and testing of the samples in Government laboratores at his own cost. A register shall be maintained at site of the work.

Results of the test shall be as per requirements as per I.S. If the results are found slightly below the prescribed limit and within permissible range. The work shall be accepted by the Engineer-in-charge as a special case if deemed proper otherwise the work shall be rejected.

14. Finishing :
After removing the centering all exposed R.C.C.members shall be tightly chiselled to have proper key with mortar plastering work and shall be finished with cm 1:3 cement plastered of required thickness of 1/2" to bring the work in line and level including cement finishing etc.

Item includes all materials, labours, tools plants and machinery required for the satisfactory completion of item in cluding forms, centering, scaffolding and carrying out necessary test as per I.S.516:1959 including finishing etc. complete.

Rates :
The item shall be measured and paid on cubic meter basis.

DTS No. 12
Providing & laying ordinary cement concrete in C.C.1:1.5:3 (1 Cement,1.5Coarse sand & 3 coarse agreegate 20 mm Nominal Size)

(a) For RCC Slab in C.C.1:1.5:3 for valve chamber
(b) For RCC Encasing
(c) For Thrust Block

1. Materials :-
Water shall conform to M-1, Cement shall conform to M-3. Sand shall conform to M-5. Grit shall conform to M-6. Graded stone aggregate 20 mm nominal size shall conform to M-9.

2. General :-

2.1 The concrete mix is not required to designed by preliminary tests. The proportion of the concrete mix shall be 1:1 1/2:3
[1 cement:1 1/2 coarse sand:3 graded stone aggregate 20 mm nominal size] by volume Concrete work shall have exposed concrete surface or as specified the item.

2.2 The designation ordinary M-100, M-150, M-200, M-250 specified as per I.S. corresponding approximately to 1:3:6 1:2:4, 1:1:1, 1:1 1/2: 3 and 1:1:2 nominal mix of ordinary concrete by volume respectively with conforming to IS:456.

2.3 The ingredients required for ordinary work, containing one bag of cement of 50 kg. by weight [0.0342 cu.m.] for different proportion of mix shall be as under.

Grade of concrete	Total quantity of dry aggregate by volume per 50 kg. of cement to be taken as the sum of individual volume of fine and coarse aggregate maximum	Proportion of line aggregate to coarse aggreagate	Quantity of water per 50 kg.of cement maximum
M-100 [1:3:6]	300 Litres	Generally 1:2 for fine aggregate to	34 litres
M-150 [1:2:4]	220 "	Coarse aggregate by volume but subject	32 "
M-200 [1:1.5:3]	160 "	to and upper limit of 1:1 1/2 & lower	30 "
M-250 [1:1:2]	100 "	limit 1:3	27 "

2.4 The water cement ratios shall not be more then those specified in the table. The cement content of the mix specified in the table shall be increased if the quantity of water in a mix has to be increased to overcome the difficulties of placement and compaction so that the water cement ratio specified in the table is not exceeded.

2.5 Workaability of the concrete shall be controlled by maintaining a water cement ratio that is found to give a concrete mix which is just sufficiently wet to be placed and compacted without difficulty with the means available.

2.6 The maximum size of coarse aggregate shall be as large as possible within the limits specified but in no case greater than one fourth of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement throughly and to fill the corners of the form.

2.7 For reinforced concrete work, coarse aggregates having a nominal size of 20 mm enerally considered satisfactory.

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

2.9 Where the reinforcement is widely spaced as in solid slabs, limitations of size of the aggregate may not be so important and the nominal maximum size may some times be as great as or grearar than the minimum cover.

2.10 Admixture may be used in concrete only with approval of Engineer-in-charge based upon the evidance that with the passage of time; neither the compressive strength of concrete is reduced nor are other requisite qualities of concrete and steel impaired by the use of such admixtures.

3. WORKMANSHIP :

3.1 General :- The bars shall be kept in position by the following method:

In case of beam and slab construction, sufficient number of precast cover blocks in cement mortar 1:2 [1 cement 2 coarse sand] about 4 x 4 cms. section of thickness equal to the specified cover shall be placed between the bars and shuttering as to secureand maintain the requisite cover of concrete over the reinforcement.

In case or cantilevered or doubly reinforced beams or slabs, the main reinforcing bars shall be held in position by introducing cabin spacers or supports bars at 1.0 to 1.2 metres centres.

In case of columns and wall, the vertical bars shall be kept in position by means of timber timpltes with slotes accurately cut in them, the templtes shall be removed after concreting has been done below it. The bars may also be suitably tied by means of annealed steel wires to the shuttering to maintain their position during concreting.

All bars projecting from pillars, columns, beams, slabs etc. to which other bars and concrete are to be attached or bounded to lateron, shall be protected with a coat of thin neat cement grout, if the bars are not likely to be incorporated with succedding mass of concrete within the following 10 days. This coat of thin neat cement shall be removed before concreting.

3.2 Proportioning :-

Proportioning shall be done by volume, except cement which shall be measured in terms of bags of 50 kg. weight. The volume of one such bag being taken as 0.0342 cu. metre Boxes of suitable sizes shall be used for measuring sand and aggregate. The size of the boxes [internal] shall be 35x25 cms.and 40 cms.deep.While measuring the aggregate and sand,the boxes shall be filled without shaking, ramming or hammering. The proportioning of sand shall be on the basis if its dry volume and in case if damp sand, allowances for bulkage shall be made.

3.3 Mixing :-

3.3.1 For all work, concrete shall be mixed in a mechanical mixer which alongwith other accessories shall be kept in first class working condition and so maintained throughout the construction. Measured quantity of aggregate, sand and cement required for each batch shall be poured into the drum of the mechanical mixer while it is continuously running. After about haif a minute of dry mixing measured quantity of water required for each batch of concrete mix shall be added gradually and mixing continued for another one and half minute. Mixing shall be continued till materials are uniformly distributed and uniform colour of the entire mass is obtained and each individual particle of the coarse aggregate shown complete coating of mortar containing its proportinate amount of cement. In no case shall the mixing be done for less than two minutes after all ingredients have been put into the mixer.

3.3.2 When hand mixing is permitted by the Engineer-in-charge for small jobs or for certain other reasons, it shall be done on the smooth watertight platform large enought to allow efficient turning over the ingreadients of concrete before and after adding water.Mixing platform shall be so arranged that no foreign material gets mixed with concrete nor the mixing water flow out. Cement in required number of bags shall be placed in a uniform layer on top of the measured quantity of fine and coarse aggregate, which shall also be spread in a layer of uniform thickness on the mixing platform. Dry coarse and fine aggregate and cement shall then be mixed throughly

by turning over to get a mixture of uniform colour. Specified quanitty of water shall then be added gradually through a rose can and the mass turned over till a mix of required consitency is obtained. In hand mixing, quantity of cement shall be increased by 10 percent above that specified.

3.3.3 Mixer which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch, unless otherwise agreed to by the Engineer- in-charge. The first batch of concrete from the mixture shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement concrete to another.

3.4 Consistency :

The degree of consistency which shall depend upon the nature of the work and methods of vibration of concrete, shall be determined by regular slump test in accordance with I.S. 1199 : 1959. The slump of 10 mm to 25 mm shall be adopted when vibrators are used and 80 mm when vibrators are not used.

3.5 Inspection :

3.5.1 Contractor shall give the Engineer-in-charge due notice before placing any concrete in the forms to permit to inspect and accept the false work and froms as to their strength, alignmentand general fitness but such inspection shall not relieve the contractor of his res-ponsibility for the safety of men, machinary, materials and for results obtained. Immediately before concreting, all forms shall be thoroughly cleaned.

3.5.2 Centring design and its erection shall be got approved from the Engineer-in- charge. One carpenter with helper shall invariably kept present throughout the period of concreting. Movement of labour and other persons shall be totally prohibited for reinforcement laid in position. For access to different parts suitable mobile platform shall be provided so that steel reinforcement in position is not disturbed. For ensuring proper cover, mortar blocks of suitable size shall be cast and tied to the reinforcement. Timber, kapachi or metal pieces shall not be used for this purpose.

3.6 Transporting and laying :-

3.6.1 The method of transporting and placing concrete shall as approved. Concrete shall be so transported and placed that no contamination segregation or loss of its consituent material takes place.

3.6.2 All form work shall be cleaned and made free from standing water dust snow or ice immediately before placing of concrete. No concret shall be placed in any part of structure until the approval of Engineer-in-charge.

3.6.3 Concreting shall proceed continously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed. Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer. Except where otherwise agreed to by the Engineer-in-charge concrete shall be deposited in horizontal layers to a compacted depth of not more than 0.45 metre when internal vibrators are used and not exceeding 0.30 metre in all other cases.

3.6.4 Unless otherwise aggreed to by the Engineer-in-charge, concrete shall not be dropped into place from a height exceeding 2 meters.

3.6.5 When trunking or chutes are used they shall be kept close and used in such a way as to avoid segregation. When concreting has to be resumed on a surface which has hardened, it shall be roughened, swept clean, throughly wetted, and covered with a 13 mm thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself, this 13 mm layers of mortar shall be freshly mixed and placed immediately before placing of new concrete. Where concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislogement of any particles, of coarse aggregate. The surface shall then be thoroughly wetted, all free water removed, and then coated with neat cement grout, The first layers of concrete to be placed on this surface shall not exceed 150 mm in thickness and shall be well rammed against old work, particular attention being given to corners and close spot.

3.6.6 All concrete shall be compacted to produce a dense homogeneeous mass with the assistance of vibrators, unless otherwise permitted by the Engineer - in - charge for exceptional cases such as concreting under water where vibrators cannot be used. Sufficient vibrators in serviceable condition shall be kept at site so that spare equipment is always available in the event of breakdowns.

3.6.7 Concrete shall be judged to be compacted when the mortar fills the spaces between the coarse aggregate and begins to cream upto form an even surface. Compaction shall be completed before the initial setting starts i.e. within 30minutes of addition of water to dry mixture. During compaction.It shall be observed that needle vibrators are not applied on reinforcement which is likely to destory the bond between concrete and reinforcement.

3.7 Curing :-

Immediately after compaction, concrete, weather including rain, running water, shocks, vibration, traffic, rapid tempreature changes frost and drying out process it shall be covered with wet sacking, hossion or other similar absorbant material approved, soon after the initial set and shall be kept continuously wet for a period of not less than 14 days from the date of placement. Masonary work over foundation concrete may be started after 48 hours of its laying but curing of concrete shall be continued for a minimum period of 14 days.

3.8 Sampling and Testing of concrete :-

3.8.1 Samples from fresh concrete shall be taken as per IS 1199:1959 and cubes shall be made, cured and tested at 7 days and 28 days as per requirements in accordance with IS 516:1959. A random sampling procedure shall be adopted to ensure that

each concrete batch shall have a resonable chance of being tested i.e. the sampling should be spreed over the entire period of concreting and cover all mixing units. The minimum frequency of sampling of concrete of each grade shall be in accordance with following.

3.8.2 Quantity of concrete in the work — No. of samples

Quantity of concrete in the work	No. of samples
1-5 Cmt.	1
6-15 Cmt.	2
16-30 Cmt.	3
31-50 Cmt.	4
51-and above	4+one additional sample for each additional 50 cmt. or part there of.

Note:- Atleast one sample shall be taken from shift. The test specimens shall be made from each sample, five for testing at 7 days and the ramaining five at 28 days. The samples of concrete shall be taken on each day of the concreting as per above frequency. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge when procedure of tests given above reveals a poor quality of concrete and in other special cases.

3.8.3 The average strength of the group of cubes cast for each day shall not be less than the specified cube strength of 150 kg/cm2 at 28 days. 20% of the cubes cast for each day may have value less than the specified strength provided the lowest value is not less than 85% of the specified strength. If the concrete made in accordance with the proportion given for a particular grade does not yield the specified strength such concrete shall be classified as belonging the the appropriate lower grade. Concrete made in accordance with the proportions given for a particular grade shall not, however, be placed in a higher grade on the ground that the test strength are higher than the minimum specified.

3.9 Stripping :

3.9.1 The Engineer- in- charge shall be informed in advance by the contractor of his intention to struck the form work. While fixing the time for removal of form work, due consideration shall be given to local conditions, character of the structure,the weather & other conditions that influence the setting of concrete and of the materials used in the mix. In normal circumstances [generally where temperatures are above 20'c] and where ordinary concrete is used forms may by struck after expiry of period specified in the Item No.4 for respective item of form work.

3.9.2 All form work shall be removed without causing any shock or vibration as would damage the concrete. Before the soffit are removed,the concrete surface shall be exposed, where necessary in order to ascertain that the concrete has sufficiently hardened.Centring shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually. Where internal metal ties are permitted they or their removeable parts shall be extracted without causing any damage to the concrete and ramaining holes filled with mortar. No permanently embeded metal part shall have less than 25 mm. Cover to the finished concrete surface. Where it is intended to re-use the from work, it shall be cleaned and

made good to the satisfaction of the Engineer-in-charge. After removal of form work and shuttering, the Executive Engineer shall inspect the work and satisfy by random checks that concrete prosuded is of good quality.

3.9.3 Immediately after the removal of forms all exposed bolts etc. Passing through the cement member and used for shuttering or any other purpose shall be cut inside the cement concrete member to a depth of at least 25 mm. below the surface of the concrete and, the resulting holder be filled by cement mortar. All fins caused by from joints, all cavities produced by the removal of form ties and all other holes and depression, honeycomb spots, broken edges or cornersand other defects, shall be thoroughlly cleaned, saturated with water and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in the proportions used in the grade of concrete that is being finished and so as dry consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all avoids.Surfaces which are pointed shall be kept moist for a period of 24 hours.

3.9.4 If rock pockets/honeycmbs in the opinion of the Engineer-in-charge are of such an extent or character as to effect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare portions of the structure affected.

4.0 Mode of measurement and payment :

4.1 The consolidated cubical contents of concrete work as specified in item shall be measured. The concrete laid in excess of section shown on drawings or as directed shall not be measured. No deductions shall be made for.

[a] Ends of dis-similar materials such as joints, beams, posts, girders, rafters, purline, trusses, corbels and steps etc.upto 500 sq.cm. in section.

[b] Opening upto 0.1 sq.m.

[c] The volume occupied by reinforcement shall not be deducted from R.C.C.work.

4.2 The rate includes cost of all materials labour, tools and plant required for mixing, placing inposition vibrating and compacting, finishing as directed, curing and all other incidential expenses for producing concrete of specified strength. The rate excludes the cost of form work.

4.3 The rate shall be for a unit of one cubic metre.

DTS No. 13

Providing & fixing T.M.T Fe-500 Bar reinforcement for RCC work including, bending, binding and placing in position etc. complete.

(a) For Valve Chamber

(b) For RCC Encasing

(c) For Thrust Block

1.0 MATERIALS

1.1 Mild steel bars shall conform to M-14 TMT bar shall conform to M-15, Mild steel binding wires shall conform to M-17.

2.0 WORKMANSHIP

2.1 The work shall consist of furnished and placing reinforcement to the shape and

dimensions shown as on the drawings or as directed.

2.2 Steel shall be clean and free from rust and loose mill scale at the time of fixing in position and subsequent concreting.

2.3 Reinforcing steel shall conform accurately to the dimen- sions given in the bar bending schedules shown on relevant drawings.
Bars shall be bent cold to specified shape and dimensions or as directed, using a proper bar bender, operated by hand or power to attain proper radius of bends. Bars shall not be bent or straightened in a manner that will injure the material.
Bars bent during transportation or handling shall be straightened before being used on the work. They shall not be heated to facilitate bending. Unless otherwise specified for mild steel a "U" type hook at the end of each bar shall invariably be provided to main reinforcement. The radius of the bend shall not be less than twice the diameter of the round bar and the length of the straight part of the bar beyond the end of the curve shall be at least four times the diameter of the bar. In case of bars which are not round and in case of deformed bars, the diameter shall be taken as the diameter of the circle having an equivalent effective area.
The hooks shall be suitably encased to prevent any splitting of the concrete. The cold twisted steel bars shall be used without hooks at the ends. Deformed bars without hooks shall, however, comply with relevant anchorage requirements.

2.4 All the reinforcement bars shall be accurately placed in exactly the same position as shown on the drawings, and shall be securely held in position during placing of concrete by annealed binding wire not less than 1 mm. in size, and by using stay blocks or metal chair spacers, metal hangers,supporting wires or other approved devices at sufficiently close intervals. Bars shall not be allowed to sag between supports nor displaced during concreting or any other operations of the work. All devices used for positioning shall be of non-corrodible material. Wooden and metal supports shall not extend to the surface of the concrete, except where shown on the drawings. Placing bars on layers of freshly laid concrete as the work progresses for adjusting bar spacing shall not be allowed. Pieces of broken stone or brick wooden blocks shall not be used. Layers of bars shall be separated by spacer bars, precast mortar blocks or other approved devices.
Reinforcement after being placed in position shall be maintained in a clean condition until completely embedded in concrete. Special care shall be exercised to prevent any displacement of reinforcement in concrete already placed.To prevent reinforcement from corrosion, concrete cover shall be provided as indicated on drawings. All the bars are to be spliced and which are likely to be exceeding 10 days shall be protected by a thick coat of neat cement grout.

2.5 Bars crossing each other where required shall be secured by binding wires (annealed) of size not less than 1 mm.in such a manner that they do not slip over each other at the time of fixing and concreting.

2.6 As far as possible, bars of full length shall be used, in case this is not possible,overlapping of bars shall be done as directed. When practicable, overlapping bars shall not touch each other, but be kept apart by 25 mm. or 1.25 times the maximum size of the coarse aggregate whichever is greater between them. Where not feasible, overlapping bars shall be bound with annealed wires,not less than 1

mm.thick twisted tight.The overlaps shall be staggered for different bars and located at points, along the span where neither shear nor bending moment is maximum.

2.7 Whereever indicated on the drawings or desired by the Engineer-in-charge bars shall be joined by couplings which shall have a cross section sufficient to transmit the full stresses of bars. The ends of the bars that are joined by coupling shall be upset for sufficient length so that the effective cross section at the base of threads is not less than the normal cross section of the bar. Threads shall be standard threads. Steel for coupling shall conform to I.S-226.

2.8 When permitted or specified on the drawings, joints of reinforcement bars shall butt-welded so as to transmit their full stresses. Welded joints shall preferably be located at points when steel will not be subjected to more than 75% of the maximum permissible stresses and welds so staggered that at any one section not more than 20% of the rods are welded. Only electric welding using a process which excludes air from molten and conforms to any or all other special provisions for the work shall be accepted.

Suitable means shall be provided for holding bars securely in postion during welding. It shall be ensured that no voids are left in welding and when welding is done in two or three stages, previous surface shall be cleaned properly. Ends of the bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before welding. Only competent welders shall be employed on the work. The M.S. electrodes used for welding shall conform to I.S.814. Welded pieces of reinforcement shall be tested. Specimen shall be taken from the actual site and their number and frequency of test shall be as directed.

3.0 MODE OF MEASUREMENT & PAYMENT

3.1 For the purpose of calculating consumption, wastage shall not be permitted beyond 7.5%. Excess consumption over 7.5% will be charged at penal rate as per special condition of contract .

3.2 Reinforcement shall be measured in length including overlaps, separately for different diameters as actually used in the work. Where welding or coupling is resorted to, in place of lap joints, such joints shall be measured for payment as equivalent length of overlap as per design requirement. From the length so measured, the weight of reinforcement shall be calculated in tonnes on the same basis of as per M-14 even though steel is supplied to the contractor by the department on actual weight. Length shall include hooks at the ends. Wastage and annealed steel wire for binding shall not be measured and the cost of these items shall be deemed to be included in the rate for reinforcement.

3.3 The rate for reinforcement includes cost of steel binding wires,its transporting from departmental store to work site cutting,bending, placing and fixing in position as shown on the drawings and as directed. It shall also include all devices for keeping reinforcement in approved position,cost of joining as per approved method and all wastage.

3.4 The rate shall be for unit of one MT.
Note :-Read M.S.Binding wire instead of G.I. binding wire when and where specified

DTS No. 14
Providing & constructing brick work using Fly ash bricks having crushing strength not less than 35 kg/sqcm in foundation and plinth in CM (1:6) (1 cement : 6 fine sand) Conventional

1.0 MATERIALS

Water shall conform to M-1, Cement shall conform to M-3, Sand shall conform to M-5, Flyash Flyash building bricks shall conform to M-12, Cement mortar shall conform to M-8.

2.0 WORKMANSHIP

2.1 Proportion : The proportion of cement mortar shall be 1:6 (1 cement, 6 fine sand) by volume.

2.2 Wetting of Flyash building bricks : The Flyash building bricks required for masonary work shall be thoroughly wetted with clean water for about two hours before use or as directed. The cessation of bubbles, when the Flyash building bricks are wetted with water, is an indication of thorough wetting of Flyash building bricks.

2.3 Laying : Flyash building bricks shall be laid in English bond unless directed otherwise. Half or cut Flyash building bricks shall not be used except when necessary to complete the bond. Closures in such case shall be cut to required size and used near the ends of the walls.

A layer of mortar shall be spread on full width for suitable length of the lower course. Each Flyash building bricks shall first be properly bedded and set home by gently tapping with handle of trowel or wooden mallet. Its inside face shall be flushed with mortar before the next Flyash building bricks is laid and pressed against it. On completion of course, the vertical joints shall be fully filled from the top with mortar.

The walls shall be taken up truly in plumb. All courses shall be truly horizontal and all vertical joint shall be truly vertical. Vertical joints in alternate course shall generally be directly one over the other. The thickness of Flyash building bricks course shall be kept in uniform.

The Flyash building bricks shall be laid with frogs up wards. A set of tools comprising of wooden straight edges, manson's spirit level, square half metre rub, and pins, string and plumb shall be kept on the site of work for frequent checking during the progress of work.

Both the faces of walls of thickness greater than 23 cms. shall be kept in proper place. All the connected Flyash building bricks work shall be kept not more than one metre over the rest of the work. Where this is not possible, the work shall

beraked back according to bond (and not left toothed) at an angle not steeper than 45 degrees. All fixtures, pipes, outlet of water, hold fasts of doors and windows etc. which are required to be built in wall shall be embeded in cement mortar.

2.4 Joints : Flyash building bricks shall be so laid that all joints are quite flush with mortar. Thickness of joints shall not exposed 12 mm. The face joints shall be raked out
as directed by raking tool daily during the progress of work, when the mortar is still green so as to provide key for plaster or pointing to done.

The face of Flyash building bricks shall be cleaned the very day on which the Flyash Building brick work is laid and all mortar droping removed.

2.5 Curing : Green work shall be protected from rain suitably.
Masonary work shall be kept moists on all the faces for a period of seven days. The top of masonary work shall be kept well wetted at the close of the day.

2.6 Preparation of Foundation Bed : If the foundation is to be laid, directly on the excavated bed, the bed shall be levelled, cleared of all loose materials, cleaned and wetted before starting masonary.

If masonary is to be laid on concrete footing the top of concrete shall be cleaned and moistened. The contractor shall obtain the engineer's approval for the foundation bed, before foundation masonary is started. When pucca flooring is to be provided flush with the top to plinth, the inside plinth offset shall be kept lower than the outside plinth top by the thickness of the flooring.

2.7 Fixtures - The frames of doors, windows, cup-boards etc. shall be housed into the Flyash building bricks work at the correct location and level as directed. The heavy steel doors, window frames etc. shall be built in with Flyash building bricks work, but for ordinary steel doors and windows required opening for frames, hold-fasts etc. shall be left in the wall and frames embeded later on in order to avoid damage to the frames.

2.8 Scaffolding - Necessary scaffolding shall be provided. The supports of the scaffolding shall be sound and strong tied together with horizontal pieces, over which the scaffolding plunks shall be fixed. Simple scaffolding shall be allowed normally. In this case scaffolding hole shall rest in hole header horizontal course only. Minimum number of holes shall be left in Flyash building bricks work for supporting horizontal scaffolding poles. The contractor is responsible for providing and maintianing sufficiently strong scaffolding so as to withstand all loads likely to come upon it.

2.9 Packing out of Joints - For the face of Flyash building bricks work, where plastering is to be done, joints shall be raked out to a depth not less than thickness of joints. The false of Flyash building bricks work shall be cleaned and mortar dropping removed on very same day that Flyash Flyash building bricks work is laid.

3.0 MODE OF MEASUREMENTS & PAYMENT :

3.1 The measurements of this item shall be taken in cubic meter and for the Flyash

building bricks masonary fully completed for limiting dimensions not exceeding those shown on the plans or as directed shall be final.

3.2 No deductions shall be made from quantity of Flyash building bricks work. No extra payment will be made for embedding in masonary holes is respect of the following items -

i] Ends of joints, beams, posts, girders, rafters, purlins truses corbel, steps etc. where cross sectional area does not exceed 500 Sq.Cm.

ii] Opening not exceeding 1000 Sq.Cm.

iii] Wall plate sand bed plates, bearing of slab, chajjas, and like whose thickness does not exceed 10 Cms. and the bearing does not extend the full thickness of wall.

iv] Drainage holes and recesses for cement concrete blocks to embed hold fasts for doors, windows etc.

v] Iron fixtures; pipes upto 300 mm. dia. hold fasts of doors and windows built into masonary and pipes etc. for concealed wiring.

vi] Forming charges of section not exceeding 350 Sq.Cm. in masonary.

vii] Apertures for fire places, shall not be deducted nor shall extra labour required to make splaying of jamps, throating and making arches over the aperture be paid for separately.

3.3 The rate shall be for a unit of one cubic metre.

DTS No. 15

Providing and applying 10 mm thick cement plaster in single coat on brick / concrete walls similar surface for plastering and finished even and smooth with a floating coat of neat cement slurry mixed with admixture of lime or neeru required proportion etc. complete in C.M. 1:3 (1 cement : 3 sand) as directed by the Engineer-in-charge.

1.0 MATERIALS

Water shall conform to M-1. The cement mortar of proportion 1:3 shall conform to M-8.

2.0 WORKMANSHIP

2.1 Scaffolding - Wooden ballies, bamboos, planks, treatles and other scaffolding shall be sound. These shall be properly examined before erection and use. Stage scaffolding shall be provided for ceiling plaster which shall be independent of the walls.

2.2 Preparation of Background - The surface shall be cleaned of all dust, loose mortar droppings, traces of algae, afflorsence and other foreign matter by water or by brushing. Smooth surface be roughened by wire brushing if it is not hard and hacking if it is hard. In case of concrete surface, if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface. Trimming of projections on brick/concrete surfaces where necessary shall be carried out to get an

even surface. Raking of joints in case of masonary work where necessary, shall be allowed to dry out for sufficient period before carrying out the plaster work.

The work shall not be soaked but only damped evenly before applying the plaster. If the surface becomes dry, such areas shall be moistened again.

For external plaster, the plastering operation shall be started from top floor and carried downwards. For internal plaster, the plastering operations may be started wherever the building frame and cladding work are ready and the temporary supports of the ceiling resting on the wall of the floor have been removed. Ceiling plaster shall be completed before starting plaster to walls.

2.3 APPLICATION OF PLASTER

The plaster about 15 x 15 Cms. shall be first applied horizontally and vertically at not more than 2 metres intervals over the entire surface to serve as gauge. The surface gauges shall be truly in place of the finished plastered surface. The mortar shall then be applied in uniform surface slightly more than the specified thickness then brought to a true surface by working a wooden straight edge reaching across the gauges with small upward and sideways movements at a time. Finally, the surface shall be finished off true with a trowel of wooden flat according as a smooth or a sandy granular texture is required. Excessive trowelling or overworking the float shall be avoided. All corners, arises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished Rounding or chamfering, corners, junctions etc.shall be carried out with proper templates to the size required.

Cement plaster shall be used within half an hour after addition of water. Any mortar or plaster which is partially set shall be rejected and removed forthwith from the site. In suspending the work at the end of the day, the plaster shall be left out clean to the line both horizontally and vertically. When recommending the plaster, the edges of the old work shall be scrapped clean and wetted with cement putty before plaster is applied to the adjacent areas to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of the wall and nearer that 15 cms. to any corners or arises. It shall not be closed on the body of features such as plaster bands and cornices not at the corners or arrises. Horizontal points in plaster work shall not also occur on parapet tops and copings as those invariably lead to leakage. No portion of the surface shall be left out initially to be packed up later on.

Each coat shall be kept damp continuously till the next coat is applied for a minimum period of 7 days. Moistening shall commence as soon as plaster is hardened sufficiently. Soaking or walls shall be avoided and only as much water as can be readily absorbed shall be used, excessive evaporation on the sunny or windward side of building in hot air to dry weather shall be prevented by hanging mattings or gunny bags on the outside of the plaster and keeping them wet.

3. MODE OF MEASUREMENTS & PAYMENT

3.1 The rate shall include the cost of all materials, labour and scaffolding etc. involved in the operations described under workmanship.

3.2 All plastering shall be measured in square metres unless otherwise specified. Length, breadth or height shall be measured correct to a cenimetre.

3.3 Thickness of the plaster shall be exclusive of the thickness of the key i.e. grooves or open joints in brick work, stone work etc. or space between laths. Thickness of plaster shall be average thickness with minimum 10 mm. at any point on this surface.

3.4 This item includes plastering at any level.

3.5 For jambs, soffits, sills etc. for openings not exceeding 0.5 Sq.Mts. each in area for ends of joints, beams, posts, girders, step etc. not exceeding 0.5 Sq.Mts. each in area for and for openings exceeding 0.5 Sq.Mts. and not exceeding 3 Sq.Mts. in each area deductions and additions shall be made in the following manner ---

a] No deductions shall be made for ends of joints, beams, posts etc. and openings not exceeding 0.5 Sq.Mts. each and no addition shall be made for reveals, jambs, soffits, sills etc. of these openings for finish to plaster around ends of joints, beams, posts etc.

b] Deduction for openings exceeding 0.5 Sq.Mts. but not exceeding 3 Sq.Mts. each shall be made as follows and no additions shall be made for reveals, jambs, soffits sills etc. of these openings --

i] When both faces of all wall are plastered with same plaster, deduction shall be made for one face only.

ii] When two faces of wall are plastered with different types of plaster or if one face is plastered and the other pointed, deductions shall be made from the plaster or pointing on the side of frame for doors, windows etc. on which width of reveals is less than that on the other side but no deduction shall be made on the other side. Where width of reveals on both faces of all are equal, deductions of 50% of area of opening on each face shall be made from areas of plaster and/or pointing as the case may be.

3.6 The rate shall be for a unit of one Sq.Mts.

6.20.7
DETAILED TECHNICAL SPECIFICATIONS (DTS) FOR MECHANICAL WORKS (GENERAL)

TECHNICAL SPECIFICATIONS: MECHANICAL WORKS

PART- 1: PUMPS

(A/ 1) HORIZONTAL SPLIT CASING CENTRIFUGAL PUMP SET

1 SCOPE:

This specification covers the design, manufacturer, testing performance guarantee and supply of horizontal split casing centrifugal pumps. The pump shall be directly coupled with electric motors. A common base plate shall be provided for the pump motor with all accessories such as coupling, coupling guard, foundations bolts etc. complete. Manufacturer/Contractor to do pump model study, sump model study from government approved agency.

1 STANDARDS & CODES:

The horizontal split casing centrifugal pumps as specified herein shall comply with requirement for all applicable codes, regulation and safety codes in the locality where the pump sets will be installed and the pump data sheet attached.

The latest editions of the following standard shall be followed.

a) IS – 6595 (part-I): 1993 Horizontal Centrifugal Pump for clear, cold and freshwater.

b) IS – 11346:1985 Tests for agricultural & water supply pumps code of acceptance.

c) IS – 9137:1978 & IS – 5120:1977 Pumps performance tests.

2 SPECIFIC REQUIREMENT:

2.1 The contractor shall make his own assessment of the friction losses under all conditions of operation and suitable head shall be selected Data given in the data sheets is indicative.

2.2 Details of pump and motors such as discharge, efficiency, head, B.H.P., R.P.M. etc. shall be worked out and filled up by the contractor in the enclosed data sheets.

2.3 The pump sets are to be accommodated in the prescribed size of pump house. There will not be any change in the size of pump house. The layout of the pump sets shall suit to that shown in the respective pump house drawing.

2.4 Pumps shall have a continuous rising head characteristic form the operating point towards shut off without any zone of instability. Pump with dropping curves shall not be acceptable. The contractor shall submit system resistance curve superimposed on solo and parallel operation curves for the pumping station. The head capacity curve shall be continuously rising towards shut-off with the highest at shut-off head shall be minimum 120 % of the duty point head.

2.5 Pumps of each category shall be identical in all respect and shall be suitable for parallel operation and from the same manufacturer.

2.6 The power rating for motor thus selected should be higher than the power consumption on any point of the Characteristic curve.

2.7 Material of construction of pumps shall be as per data sheets enclosed.

3 GENERAL REQUIREMENT:

The calculation for system resistance is to be furnished along with offer. The Head vs Flow characteristic

of pump to be super imposed on system resistance curve for solo and parallel operation & to be enclosed with bid. The pump model shall be the one from the existing regular production range of the manufacturer.

4 CONSTRUCTION FEATURES:

Construction features shall be generally as specified here under.

4.1 CASING

Double Suction, Split Axially/ horizontally along the central axis lower half contains suction and delivery branches to facilitate dismantling inspection and repairs. Casing shall be robust construction and shall be tested to withstand 1.5 times maximum discharge pressure for 30 minutes.

4.2 IMPELLER

The impellers should double entry to eliminate thrusts and it shall be dynamically balanced to ensure freedom from vibrations. It shall be positively locked on shaft and shall not loosen under reverse rotation. In case of pumps up to 2000 rpm the impeller shall be statically and dynamically balanced. In case of pumps above 2000 rpm impeller shall be balanced as per grade G6.3 of IS 11723:1985

4.3 WEARING RINGS

It shall be or renewable type and these shall be held in place by screwing against rotation, press fit and locked with pins, flanged and screwed. Material construction shall be as per data sheet

4.4 SHAFT & SHAFT SEALS

A single piece shaft shall be designed for 0.05 mm maximum deflection at stuffing box face under worst condition of shut off head. Renewable shaft sleeves shall be provided with suitable packing to prevent leakages. Shaft shall be properly balanced so as not to cause any vibration during operation. The shaft shall be of adequate size to transmit the required power over the entire range.

The design of the shaft shall also take into consideration the critical speed of the shaft which shall be all test 20% above/below the operating speed. Mechanical seal to be provided for shaft sealing.

Material of construction shall be as per data sheet

4.5 MECHANICAL SEAL

Pumps shall be equipped with mechanical seals and sealing systems in accordance with ISO 21049, including pump and seal interface dimensions. Seal Face material shall be Silicon Carbide vs Silicon Carbide.

Seal must be designed to handle pumping of river raw water. For cooling of mechanical seal same river water will be used. No clear water will be available for seal cooling.

For flushing/quenching plan as per API-610/API-682 shall be followed. In addition, where pressure-reducing valve is required, it shall be provided.

Seal flush medium, pressure, temperature and flow rate shall be specified on each drawing The flushing piping shall be in stainless steel and cooling water piping and fittings shall be carbon

steel.

Mechanical seal shall be cartridge, balanced type. The seal box size shall be sufficient to dissipate the heat generated. Pump seal boxes shall be sized to accommodate dual mechanical seal system.

The seal cartridge shall be removable without disturbing the driver.

Pump Manufacturer is responsible for arrangement of cooling by river raw water required for bearing pedestal cooling and seal cooling stating required flow and confirming available pressure.

External fluid piping shall be designed to suit pressure / temperature of fluid.

Provisions shall be made to centre the seal gland and/or chamber with either an inside or outside diameter register fit. The register fit surface shall be concentric to the shaft and shall have a total indicated runout of not more than 125 µm (0,005 in). Using the seal gland bolts to centre mechanical seal components is not acceptable.

Seal chamber face runout (TIR) shall not exceed 0,5 µm/mm (0,000 5 in/in) of seal chamber bore.

If cooling is required, then suitable cooling plan as per API 610 / API-682 shall be provided. Seal box vent and drain piping with isolation valves manifold to other pump vent / drain connections shall be provided.

Pumps in corrosive services shall have provisions to collect and drain seal or packing leakages. Corrosion resistance of the tray material shall be equivalent to that of casing material.

Specified seal and pump connections shall be identified by symbols permanently marked into the component (such as stamped, cast, or chemically etched). Symbols shall be in accordance with those specified in ISO 21049.

Seal glands and seal chambers shall have provision for only those connections required by the seal flush plan.

Provision shall be made to ensure complete venting of the seal chamber.

Mechanical seal to be sourced from GWSSB/ GWIL approved vendors only. Shaft shall be provided with sleeve below packing / seal. Sleeve shall be locked to the shaft.

SHAFT SLEEVES

Replaceable shaft sleeves shall be provided to protect shaft where it passes through stuffing boxes. The end of the shaft sleeves shall extend through the packing gland. Shaft sleeves shall be securely locked or keyed to the shaft and shaft sleeves shall be machined and assembled for concentric rotation. Material construction shall be as per data sheet

4.6 BEARING

1. Bearings may be ball, roller or sleeve type to take on axial and radial loads generated while operation.
2. Water deflectors or any other preventive arrangement shall be made to prevent ingress of water into the bearing if such possibility exists in the system.
3. Bearings shall be easily accessible without disturbing the alignment of pumps.
4. Each bearing housing shall be provided with a drain plug.
5. Oil level indicator shall be provided in oil bath if indicating medium for the bearings is oil. In case of grease lubricated bearings (In case of grease lubrication design) following requirements have to be met with.
   a) Shaft speed should not exceed the speed limit recommended by the bearing manufacturer.
   b) Suction pressure is below 7 kg/Cm2 and with no other source of high thrust load.
6. Incase of thrust bearings, clearance adjusting arrangement shall be made. Sleeve and thrust bearings shall be fitted with spring loaded thermocoles.

4.7 COUPLING

Pump shall be furnished with flexible coupling of approved make. Spacer type coupling shall be provided so as to permit dissembling of pump without removal of pipe connections and or to permit removal of mechanical seal without disturbing pump and primemover. Both halves of coupling shall be bored and keyed to fit into the shaft of the pump and motor. Both halves shall be match marked and supplied with required no of bolts and nuts and with rubber bushing. Coupling guards of expanded metal bolted to the plate shall be supplied with each pump set..

BASE PLATE

The base plate shall be of rigid construction and fabricated out of standard steel section conforming to

IS-22. The minimum height of section shall conform to the following:

PUMP WITH DRIVE RATING UP TO	MIN. SECTION HEIGHT
7.5 KW	100 mm
18.5 KW	125 mm
45.0 KW	150 mm
75.0 KW	200 mm
75.0 KW AND ABOVE	250 mm

The base plate grouting holes shall be accessible without removing the pump and drive shall permit filling of the entire cavity the base plate without trapping air pockets.

4.8 DRIVER RATING

The minimum percentage of margin over the input power required at pump design should be provided as mentioned here under. Motor KW Shall be suitable to cover complete operating ranges.

PUMP BKW	% OF MARGIN FOR MOTOR DESIGN KW AT DUTY POINT
1.5 kW & Less	150%
1.5 to 3.7 kW	140%
3.7 to 7.5 kW	130%
7.5 to 15 kW	120%
15 to 75 kW	115%
Over 75 kW	110%

5 TESTS:

5.1 INSPECTION AND TESTING AT MANUFACTURER'S WORKS

Inspection and testing at manufacture's works shall be carried out as specified below. All instruments and equipments required for such tests shall be provided by the vendor and the instruments shall be calibrated and certified by an approved independent testing authority. The testing data of the instruments not more than one month period to the inspection. All the tests shall be carried out as per the relevant IS code. Brief description of the tests to be carried out is as follows.

5.1.1 HYDROSTATIC TEST:-Factory test certificate to be produced

All the pressure containing parts shall be tested with water at 1.5 times the maximum discharge pressure on the head characteristic curve or twice the rated pressure whichever is higher.

Unless otherwise stated in data sheet the hydrostatic test shall be conducted for a minimum duration of 30 minutes.

5.1.2 MECHANICAL BALANCING

STATIC BALANCING

Major rotating components of the pump like impeller shaft etc. shall be individually statically balanced.

DYNAMIC BALANCING

In addition to static balancing impeller and pump rotating assembly shall be dynamically balanced at rotating speed of rotation.

5.1.3 PERFORMANCE TESTING –performance test for each pump as per relevant IS

Each pump shall be tested for its full operating range in accordance with the IS standard, site condition shall be stipulated as near as possible. They shall be carried out with minimum NPSH as available at site for rated at its rated discharge and maximum discharge. Each pump shall be tested at its rated speed with

its entire working range. Test shall preferably be conducted with actual drive capacity motor. During pump testing reading to the extent possible shall be taken to correspond to the net effective range specification in the data sheet and cover its full working range from its closed valve condition to full valve open condition. Head flow and overall efficiency characteristic curves shall be drawn. The curve produced shall determine the capability of pump set to meet the guaranteed performance at site.

Pumps shall be offered for visual inspection to the purchaser before dispatch. Components of pump shall not be painted before inspection.

5.1.4 MATERIAL TEST CERTIFICATE

Material test certificate for the various pumps components shall be furnished at the time of Inspection and provided with TPI report.

6 DRAWINGS / DATASHEET

The following drawings shall be submitted by the manufacturer.

i) General arrangement drawing of Pumping station with civil foundation with all pipeline and accessories

ii) Preliminary outline dimensional drawings showing details of pump, motor, civil foundation, clearances, minimum submergence, etc.

iii) Data Sheet

iv) Performance curves for capacity V/s head, efficiency, KW requirement shall be furnished. The capacity range shall be zero flow to maximum flow.

v) Pump performence curves superimposed on system resistance curves for solo & parallel operation.

vi) Typical cross sectional drawing showing constructional details with the complete bill of material & relevant standards.

7 EVALUATION

It is clarified that no commercial implications of bids based on efficiencies shall be applicable i.e. allbids below the minimum achievable efficiencies shall be rejected while all bids meeting or exceedingthe same are to be accepted at par.

8 PENALTY:

If guaranteed efficiencies are not achieved during the test, client shall have the right to reject the pump or right to accept the equipment with lower efficiencies & shall have right to charge penalty for that.

9 INDUCTION MOTOR (TEFC) (FOR HSCF PUMP SET)

9.1 Design Requirements

The motors shall energy efficient and generally conforming to latest revision of IS 325 and 4722 with latest national & international code of practises. Additionally the specific requirements mentioned in the following clauses shall also be met.

9.2 Performance and Characteristics

Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions:

a) Variation in supply voltage + 10%

b) Variation in supply frequency + 5%

c) Combined voltage and frequency variation ±10%

LV motors shall be suitable for DOL/ star- delta/ATS starting with / without FCMA soft starter panel as the case may be.

The Power rating of the motor shall be the larger of the following :

a) 115% of the power input to the pump at duty point at a speed corresponding to the frequency of 48.5 Hz.

b) Maximum power input while operating solo or in parallel within maximum and minimum system resistances corresponding to the speed at 50Hz.

9.3 Insulation

Any joints in the motor insulation such as at coil connections or between slot and winding sections, shall have strength equivalent to that of slot sections of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The motors shall be provided with class F insulation with temperature rise limited to that of class B insulation.

Motors shall be given power house treatment. This comprises an additional treatment to the winding over and above the normal specified treatment. After the coils are placed in slots and all connections have been made, the entire motor assembly shall be impregnated by completely submerging in suitable insulating compound or varnish followed by proper baking. At least three such submersions and bakings shall be applied to the assembly.

9.4 Constructional Features

The motor construction shall be suitable for easy disassembly and reassembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repair.

Motors weighing more than 25 kg shall be provided with eyebolts, lugs or other means to facilitate safe lifting.

The rotor bars shall not be insulated in the slot portion between the iron core laminations for squirrel cage motors.

9.5 Terminal Box

Terminal boxes shall be of weather proof construction designed for outdoor service. To eliminate entry to dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame. It shall be suitable for bottom entry of cables. It shall be capable of being turned through 360 degrees in steps of 90 degrees.

The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. They shall be designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearances. Suitable cable glands and cable lugs shall be supplied to match specified cables.

9.6 Accessories

Two independent earthing points shall be provided on opposite sides of the motor, for bolted connections. These earthing points shall be in addition to earthing stud provided in the terminal box.

Note: Bidders has to enclose confirmation as regards to efficiency quoted, from original manufacturing alongwith tender documents.

9.7 L.V. Motors

Motors shall be suitable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is 85% of the rated motor voltage.

The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard).

Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation.

Stator leads shall be brought to the terminal box as insulated cable through a suitable barrier and terminated in clamp type terminals.

(A/ 2) SUBMERGED CENTRIFUGAL TYPE PUMPS

1 SCOPE:

This specification covers the design, manufacturer, testing performance guarantee and supply of submerged centrifugal pumps. The pump casing shall be of high efficiency, Volute Casing type with the Impeller mounted directly onto the Extended Solid Motor Shaft (without any couplings). Number of Stages shall be decided as per maximum efficiency as per H.I.S.

Manufacturer/Contractor to do pump model study, sump model study from government approved agency.

2 STANDARDS & CODES:

The submerged centrifugal pumps as specified herein shall comply with requirement for all applicable codes, regulation and safety codes in the locality where the pump sets will be installed.

3 DESIGN FEATURES:

The contractor shall make his own assessment of the friction losses under all conditions of operation and suitable head shall be selected Data given in the data sheets is indicative.The contractor shall submit system resistance curve for the pumping station.

Details of pump and motors such as discharge, efficiency, head, B.H.P., R.P.M. etc. shall be worked out and filled up by the contractor in the enclosed data sheets.

The head capacity curve shall be continuously rising towards shut off with the highest at shut off. The shut off head shall be atleast 120% of the specified duty point head.

Pumps of each category shall be identical in all respect and shall be suitable for parallel operation and from the same manufacturer.

4 INSTALLATION

The pumps should always be suitable for Vertical or Horizontal installation; Permanent or Portable Installation & be interchangeable between these modes throughout their working life time (by suitable use of base frames/ auto coupling systems which can be ordered either during the main P.O. or at a later stage).

The detailed scope of supply & mode of installation shall be as per the specific tender data sheets or as per CDR instructions.

The Installation Arrangements shall be any of the following type, as specified in the Data sheet:

4.1 HORIZONTAL, PORTABLE; WET (SUBMERGED) INSTALLATION :

The pump shall be offered with fully portable & robust MS portable base frame.

In case the pump is to be installed on a Concrete Canal Bed where vibrations are to be suppresed; the pump should be provided with Anti Vibration Shock Pads between the pump & the Base frame.

4.2 VERTICAL, PORTABLE; WET (SUBMERGED) INSTALLATION

The pump shall be offered with a fully portable & robust MS portable base frame which allows for installation of the pump in either Vertical or Horizontal mode – i.e. both modes should be possible with the same base frame.

4.3 VERTICAL, PERMANENT; WET INSTALLATION –I.E. AUTO COUPLING SYSTEM :

The pump set should be coupled to the rising mains by an Automatic Coupling system/directly. In case of automatic coupling system should have a pedestal (which is bolted on to sump bottom by pregrouted foundation bolts) which is permenently bolted onto the rising mains.

The automatic coupling system design should be such that a unibuilt bend is integrally cast with the pedestal. This design obviates the need of bolting on a seperate duck foot bend to pedestal. Seperately bolted CI IS DF bends are not allowed as they are not conductive to replace flange gaskets (between the CI IS DF bend and the pedestal).

To prevent swiveling of the pump set (while lowering into & pulling out of sump), Larger (with discharge size ≥ 125m) &/or Deep Installed (with installation depth more than 10m) pumps; the Auto Coupling system should compulsorily have Two Guide Elements (either Pipes or Wires) – i.e. Single Guide Element shall not be preferred.

To "fish out" a Vertically Installed Submerged Pump Set (even if a chain has not been attached to the lifting hook prior to the Pump Set being lowered) the pump should have a self centering lifting hook. Its design should be such that the lifting chain's hook can be engaged to the pump's lifting hook without the need for man to enter the wet sump to engage the same.

The scope of supply shall include Auto Coupling System (with Integral Duck Foot Bend), SS Foundation Bolts, Alloy Steel Chain & Guide Rail Pipe / Wire (as per sump depth).

5 CONSTRUCTION FEATURES:

The pump may be mounted directly into the water body (Canal / Sump / River or unscreened Jack well), so it may suck up lot of silt, clay, pebbles & vegetation. Hence it should be reliable & robust.

Construction features shall be generally as specified here under.

5.1 PUMP END

Speed: Upto 1500rpm.

The pump shall be capable of developing the required total head at rated capacity for its continuous operation. Pumps of particular category shall be identical and shall be suitable for parallel operation.

The Head - Capacity (H-Q) curve shall be continuously rising towards shut off with the highest at shut off. The shut off head shall be atleast 120% of the specified duty point head. The Impeller shall be of high efficiency Multi Channel Enclosed type.

Suction Strainer: The pump is fitted directly with a Suction Bell mouth to which is compulsorily fitted a Heavy duty Strainer (to avoid pick up of gravel, pebbles, vegetation, etc.). As per Documents. Max. Suction velocity @ strainer @ dp< 1 m/s.

The pump set shall be suitable for starting with delivery valve open as well as closed at any operating point. The motor should also start accordingly. The pump set shall be capable of withstanding the accidental rotation in reverse direction.

The pump shall be capable of developing the required total head at rated capacity for its continuous operation. Pumps of particular category shall be identical and shall be suitable for parallel operation.

The pump set shall be suitable for starting with delivery valve open as well as closed at any operating point. The motor should also start accordingly. The pump set shall be capable of withstanding the accidental rotation in reverse direction.

Fully filled up stamped data sheets, as per attached format, performence curves(Q-H, Q-P, Q-Eff, Q-NPSHr) and performence curves superimposed on system resistance curve for solo & parallel operation shall be submitted along with Technical Bid

5.2 INDUCTION MOTOR (SUBMERGED)

The motors shall energy efficient and generally conforming to latest revision of IS 325 and 4722 with latest national & international code of practises. The Motor should be Squirrel Cage, Induction type, Air Filled yet capable of Water immersion up to 20mwc for S1 duty – Motors with Oil or Water filled windings shall not be allowed.

It is suitable for available power supply. Its winding should be of Class "H" insulation * (withstanding winding hot spot temperature of up to 185°C respectively) while the nominal temp rise of winding hotspot should not exceed that of class "B".

It should be wound using Dual Coated, Super Enamelled; Copper wire with high temperature index as per I.S. 4800 Part-13. PVC / Poly propylene – poly ethylene insulation for winding wires shall not be allowed. Motor's Insulation should be Vacum Varnish Impregnated & Oven Baked to ensure Moisture Impervious & Mechanically Robust insulation. Dip or Pour type Air Dry Varnishing shall not be allowed.

The Motor Rating should be higher of the two criteria: Maximum power consumption throught the range of performance at 50 Hz OR 15 % more power consumed at duty point at 50 Hz.

Selected Min Motor Rating (Round off to next available size contractor is to offer this as Minimum rating irrespective of the Pmax or BkW of his selected pumpset)Standard commercially available motor ratings are :

- 3.7, 5.5, 7.5, 9.3, 11, 15, 18.5, 22, 30, 37, 45, 55, 75, 90, 110, 132, 160, 200, 250, 315, 400, 450 kW
- Do not select less than 3.7kW under any circumstances

The motor Rotor shall be of Dual cage Copper Bar Braszed type* to assure:

Long Corrosion free Service life

Easy of on site Repairing

Beneficial Fly Wheel type Inertial effect which reduces detrimental effects of water hammer

Better Motor Efficiency & Cooler Operating Temperature

5.2.1 Motor Cooling :

To restrict the Dead Water Level (in case of Vertical Installation) in the Sump to 1m, Medium & Large sized pumps (≥55kW) should have a Cooling Jacket – i.e. motor cooling is accomplished by circulation of pumped water between the motor casing & the jacket shell. This jacket shell is fed by cold water from the pump casing & discharges its heated water back into the sump (in case of Wet Installation) or Pump casing (in case of Dry Installation) by integrally cast ducts. There should not be any pipes, hoses, etc for this circulation.

In case the pumps are to be installed horizotally OR the dead water level in the sump or well exceeds 1.5 mts. From the pump center line, the motor can be cooled just by water immersion i.e. no jacketing is required. The mode of cooling either direct immersion or via. Jacket cooling.

5.2.2 Motor Protection

Thermal Overload Protectors (Bi Metallic Over Load Relays) should be embedded in each phase of the stator winding to detect overheating & trip the motor from the control panel in the event of the temperature exceeding the safe operating limit (above 130°C).

To detect primary Mechanical Seal's Leakage a Moisture Sensor shall be provided in intermediately Oil Chamber (& not in the Motor casing or else where) – this shall detect water mixing in oil by mode of increased leakage current from the moisture sensor.

5.3 CABLES

A watertight Cable Junction Box sealed from the motor shall be provided for the motor power and signaling cables.

The cable shall be brought directly out of the submerged motor without joints, and shall be of sufficient length as per price bid to be terminated in an IP 67 junction box outside adjacent to the wet well & above the HFL.They shall be sized in accordance with the electricity utility regulations and BS 7671.

It should have Power as well as Control Cables of Dual Sheathed EPRS / PVC Armored type with Copper Core of required size as per detail engineering. However the Cross Section of the cable shall be ample enough to ensure a Voltage Drop of not more than 2% at actual site conditions.

5.4 SHAFT & BEARINGS

The Solid Shaft shall be supported by heavy duty Ball or Roller bearings with a minimum L10 life of 75,000 hours in accordance with BS 5512. The bearings should be Permanently Greased with Premium Quality,High Temperature, Long Life Grease thereby obviating the need of re-lubrication for upto L10 life of the bearings.The Bearing should be of metric series & not imperial only.

Oil Lubricated bearings shall not be allowed.

In case the motor is to be driven via a VFD, atleast one of the bearings (DE or NDE) should be Current Insulated to prevent "electric fluting damage" caused by Harmonics.

Mechanical seal to be provided for shaft sealing.

5.5 STUFFING BOX / OIL CHAMBER

The pressurized entry of water into the motor (from the pump's volute casing) should be prevented by Two separate mechanical seals in mounted in a Tandem mode within an oil chamber.

The Primary (Inboard) seal should be of Silicon Carbide or Tungsten Carbide faces to withstand erosive wear due to any silt particles.

The Secondary (Outboard) seal should be of Carbon v/s Cast Chrome Molybdenum Steel or Silicon Carbide or Tungsten Carbide – i.e. Thermally Unstable materials like Alumina/ Aluminum Oxide shall not be allowed.

5.6 MATERIALS OF CONSTRUCTION

Unless otherwise specified in Data Sheet, the Material of Construction for the pumps shall be as follows:

Motor casing, oil chamber &other parts	2% NICI / CI IS: 210 Grade FG 260 or GG25 or EN JL1040
Rotor of submersed motor	Aluminium Die Cast or Dual Cage Copper Bar (for motors ≤ 300 HP)
	Dual Cage Copper Bar (for motors > 300 HP)
Motor cooling jacket	SS 202 or Epoxy Coated MS

(if applicable)	
Mechanical seals	**Primary (Inboard):** Silicon Carbide v/s Silicon Carbide or Tungsten Carbide v/s Tungsten Carbide
	Secondary (Outboard): Carbon v/s Cast Chrome Molybdenum Steel or Silicon Carbide or Tungsten Carbide
	Elastomers: - All "O" rings of Viton only - Bellows of either Viton or Nitrile
Fasteners	Stainless Steel or Hot Dip Galvanised BHT Alloy Steel
Auto coupling system (if applicable)	**Pedestal cum Delivery Bend** CI IS: 210 Grade FG 260 or GG25 or EN JL1040
	Slider Bracket Ductile Cast Iron or Cast Steel (SG 400/12 or EN - JS1050 or GGG 40) or WCB
	Guide Rail Pipes/ Wires & F. Bolts SS 304 or Higher grade
Pump (volute / bowl) casing	**Pumps with Head ≤ 80 m & Delivery Size≤ DN 100 mm** 2% Nickel Cast Iron
	Pumps with Head ≤ 60 m & Delivery Size≤ DN 125mm 2% Nickel Cast Iron
	Pumps with Head > 60 m & Delivery Size > DN 125 mm or Pumps with Head > 80 m Ductile Cast Iron or Cast Steel (SG 400/12 or EN - JS1050 or GGG 40 or ASTM 80 -55 - 06 or WCB)
Suction bell mouth & miscellaneous pump parts	2% Nickel Cast Iron
Impeller	Cast Austenitic Stainless Steel (SS 316 or CF 8M or 1.4406)
Wearing rings (suction head casing & impeller)	Cast Austenitic Stainless Steel (SS 316 or CF 8M or 1.4406) or Bronze
Pump motor shaft	Stainless Steel (SS 410 or SS 430 or 1.4021 or 1.4460)* * Larger Motors (i.e. > 265 HP) may be supplied with High Carbon Alloy Steel Shaft (EN 8 or DIN 1.7225 or others) protected with SS 316 Shaft Sleeves
Suction strainer	MS (C15) Fabricated with Epoxy Coating
Portable stand (if applicable)	MS (C15) Fabricated with Epoxy Coating

6 TESTS:

6.1 INSPECTION AND TESTING AT MANUFACTURER'S WORKS

The Pump Sets shall be tested at the in accordance of ISO 9906 or IS: 9137 or IS : 5120(Tolerance Class 2) ; with or without VFD.

As these pumps may be installed on specialized Auto Coupling Device, where no external bolting between the pump & the delivery piping is possible – so it is absolutely essential that this joint is leak free or else there may be a substantial ressure / Leakage Loss between the Pump & the Auto Coupling System (as they are not clamped together like conventional Casketed & Bolted Flanged Joints). So, it is compulsory that the pump should be tested on an Auto Coupling System only– i.e. testing the pump with flange, gasket bolted delivery piping is not allowed.

The Flow shall be measured by Full Bore Electro-Magnetic or Ultrasonic Flow Meters (of 0.5% or less accuracy class).

In case of MNC pump manufacturer not having adequate testing facility within reasonable distance (i.e. decided by the area of operation of the TPI); the pumps should be tested at the Alternative Test Bed or at Field within 30 days of installation which the contractor/ manufacturer is bound to offer at no extra cost. The Field Testing shall include the following:

- Motor Routine Tests:
- IR
- HV
- No load amperes, Vibration etc.

Pump Performance Testing (in accordance with IS 5120 / IS ISO 9906, Grade 2 -5% / ISO 2548- 5%) :

(1) Measurement of Head, Discharge, Motor Input at at least 6 different points to plot the Actual Performance Curves

All the Extra Charges for such Field Testing shall be borne by the Contractor. It is clarified that, in case of Field Testing Failure; GWSSB reserves the right to detain the pumps in their custody until the contractor replaces the failed pumps withNew pumps which shall again be subjected to Retesting. No extra charges shall be allowed by GWSSB to the contractor.

Pump testing should be carried out preferably with VFD. In case the pump sets are to be used with VFD then the testing has to be conducted compulsorily with VFD (to ascertain compatibility with

7 DRAWINGS / DATASHEET

The following drawings shall be submitted by the manufacturer.

i) General arrangement drawing of Pumping station with civil foundation with all pipeline and accessories

ii) Preliminary outline dimensional drawings showing details of pump, motor, civil foundation, clearances, minimum submergence, etc.

iii) Data Sheet

iv) Performance curves for capacity V/s head, efficiency, KW requirement shall be furnished. The capacity range shall be zero flow to maximum flow.

v) Performance curves superimposed on system resistance curve for solo & parallel operation.

vi) Typical cross sectional drawing showing constructional details with the complete bill of material & relevant standards.

8 EVALUATION

It is clarified that no commercial implications of bids based on efficiencies shall be applicable i.e. allbids below the minimum achievable efficiencies shall be rejected while all bids meeting or exceedingthe same are to be accepted at par.

9 PENALTY:

If guaranteed efficiencies are not achieved during the test, client shall have the right to reject the pump or right to accept the equipment with lower efficiencies & shall have right to charge penalty for that.

(A/ 3) HORIZONTAL MONO SUBMERSIBLE PUMP SET

1 GENRAL:

The Horizontal Mono Submersible Pump Sets for the Water Supply Scheme should be as per IS-14220:1994 with Latest revision. The standard specifies the technical requirement for three Phase Mono Submersible Pump sets, for handling clear cold water for water supply. The duty point of the set should be located at the optimum efficiency point of the pump rating curves and there should not be steep fall in efficiency in the operating range as specified in data sheet. The verification of the pump set performance will be as per relevant latest is at rated voltage. The pump with lesser number of stages will be preferred. R.P.M. of pump set shall be 1500 at 50 Hz.

Contractor shall be offered the Efficiency within +3 to -3 at Pump Operating Head Rang at +10 to -25 (i.e. if contractor shall be offered 50% Efficiency at Duty Point in that case 47% to 53% Efficiency are maintained at Pump Head Operating Rang +10 to -25). Three phase - 50Hz, 415 (+ 10% - 15%) volts, 2900 RPM. Minimum Motor Horse Power Rating, Cable Size, Starting System and Delivery Size shall be as per Annexure – I.

2 PUMP:

The pump Casing should be free from blow holes, sludge inclusion and other detrimental defects. Casing should be provided with renewable wearing rings except in radial flow pump set. Casing should be provided with wearing rings. Casing should be hydraulically tested up to 1.5 times shut off pressure. Shut off head shall be at least 115 % of Maximum Head Range.

2.1 IMPELLER:

Impeller should be of closed type, ensuring required performance and free of cavitation. The material of impeller will be SS CF 8M or as per BOQ/Data Sheet.

2.2 SHAFT:

The common shaft of pump & motor below the impeller shaft assembly, shaft protection sleeve shall be provided. It shall have surface finishing of 0.75 Microns. The material of shaft shall be as per data sheet

3 MOTOR:

The submersible motor shall confirm to IS: 9283/1995 with Latest revision. It should be totally enclosed squirrel cage induction type water - cooled and water lubricated sealed against entry from outside water.

The windings shall be of wet type. The thrust bearing should be of wet type water lubricated and designed to take all untoward load at most unfavorable running conditions. Front and Rear bearing housing and thrust bearing housing should preferably be fixed separate replaceable bolts/studs and (not threaded connections) to the starter to facilitate easy dismantling. Inspection agency will open the motor base and check the thrust bearing and mark the identification with hard punch or with indelible ink. If the fibber thrust bearing is provided then it shall be marked with indelible ink. Full proof sealing arrangement by sand guard shall be preferred in the Motor inlet body to prevent open well water impurities like sand, silt from entering the motor bearing Stator and Motor should be impregnated with a superior varnish class-B thermal insulation properties by vacuum pressure or epoxy paints on stator cold rolled stamping used and rotor shall be painted with Polyurethane paint & backed properly under controlled temperature condition and not by manual or gravity flow to remove air pocket so that these are thoroughly filled up by varnish. Motor rotor should be preferably lead shot blasted. Subsequently, rotor body should be baked repeatedly under controlled conditions to ensure long life of paint and hard finish to the surface to avoid corrosion before power coating.

The rotor shaft shall be as per Annexure – II and provided with sleeves having materials as per data sheet. The windings should be accessible to facilitate checking and locating any faults without disturbing all the coils and also to enable replacement of any defective coils. It should be possible to rewind the Stator with readymade protested coils in order to save time during the repair. Kelvin bridge/digital resistance meter shall be treated preferable for measurement of hot and cold resistance of winding for evaluated temperature rise. Full proof arrangement should be made for stopping the rotating of shifting of stampings inside the stator body due to operation of pump sets. Earth leakage current should not be more than 50 milli amperes at rated voltage.

The quoted H.P. of motor should meet both the following conditions;

PUMP BKW	% OF MARGIN FOR MOTOR DESIGN KW AT DUTY POINT
1.5 kW & Less	150%
1.5 to 3.7 kW	140%
3.7 to 7.5 kW	130%
7.5 to 15 kW	120%

a) Minimum H.P. rating shall not be less then the H.P. shown in the Data Sheets. However, the motor shall not get overloaded during the specified range. Also, the shut-off head of the pump shall be more than 15 % of the Duty point Head shown in data sheet

NOTE: Starting method: Up to 7.5 HP D.O.L. Starter / 8 to 20 HP Star Delta and 21 H.P. and above Auto Transformer Starting.

4 CABLE:

Motor shall be provided with Three Core Flat PVC waterproof and flexible copper submersible cable of min. 5 mt. length and of suitable size as per actual requirement. The cross sectional areas should be sufficient so as not to cause voltage drop of more than 2.5% of nominal voltage i.e. 10 volts at 400 volts throughout the length of the cable size of flat cable as per Annexure - I. The flat cable should be as per approved vendors.

5 MARKING:

A Name plate of corrosion resistance material shall be affixed on pump sets with following details:

(1) Manufacture Name

(2) Model

(3) Sr. No.

(4) Delivery size in mm.

(5) No. of Stage

(6) Head in Meters declared at duty points.

(7) Operating Head range for over loading requirement.

(8) Overall Efficiency at Duty Point.

(9) Discharge at Duty Point.

(10) Motor Rating

(11) Rated Current.

6 MATERIAL OF CONSTRUCTION

Unless otherwise specified in the Data Sheet, the materials of components of monoset Horizontal submersible pumps (as per IS- 14220-1994) shall be as follows:

Motor casing, oil chamber &other parts	CI IS: 210 Grade FG 260or GG25 or EN JL1040
Rotor of submersed motor	Aluminium Die Cast or Dual Cage Copper Bar (for motors ≤ 300 HP)
	Dual Cage Copper Bar(for motors > 300 HP)
Motor cooling jacket (if applicable)	SS 202 or Epoxy Coated MS
Mechanical seals	**Primary (Inboard):** Silicon Carbide v/s Silicon Carbide or Tungsten Carbide v/s Tungsten Carbide
	Secondary (Outboard): Carbon v/s Cast Chrome Molybdenum Steel or Silicon Carbide or Tungsten Carbide
	Elastomers: - All "O" rings of Viton only - Bellows of either Viton or Nitrile
Fasteners	Stainless Steel or Hot Dip Galvanised BHT Alloy Steel
Auto coupling system (if applicable)	**Pedestal cum Delivery Bend** 2% Nickel Cast Iron
	Slider Bracket Ductile Cast Iron or Cast Steel (SG 400/12 or EN - JS1050 or GGG 40) or WCB
	Guide Rail Pipes/ Wires & F. Bolts SS 304 or Higher grade
Pump (volute / bowl) casing	**Pumps with Head ≤ 80 m & Del Size ≤ DN 100 mm** 2% Nickel Cast Iron
	Pumps with Head ≤ 60 m & Del Size ≤ DN 125mm 2% Nickel Cast Iron
	Pumps with Head > 60 m & Delivery Size > DN 125 mm or Pumps with Head > 80 m Ductile Cast Iron or Cast Steel (SG 400/12 or EN - JS1050 or GGG 40 or ASTM 80 -55 - 06 or WCB)
Suction bell mouth & miscellaneous pump parts	2% Nickel Cast Iron
Impeller	Cast Austenitic Stainless Steel (SS 316 or CF 8M or 1.4406)
Wearing rings (suction head casing & impeller)	Cast Austenitic Stainless Steel (SS 316 or CF 8M or 1.4406) or Bronze
Pump motor shaft	Stainless Steel (SS 410 or SS 430 or 1.4021 or 1.4460)** Larger Motors (i.e. > 265 HP) may be supplied with High Carbon Alloy Steel Shaft (EN 8 or DIN 1.7225 or others) protected with SS 316 Shaft Sleeves
Suction strainer	MS (C15) Fabricated with Epoxy Coating
Portable stand (if applicable)	MS (C15) Fabricated with Epoxy Coating

7 SPECIFIC REQUIREMENTS:

Unless otherwise specified in Data sheet, the applicable specifications shall be as follows:

(1) Casing individually tested to hydraulic test pressure 1.5 times of shut off pressure.

(2) All rotating parts should be individually balanced on machine for rated RPM according to the relevant IS (and vibrations of the assembly during the testing shall not exceed to 80 micron peak to peak)

(3) Impeller closed type.

(4) Impeller material shall be SS CF 8M or as per BOQ/Datasheet

(5) Bearing bush materials SS 304.

(6) Motor as per IS: 9283 / 1994 with relevant latest amendment.

(7) Motor Wet type.

(8) Brass/Carbon steel drain plug provided

(9) Compensating device provided

(10) Stator varnished by vacuum pressure method or EPOXY painted (if cold rolled stamping used).

(11) Rotor varnished by vacuum pressure method or Epoxy Paint methane paint duty properly backed.

(12) Rotor painted and baked under controlled condition or powder coated.

(13) Winding easily assembles.

(14) Winding subjected to 1.5 KV for 30 Seconds.

(15) Matching grooves for stopping from rotation and shifting.

(16) SS 304/Brass suction strainer preferred.

(17) Stud and nuts shall be of alloy steel and nut shall be additionally " Nyloc Nut"

(18) Stator end ring shall be of bronze metal or M.S.

(19) Stator is rewind able with readymade protested coils in each type of motor offered

(20) Cable confirming to IS : 694

Note: The material component should be as per relevant ISS and with latest revision accept that shown in Data Sheet Volume III. If any details missing or further clarifications required the same should got clarify during Pre – bid meeting or otherwise the decision as may be taken their after shall be binding to all.

8 TESTING & PERFORMANCE AS PER IS-14220:1994 WITH LATEST REVISION

Motor will be tested as per IS- 9283:1995 at manufacturer works.

(1) Wherever the IS is specified it shall be as per latest revision.

(2) Winding wires shall have to be utilized as per latest IS- 9283:1995.

(3) Pumps will be tested with NRV fitted.

(4) Contractor have to give internal test report.

(5) The contractor has to maintain and produce proper record such as calibration of instrument etc. for verification by inspecting agency.

(6) The leakages current of submersible pump set shall not exceed 50 mills Ampere at rated Voltage.

(7) The contractor shall furnish their quality assurance plan to the inspecting agency that will review the same to their satisfaction.

(8) Rejection of any kind during inspection will be viewed seriously as sub standard product of manufacturer and employer will reserve the right to reject pump set under this contract.

(9) TESTING:

a) Pump Sets are to be tested as per IS – 9137:1978 & IS – 5120:1977 / IS- 14220:1994 with latest revision.

b) STRIP TEST: The inspecting agency shall dismantle the pump set precisely to carry out the strip test, which shall also include through review of the material used with reference to the relevant tests. If required to ensure the use of proper material they may also suggest carrying out any of required tests.

c) TYPE TEST: The type test certificate as per IS: 9283 with latest amendment from Government laboratory / CEIL / RITES / NPC for each Pump of Submersible Motor shall invariably be submitted at the time of Inspection.

Further at the time of inspection against supply order under this contract, the inspecting agency shall review the type test of each motor for each H.P. rating / frame size of motor as per annexure - I and if required the inspecting agency may suggest fresh type test, mat. Test certificate shall produce for review at the time of inspection.

However, if such tests are not carried out previously the same shall have to be carried out once at the time of inspection. The inspecting agency shall mention about its findings in the inspection note.

9 COST LOADING FOR BID EVALUATION

It is clarified that no commercial implications of bids based on efficiencies shall be applicable i.e. allbids below the minimum achievable efficiencies shall be rejected while all bids meeting or exceedingthe same are to be accepted at par.

PART- 2: VALVES

1 GENRAL:

Valves shall be as per internationally recognized standards. Flanges shall be manufactured as per IS:1538.

Valves shall be double flanged type and the face shall be parallel to each other and flange face should be at right angles to the valve centerline. Back side of valve flanges shall be machined or spot faced for proper seating of the head and nut.

Valve buried or installed in underground chamber, where access to a hand wheel would be impractical, shall be operated by means of extension spindle and/or keys.

Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position.

The valve stem, thrust washers, screws, nuts and all other components exposed to the water shall be of a corrosion resistant grade of stainless steel.

Valves shall be free from sharp projections.

Butterfly, non return valves and non rising spindle sluice valves size are small hence shall be provided without bypass arrangement. Butterfly shall have a gear mechanism operating arrangements with indicator to see the open close status.

(a)	IS: 14846-2000	Sluice valve for water works purposes
	Class - I	(PN 1.6/PN 1.0)
(b)	IS: 13095-1991/BS 5155	Butterfly valve for water works purposes

		(PN1.0/PN 1.6)
(c)	API 594/API 598	Dual Plate Check Valve (PN1.0/PN 1.6)
(d)	IS: 5312(Part-I):2004	Swing check type reflux (Non Return) valve (PN1.0/PN 1.6)

The tolerance on the valve dimensions shall be as per relevant standard / code but not exceeding the following;

1)	Face to face	(+) or (-) 3 mm
2)	CD of flange	(+) or (-) 3 mm
3)	Bolt circle diameter	(+) or (-) 2 mm
4)	Thickness of flange	(+) or (-) 2 mm

Dimensional tolerance on casting shall be as indicated in IS: 5519

For sluice valves located below floor, suitable floor stands for extension bonnets as required shall be provided. These shall be complete with proper extension stamps, valve stem coupling hand wheel above offer shall be minimum 600 mm.

Testing for all types of valves:

All valves shall be tested, hydraulically as per relevant IS standards. Body test and Seat test shall be carried out and checked for water tightness (wherever applicable).

Materials certificate, Physical & Chemical analysis certificates of all component of the valve shall be furnished to GWSSB.

Certified hydraulic test report for all body casting shall be furnished to GWSSB.

2 BUTTERFLY VALVE

Resilient seated butterfly valve shall be as per IS 13095-1991/ BS 5155. Valve shall be suitable for mounting in any position.

The valve seat shall be of integrally cast or replaceable design. When the valve is fully closed, the seat shall sit firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.

All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.

Valve shall be suitable for throttling purpose.

All valve, spindles and hand wheels shall be positioned to give good access for operational personnel.

Valve of diameter 450 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

Specification & M.O.C. of Butterfly valve:

2.1 General

a	Type	Both end flanged hand wheel / Gear operated
b	Rating of valves	PN1.0/PN 1.6

c	Manu. Standard	IS-13095:1991 / BS 5155
d	Sizes and quantity	As per Price schedule

2.2 Material of construction

a	Internal Hardware	S.S. AISI-304
b	Body./ Disc	CI. IS 210 FG260
c	Body ring(Retainer/seat)	Stainless steel ; AISI -304
d	Shaft Stainless steel;	AISI-410
e	Disc seat	EPDM rubber/ Nitrile rubber
f	Bush & Thrust Pad	G.M. IS :318 LTB-2 / Teflon
g	Body seat	S.S. AISI-304

3 SLUICE VALVES

Sluice valve shall conform to IS 14846-2000 relevant internationally recognized standards.

They shall be of non-rising spindle type. The valve shall be furnished with a bushing arrangement for replacement of packing without leakage. They shall also have renewable channel and shoe linings. The gap between the shoe and channel shall be limited to 1.5 mm.

The gate face rings shall be securely pegged over the full circumference.

Valve of 450mm and above shall be provided with thrust bearing arrangement for ease of operation.

Valve of diameter 400 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear of all valves shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400N.

All valves, spindles and hand wheels shall be positioned to give good access for operational personnel.

All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

3.1 Specification for Sluice Valve

Standard:	IS -14846:2000
Ends:	Flanged and drilled as per IS-1538

3.2 Material of Construction

(A)	Body:	CI. IS 210 FG260
(B)	Bonnet:	CI. IS 210 FG260
(C)	Non rising Stem:	High tensile brass, IS 320 / 6912, Gr.HTB-2 / FHTB-2 or Stainless Steel, IS 6603, Gr.12Cr1304Cr 18Ni10 04Cr17Ni.12 MO2
(D)	Wedge:	CI. IS 210 FG260
(E)	Stem Nut:	Leaded tin Bronze, IS: 318,Gr.LTB-2

(F) Body seat ring, wedge face: Leaded tin Bronze, IS: 318, Gr.LTB-2 ring & bushes.

(G) Gland packing: Jute & Hemp, IS: 5414

(H) Hand Wheel: CI. IS 210 FG260

(I) Nuts: Carbon steel, IS–1363(Part-3), Class 4.0

(J) Bolts: Carbon steel, IS-1363 (Part-3), Class 4.6

(K) Bonnet Gasket: Rubber, IS-638, Type -B

3.3 Hydro test Pressure as per IS-14846:2000

Rating	Test for	Test Pressure
PN 1.0	Body	15 kg / cm² (1.5 MPa)
	Seat	10 kg / cm² (1.0 MPa)
PN 1.6	Body	24 kg / cm² (2.4 MPa)
	Seat	16 kg / cm² (1.6 MPa)

4 NON-RETURN VALVE & DUAL PLATE CHECK VALVE

The valve shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valve body.

Valves shall possess high speed closing characteristics and be designed for minimum slam condition when closing.

Dual plate check valves shall conform to API 594 and API 598. They shall have metal to metal sealing. The spring action shall optimize the equal closing rates of each plate especially when the friction coefficients are uneven due to one plate resting upon one another. The plates shall not drag on the seat while opening. The plates shall not vibrate under full or partial flow condition.

In case of the nozzle check valve, the disc shall be correctly positioned at all times to achieve fully non-slam closure. The spring shall be fully shielded from the flow stream by the central flow diffuser.

Tilting disc non-return valve shall incorporate a double offset shaft with a variable angle tilt disc configuration. Sealing shall be metal to metal. The disc shall be stable and shall not vibrate under full or partial load conditions.

Valve of diameter greater than 450 mm shall be provided, in addition to others, feet and jacking screws. Hinge pins / shaft shall preferably be square in section to ensure positive location of flaps and provide for secure fixing.

4.1 Specification for Reflux Valve (Non Return Valve)

Standard IS:5312(Part – I):2004 with latest edition

Ends Flanged flat face and drilled in accordance IS.

Type Swing type

4.2 Materials of Construction for Reflux Valve (Non Return Valve)

(A) Body, cover,bearing holder CI. IS 210 FG260

(B) Hinge pin, door pin & door Suspension pin S.S., IS-6603, 12Cr12

(C)	Body seat rings	Stainless steel AISI-410	
(D)	Door face ring ::	Leaded Tin Bronze, IS-318, Gr.LTB-2	
(E)	Bearing bushes/ Bearing block	Leaded Tin Bronze, IS-318, Gr.LTB-2	
(F)	Plugs for hinge pin / Air release Plug	Leaded Tin Bronze, IS-318, Gr.LTB-2	
(G)	Nuts	Carbon steel, IS-1363(Part-3), Class4.0 (H)	
	Bolts	Carbon steel, IS-1363(Part-3), Class 4.6	
(I)	Gasket	Rubber, IS: 638, Type –B	

4.3 Hydro test Pressure as per IS-5312(Part – I):2000

Rating	**Test for**	**Test Pressure**
PN 1.0	Body	15 kg / cm² (1.5 MPa)
	Seat	10 kg / cm² (1.0 MPa)
PN 1.6	Body	24 kg / cm² (2.4 MPa)
	Seat	16 kg / cm² (1.6 MPa)

4.4 <u>Materials of Construction for DPCV</u>

Sr. No.	**Component**	**Material**
(a)	Body Cast Iron :	IS 210 Gr. FG 260
(b)	Disc	Aluminum Bronze
(c)	Stop & hinge pin	SS AISI-410
(d)	Seat ring (Disc)	EPDM Rubber
(e)	Bearings (Body& Plate lug)	PTFE
(f)	Body Seat	SS AISI-410
(g)	Spring	Spring steel

PART- 3: PIPES & FITTINGS: Manufactured at Site for Pump House

Supply of various jointing material like MS Specials, Flanged ends, Bolts, Nuts etc. with transportation and required for erection, testing & commissioning of suction, delivery and header piping. Pump house piping shall be conforming to IS 1239 – 2000 or (latest Edition)
The jointing material shall include:

- all types of flanges fabricated from MS plates/ flats of required thickness worked out based on the design temperature & pressure and confirming to IS 2062

- Pipe supports/ valve supports from structural steel angles/channels of required size and confirming to IS standards.

- Jointing material like nuts, bolts, washers, gaskets etc.

1. Scope of works

Providing following specials and installing on the pipeline including welding as required for

- Flanged Eccentric reducer / expander at HSFC pump discharge

- Flanges with hardware and gaskets for installing various valves and expansion bellows on the pipeline. Blind flanges at the end of header and tap off for future pumps.

- Fabricating and connecting specials and bends on pump discharge pipelines and common header to suite site conditions.

- Providing suitable fabricated supports with clamps & hardware for pump discharge pipelines to suit site conditions.

2. Technical Particulars

Sr. No.	Description	Particulars
1	Plates / HR coil	Plates / HR coil- IS:2062, Gr. B 250 BR / IS:10748 Gr.III Fe410; Minimum Thickness – 6.0mm
2	Welding & Electrodes	ASME – SECT – IX, IS – 7310, IS – 7307, IS – 9595
3	Inside Food Grade Epoxy /Outside Epoxy Coating	NACE RP 0402
4	Fabrication & Manufacturing of Pipe	I.S 1239 Part-1(Heavy Class) and / or I.S 5504

1. MS PIPELINES, APPURTENANCES SPECIALS ETC.

1.1 SCOPE

This specification covers the general requirements for supply, fabrication, delivery at site laying, jointing, testing and commissioning of all welded M.S pipeline, appurtenances, specials etc. above/below ground, including Civil works required for the same.

1.2 APPLICABLE CODES & SPECIFICATIONS

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

In case of discrepancy between this specification and those referred to herein, this specification shall govern.

1. IS: 2062 Steel for general structural purposes.
2. IS : 808 Dimensions for hot rolled steel beam, column, channel and angle sections.
3. IS : 814 Covered Electrodes for manual Metal Arc Welding of carbon and C-Mn steel.
4. BS EN 499 Welding Consumables. Covered Electrodes for Manual Metal Arc Welding of Non Alloy and Fine Grain Steel. Classification
5. AWS: A-5.1 Specification for Mild Steel Covered Arc Welding Electrodes.
6. IS : 3613 Acceptance Tests for Wire Flux combinations for Submerged - Arc Welding.
7. AWS: A-5.17 Specification for Bare Mild Steel Electrodes and Fluxes for Submerged Arc Welding
8. IS: 1367 Technical Supply Conditions for Threaded Fasteners (Parts 1 to 3).
9. IS: 2016 Plain Washers.
10. IS: 2074 Ready Mixed Paint, Red Oxide Zinc Chrome and Priming.
11. IS: 102 Ready Mixed Paint, Brushing, Red Lead, no setting, Priming.
12. IS: 1786 High Strength Deformed Steel Bars and Wires for Concrete Reinforcement
13. IS : 432 Specification for Mild Steel & (Part-I) Medium Tensile bars and hard drawn steel wire for concrete reinforcement : mild Steel & Medium tensile steel bars.
14. IS.432 Specification for mild steel & (Part-II) Medium Tensile steel bars and hard drawn steel wires for concrete reinforcement : Hard drawn steel wire
15. IS : 269 Specification for Ordinary and Low heat Portland cement
16. IS : 8041 Specification for Rapid hardening Portland Cement
17. IS : 383 Specification for coarse and fine aggregate from natural source for concrete
18. IS :12330 Specification for Sulphate Resisting Portland Cement
19. IS : 456 Code of practice for plain and reinforced concrete
20. IS : 800 Code of practice for General Construction in Steel.
21. IS : 816 Code of practice for use of Metal Arc Welding for General Construction in mild steel.
22. IS : 4353 Submerged Arc Welding of Mild Steel & Low Alloy Steels – Recommendations.

23. IS: 817 Code of practice for Training and Testing of Metal Arc Welders.
24. IS: 1182 Recommended practice for Radiographic examination of Fusion - Welded Butt Joints in steel plants
25. IS: 2595 Code of Practice for Radiographic Testing.
26. IS: 3658 Code of Practice for Liquid Penetrate Flaw Detection
27. IS: 5334 Code of practice for Magnetic Particle Flaw Detection of welds.
28. ASTM E 94 Guide for Radiographic Testing
29. ASTM E 709 Guides for Magnetic Particle Examination.
30. ASTM E 165 Test Method for Liquid Penetrate Examination.
31. IS: 3600 Methods of Testing Fusion Welded Joints and weld metal in steel (Parts 1 to 9)
32. IS: 4853 Recommended Practice for Radiographic Inspection of Fusion Welded Butt Joints in Steel Pipes.
33. IS: 1239 Seamless or Electrically welded steel pipes for Water Gas and Sewage (Up to 166.5 mm Outside Diameter)
34. IS: 3589 Seamless or Electrically welded steel pipes for Water Gas and Sewage (168.3 to 2540 Outside Diameter)
35. IS: 6631 Steel pipes for Hydraulic Purposes
36. IS: 7343 Code of practice for ultrasonic Testing of Ferrous Welded Pipes and Tubular Products
37. IS: 2598 Safety Code for Industrial Radiographic Practice
38. IS: 5822 Code of Practice for Laying of Electrically Welded steel pipes for water supply
39. IS: 1608 Mechanical testing of Metals.
40. IS: 9595 Metal Arc welding of Carbon and Carbon-Manganese Steels.
41. IS: 2825 Code of unfired Pressure Vessels
42. IS: 5504 Code for Spiral Welded PIPES(457mm to 3250mm Outside Diameter)
43. IS: 10748 Requirements for Wieldable Hot Rolled Carbon Steel Strip in Coils.
44. IS: 10234 Recommendation for radiography for general pipeline welding.
45. API-1104 Welding of pipeline & related facilities

1.3 MATERIALS

1.3.1 **Steel Coils** - The steel Coils for pipes, fittings, specials and stiffeners shall be of mild steel conforming to IS: 10748 grade III and shall bear ISI mark

1.3.2 **Welding Consumables** - such as electrodes, filler rods and wires shall conform to IS: 814, IS: 3613, IS: 6419 and IS: 7280 and shall be of GWSSB approved make (If any).

Before fabrication of pipes and specials/fittings is commenced, the copies of the mill sheets and the manufacturer's test certificates for Coils and other materials required for the fabrication shall be submitted by the Contractor to the Engineer for his approval.

1.3.3 When requested by the Engineer, the Contractor shall supply free of charge to the Employer, for testing suitable samples of the materials to be used/used in the Works. The cost of such tests shall be borne by the Contractor and shall be included in his item rates.

1.4 INSPECTION

1.4.1 All works and material under specification will be rigidly inspected during all phases of manufacture and testing and such inspection shall not relieve the Contractor of his responsibility to furnish materials and performed work in accordance with this specification.

1.4.2 The Contractor shall notify the Engineer, in advance of the production of materials and fabrication thereof, in order that the Employer may arrange for mill and shop inspection.

1.4.3 The Engineer may reject any or all materials or works that do not meet with any of the requirements of this specification. The Contractor shall rectify or replace such rejected material/performed work at his own cost, to the satisfaction of the Engineer.

1.4.4 The Engineer shall have free access to those parts of all plants or any other premises and sites that are concerned with the furnishing of materials or the performance of work under this specification.

1.4.5 The Contractor shall furnish to the Employer's inspector reasonable facilities and space without charge for inspection, testing and obtaining of any information he desires in respect of the character of material used and the progress and manner of the work.

1.4.6 The Contractor shall supply free of cost required specimen of materials for testing by the Owner at any time during the progress of work and shall bear the cost of all such tests or retests to the satisfaction of Engineer.

1.4.7 The Contractor shall provide 2 (two) sets of accurate `Go' and `No Go' ring gauges to measure the diameter of pipes specials and fitting for the use of the Engineer at no extra cost.

1.5 FABRICATION OF PIPE

1.5.1 GENERAL

1.5.1.1 All Pipes (ISI Marked) and specials shall be manufactured as per **IS: 1239 part 1/ IS: 3589 and IS: 5504** out of new mild steel HR Coils (IS: 10748 grade-III) which shall be free from any cracks, surface flaws, laminations, excessive fittings or any other defects. The pipes shall be truly cylindrical, and straight in axis. The ends shall be accurately cut and prepared for field welding. The external circumference of the pipe pieces which are to be fixed adjacent to flange adapter with fixed outer diameter shall not deviate from theoretical one by more than 1 mm. To obtain this accuracy the pipe shall be rolled several times, if necessary, as pipe pieces should be truly cylindrical. The external longitudinal welding of this pipe shall be ground smooth flush with surface to the satisfaction of the Engineer, for a length of 200 mm. No extra cost shall be charged by the Contractor for this grinding work. However, the pipe shall be manufactured as per tender specification.

1.5.1.2 Minor repair by welding or otherwise shall be permitted at the discretion of the Engineer, but such repairs shall be done only after obtaining the previous permission of the Engineer. Any pipe or part thereof which develops injurious defects during shop welding or other operations shall be rejected.

1.5.1.3 **Permissible Stress**

The permissible stress in the pipe shell shall be related to yield stress (f_y) of pipe material making due allowance for weld efficiency of the joint.

i) working stress for combined bending and direct tensile stress shall not exceed 60% of yield stress of the material making due allowance for efficiency of welded joint (as per IWWA M-1).
ii) Working stress for combined bending and direct compressive stress shall not exceed 50% of yield stress making due allowance for weld efficiency (as per IWWA M-1).
iii) It is also necessary to check the shell thickness for adequate factor of safety against failure by buckling (as per IWWA M-11).

For field welded joint, efficiency factor of 80% is generally adopted, while for shop welding joint 90% efficiency is allowed (as per IS 5822).

1.5.2 FABRICATION

1.5.2.1 The Contractor shall get the fabrication work done in a duly valid licensed factory of his own or that of an approved nominated sub-contractor. This factory meant for fabrication of pipes, specials etc. shall also be involved with testing etc., machining as well as painting. For completing the work under the present contract within the contract period, the factory shall be equipped with adequate number of various equipment and plant such as :

i) Plate bending machines for rolling of pipe drums
ii) Automatic welding machines (suitable for circumferential welding)
iii) Hydraulic Testing Machines
iv) Travelling gantry or crane of capacity 10 Tones or above.
v) Mobile cranes for loading/unloading of Coils, pipes etc. 15 tones capacity each
vi) Lathe for machining of the flanges rings, Coils etc.
vii) Equipment for sand blasting and applying paint by spray gun.
viii) Equipment for cold pressing of Coils up to 25 mm thick to the required curvature (specials, plug Coils etc.)
ix) Bending machine of adequate capacity for manufacturing ring girders and other necessary equipments.

1.5.2.2 The factory shall have adequate area, and shall also have stacking yard for the stacking of Coils, structural, fabricated pipes etc. and the scrap.

1.5.2.3 The Bidder may establish pipe fabrication factory within the project site for minimizing the transportation of pipes after fabrication to bring the pipes to the trench where pipes are to be laid. Contractor shall furnish with his bid the details of the factory where he intends to get the fabrication done, such as its location within the project site and the equipment, plant and other facilities available in the factory for the manufacture of M.S. Pipes and special required under this contract. This shall be as per the MOU executed with the pipe manufacturer.

1.5.3 CUTTING OF COILS or FROM COIL ROLLED AS PER REQUIRED SIZES

1.5.3.1 The Coils shall be indented in such length as to have minimum wastage and so as to make the pipe as far as possible.

1.5.3.2 Before cutting, all the edges of the Coils shall be cleaned by brushing/grinding on both the sides.

1.5.3.3 After the Coils are cut, the edges shall be made smooth and even by polishing with an electrical or pneumatic grinder to remove all inequalities. Care shall be taken to see that the cut edges of the plate are perfectly straight. Jigs to be used for this purpose shall depend upon the types of cutting machine used. The Coils cut to the required shape shall be checked for correctness before they are rolled into pipe drums. If any corrections are required, the Contractor shall do the same by re-cutting, if necessary.

1.5.3.4 Rolling of Coils

1.5.3.5 The Coils prepared as mentioned above are cut to the exact size shall be put into a rolling machine to form a pipe of the required diameter as under :

- The Contractor shall adjust the rolling machine so as to give a uniform curvature to the pipe throughout its circumference.
- The curvature obtained shall be checked by the Contractor's foreman during the process of rolling and if proper curvature is not obtained at any place including the ends, the rolling operation shall be repeated at this stage
- Heating of Coils to obtain the desired curvature shall not be permitted.

1.5.4 WELDING

1.5.4.1 All components of a standard shell, either straight or bent etc. shall be welded, wherever possible by use of automatic arc welding machine by Submerged Arc Welding Process with alternating current. Generally hand welding shall not be permitted except specific cases, where it is absolutely necessary. This should be done in consent with client's representative. Hand welding shall also not be permitted except for sealing runs and such other minor works at the discretion of the Engineer-in-charge. The strength of the joint shall be at least equal to that of the parent material.

1.5.4.2 The Contractor shall use electrodes of GWIL approved make and size, the size depending on the thickness of coil and the type of joint. It shall also be used with standard current and arc voltage required for the machine in use with such modifications as may be found necessary after experimental welding. For this purpose, samples of welded joints shall be prepared and tested in the presence of the Engineer. The values once determined shall be maintained throughout the work and if any modifications are to be made, a written permission of the Engineer shall be obtained. In the case of thin sheets, electric arc welding may not give satisfactory results and gas welding shall be resorted to. Gas welding shall be subject to the same specifications and tests as those for electric welds. Welding should be carried out inside as well as outside.

1.5.4.3 All the shop and field joints shall be welded, all welding shall conform to the requirements of IS 9595 and IS 4353.

1.5.4.4 All circumferential joints shall be double welded butt joints. Field joints shall be from outside, with a sealing weld from inside. End preparation for such welding shall conform to IS: 2825.

1.5.4.5 All circumferential welds involving Coils of unequal thickness shall be so kept that the inside surfaces of Coils match to provide stream lined joints without alteration in the internal diameter. As far as practicable, welding of dissimilar thickness of shells shall be carried out in the shops.

1.5.4.6 The welding shall be of the best workmanship free from flaws, burns, etc. and the Contractor shall provide for his own electrodes and equipments, ovens to keep the electrodes at the desired temperatures and dry. In order to maintain a good standard in welding, welders shall be tested by the Contractor with prior intimation to the client before they are entrusted with the job. Qualification standard for welding procedures, welders and welding operation shall conform to the requirements of IS: 7307 and IS: 7310 (latest). Periodical tests as regards their efficiency shall also be taken at intervals of about 6 months and those found inefficient shall be removed from the job. Only those who pass the test shall be posted on the job. If an incompetent welder has already welded some pipes, all welding done by him previously shall be fully checked by X-ray in addition to the regular X-ray inspections. The defects if any shall be set right to the satisfaction of the Engineer. All such check tests and rectification of defects shall be entirely at the cost of the Contractor. No pipes or steel sections shall be erected unless the work of the welder concerned has been proved to be satisfactory. Specially selected welders shall do site welds.

1.5.4.7 A record shall be maintained showing the names of welders and operators who have worked on each individual joint. Hand-welding shall preferably be carried out by a pair of welders (parallel welding putting two welders at a time both will be working in diametrically opposite side of the curvature. Welding shall be divided into 4 quadrants shall be welded simultaneously, so that by observing proper sequence, distortion can be avoided. A joint entrusted to a particular individual or a pair shall be as far as possible, completed by them in all respects, including sealing run. No helper or other unauthorized person shall be permitted to do any welding whatsoever. In case of infringement of above, the persons shall be punished as directed by the Engineer.

1.5.4.8 The welded joint after welding should not become brittle or sensitive to blows and there should be no loss of toughness due to welding or heat treatment. The material after welding and heat treatment is to be tougher than the base metal and is to retain its original ductility. No allowance will be made for thinning of weld and the weld should in no point be less than the nominal thickness of plate.

1.5.4.9 Upon receipt of the order and prior to the start of fabrication, the Contractor shall submit to the Engineer for his approval the ``welding procedure'' he intends to use in the shop work. Similarly, prior to the start of the field welding, procedure for the field welding must be submitted to the Engineer for his approval. Manual welding shall be adopted only when machine welding is not possible.

1.6 ULTRASONIC & RADIOGRAPHIC TEST OF WELDED JOINTS

1.6.1 MANUFACTURED IN SITE FACTORY/WORKSHOP

1.6.1.1 For the mild steel pipes manufactured in site factory/workshop, fabricated from mild steel Coils, 100 % of weld length of each pipe shall be subjected to Ultrasonic Test either on line or off line. (As per API 5L)

1.6.1.2 For the mild steel pipes manufactured in site Factory/Workshop fabricated from mild steel coils, 15% of weld length of each pipe shall be subjected to Radiography Test by Digital Image/ X-Ray Film Method. (As per API 1104 or IS:10234)

1.6.2 FIELD WELDED JOINTS

1.6.2. For Field welded joints, 100% of each welded joint shall be examined by Ultrasonic Test either online or offline and 15% weld length of each welded joint shall be examined by Radiography Test.

In case of failure of any of the joint during RT, the contractor is to carry out radiography of thrice the number of field joints which includes 1 Repair and 2 Penalty shots.

Subsequent to RT of thrice the number of field joints, if anyone of the joint fails the contractor has to carry out RT of all field welded joints i.e. 100 % basis. All these testing's shall be carried out by the contractor at his own risk and cost.

1.6.2.2 The weld ripples or weld surface irregularities, on both inside and outside shall be removed by any suitable mechanical process to a degree such that resulting radiographic contact due to any remaining irregularities cannot mark or be confused with that of objectionable defect. The radiograph shall be made in strict accordance with the latest requirements and as per the latest and most efficient technique either with X-ray or gamma ray equipment.

1.6.1.3 The photographs are to be marked in such a way that the corresponding portion of the welded seam can be readily identified. All radiographs will be reviewed by the Engineer to identify the defect and determine those which must be removed. Defects that are not acceptable shall be removed by chipping, machining or flame gouging to sound metal and the resulting cavities shall be welded. After rectification, the joint is to be radio graphed again to prove the quality of the repair. The Engineer based on the latest standards prescribed by Indian Standard specification will judge the radiographs as acceptable or unacceptable.

1.6.1.4 All X-ray shall be made with equipment and by personnel furnished by the Contractor. Films shall be developed within 24 hours of exposure and be readily accessible at all times for inspection by the Engineer. The Contractor shall provide for the use of the Engineer suitable X-ray viewing equipment. X-ray films shall be properly maintained by the Contractor and shall be handed over to the department on completion of the Contract. All films shall be identified by the No. and chart prepared indicating location of the joint each X-ray photo represents. In the event of additional radiographic inspections required of any work associated with the pipe erection, the Radiographer at the discretion of the Engineer shall perform such inspection.

1.7 RADIOGRAPHIC INSPECTION

1.7.1 GENERAL

1.7.1.1 The Engineer shall assure himself that the welding procedure employed in the construction of pipes has been qualified. The Contractor shall submit evidence to the Engineer that the requirements have been met. The Contractor shall certify that the welding of pipes has been done only by qualified welders and welding operators and the Engineer shall ensure himself that only qualified welders and welding operators have been used.

1.7.1.2 The Contractor shall make available to the Engineer a certified copy of the records of the qualification tests of each welder and welding operator. The Engineer shall have the right at any time to call for and witness tests of welding procedure or of the ability of any welder and welding operator.

1.7.1.2.1 Radiographic Inspection of welded joints

All welded joints to be radiographed shall be examined in accordance with

IS : 2595- Code of Practice for Radiographic Testing

IS : 4853 Recommended Practice for Radiographic Inspection of Fusion Welded Butt joints in Steel Pipes.

IS :1182 Recommended Practice for Radiographic Examination of Fusion Welded Butt-Joints in steel Coils.

1.7.1.2.2 The reinforcement on each side of all butt welded joints shall not exceed 1.5 mm. A complete set of radiographs and records as described in IS: 2595 for each job shall be retained by the Contractor and kept on file for a period of at least five years.

1.7.1.2.3 Radiographers performing radiograph shall be qualified in accordance with SNT-TC-1A. Supplements and Appendices ``Recommended Practice for Nondestructive Testing Personnel Qualification and Certification'' published by the American Society for Nondestructive Testing as applicable for the technique and methods used.

1.7.1.2.4 Final acceptance of radiographs shall be based on the ability to see the prescribed pentameter image and the specified hole.

1.7.1.2.5 The acceptance criteria for radiography of the joint shall be as per IS-10234 or as per API - 1104 standard.

1.8 THERMAL STRESS RELEIVING

Not applicable

1.9 TOLERANCE

1.9.1 The shell in the completed work shall be substantially round. The difference between maximum and minimum inside diameters at any cross section shall not exceed 1% of the nominal diameter of the cross section under consideration subject to a maximum of 10 mm.

1.9.2 Machined parts shall be within the limits specified by IS 3589.

1.9.3 Straight pipes shall have their faces perpendicular to the axis of the section with a maximum deviation of 2 mm on either side of the plane. Pipe ends shall be beveled as per IS: 3589. The pipes shall be supplied in length of 10.5 meters to 12.5 meters.

1.9.4 For the shell thickness, no negative tolerances are acceptable.

1.9.5 SHOP TESTING

1.9.5.1 After fabrication, but before application of protective coatings all pipes and specials shall be subjected to a shop hydraulic test (100%). Standard lengths of pipes shall be directly subjected to test and non-standard pipe and elbows can be tested as standard pipe before being cut to size.

1.9.5.2 **FIELD HYDRAULIC TESTING**

The Pipeline after lying at site shall be subjected to 100% Hydro testing. The test pressure shall be 1.5 times working pressure or 6 kg/cm2 whichever is higher. The pressure shall be maintained for a period of 24 hours. The length of pipe for hydro testing shall be generally 5 km as directed by Engineer-In-Charge.

1.9.5.3 Each pipe shall be filled with water and the pressure slowly and uniformly increased until the required test pressure is reached.

1.9.5.4 The pipe to be tested shall be given a serial no. which shall be painted on its inside together with details such as pipe No. Shell thickness, diameter, length etc. as directed. It shall be entered in the register to be maintained by the Contractor.

1.9.5.5 Prior to testing, the pipe shall be inspected thoroughly and all the apparent defects in welding such as jumps, porosity etc. shall be repaired by gouge and re-welding.

1.9.5.6 The hydraulic test shall be carried out under cover at the fabrication shop, in the presence of and to the satisfaction of the Engineer or the inspection agency appointed by the Employer.

1.9.5.7 For indicating the pressure inside the pipe an accurate pressure gauge of approved make duly tested and calibrated for the accuracy of readings shall be mounted on one of the closures which close the pipe ends.

1.9.5.8 The pressures shall be applied gradually by approved means and shall be maintained for a period of 24 hours. The pipe shall be hammered throughout its length with sharp blows, by means of a 1 kg. hand hammer.

1.9.5.9 The pipe shall withstand the test without showing any sign of weakness, leakage, oozing or sweating. If any leak or sweating is observed in the welded joints, the same shall be repaired by gouging and re-welding after dewatering the pipe. The repaired pipe shall be re-tested to conform to the specified pressure.

1.9.5.10 If any leak or sweating is observed in pipe shell the pipe under test shall be rejected temporarily. The Contractor shall stack such rejected pipes separately in his yard. The Engineer shall inspect the same and after taking cuts if necessary, shall determine the nature of repairs to be carried out thereon and shall then decide as to how and where they shall be used. No payment shall be made for handling or carrying out repairs, but, payment for the fabrication and hydraulic testing of the pipe shall be released only after acceptance of the pipe with necessary repairs and subsequent testing etc. are carried out by the Contractor to the satisfaction of the Engineer. The Engineer shall be supplied with two copies of the results of all the tests carried out.

The Mechanical Tests for Pipe material at Manufacturers work shall be carried as per approved Quality Assurance Plan(QAP) and tests shall be as per IS:1239/ IS:3589/IS:5504.

1.9.5.11 Testing Of Site Welded Joints

(i) The welded joints at site shall be tested for Tensile test, Bend test & Tre-panned plug in accordance with procedure laid down in as per the latest edition of IS No. 3600 "code of procedure for testing of fusion welded joints and weld metals in steel".

(ii) Test pieces shall be taken by the contractors from the welded joints at the position on fabricated pipes pointed out by the Engineer in-charge.

(iii) The sample so taken shall then be cut to the exact shape and dimensions and machined as described below and handed over to the Engineer-in-charge for testing. All the work up to and including machining and arranging for test shall be done by the contractors.

1.9.6 SUBMISSION OF DAILY PROGRESS REPORT

1.9.6.1 The Contractor shall submit to the Engineer a daily progress report in the proforma approved by the Engineer, wherein all the details of the work carried out in the factory shall be fully recorded. Similarly, works done in the various units in the factory shall be separately mentioned. The Contractor shall maintain a register of all the finished materials giving dates of carrying out important operations such as testing, transport, etc. The register shall be presented at least once a week to the Engineer who shall initial the entries after verification.

1.10 TRANSPORTING OF PIPES, SPECIALS etc.

1.10.1 All pipes and specials fabricated in the site factory / workshop and temporarily stacked in the Contractor's yard shall be transported to the site of laying after cleaning them internally etc. The loading in the factory shall be carried out by means of either a crane, gantry or shear legs, so as not to cause any damage to the finished material. Similarly, while unloading and stacking, great care shall be taken to ensure that the material is not damaged or dented. The contrivances to be used for unloading will be different in different situations and in each case the one approved by the Engineer shall be adopted. The material stacked at site shall be jointly inspected by the Engineer and the Contractor and defect or damage noticed shall be repaired to the satisfaction of the Engineer before payment is admitted.

1.10.2 Props of approved designs for maintaining circularity having M.S. Angle/Pipe at both ends to avoid metal to metal contact shall be fixed to the pipes during transit to avoid undue sagging and consequent distortion. After the pipes are carefully stacked, props should be retained till pipes are joined in trenches and then props are re-used for subsequent similar operations. The stacking ground, both in the Contractor's yard and at the site of laying shall be selected in such a way as not to get waterlogged during monsoon. If this cannot be done, the pipes shall be supported on sleepers to avoid contact with wet earth and subsequent rusting. In order to prevent sagging during transit, savings of steel Coils can be utilized by cutting to the required length and tacking the same to the pipe ends, in place of props, if approved by the Engineer.

1.10.3 As explained in earlier paragraphs, materials such as pipes, tapers, etc. may be transported to the site of laying as soon as the material is finished in all respects with the permission of the Engineer to avoid congestion in the Contractor's yard. However, materials such as expansion joints, composite bends, `T' branches and other complicated materials shall be stacked in the Contractor's yard until they are required for laying in the field. In view of this, the work of fabrication of such materials shall be properly synchronized as far as possible with the laying operations.

1.10.4 Fabricated materials such as specials, appurtenances, bolts, nuts, distance pipes, flanges, saddles, collars bypass arrangements etc. shall be transported to the site of laying from the fabrication shop according to the needs of the laying operations only. In regards access roads, the Contractor shall note that access road may lead up to some points on the alignment the Contractor shall have to make his own arrangement for connecting approaches to transport the pipes cross country to the actual site of laying at his own cost. Whatever may be the mode of transport he uses it shall be incumbent on the Contractor to carry and stack the pipes and specials along the alignment as close as possible to the site of laying.

1.11 PROCEDURE FOR RECEIVING STEEL PIPES

1.11.1 General

1.11.1.1 To ensure that the work of erecting pipes is not held up at any stage and place, the Contractor shall maintain an adequate stock of standard specials, flange rings, plug Coils, manhole covers, etc. and short length of smaller diameter pipelines, etc. at site in his field stores, in consultation with the Engineer. Wherever possible, the Contractor shall arrange one full month's requirement of pipes, specials, etc. stacked along the alignment.

1.11.2 Stacking of Pipes, etc. and Inspection

1.11.2.1 The Contractor shall keep in each section a responsible representative to take delivery of the pipes, specials and appurtenances, etc. transported from the fabricating stockyard or received from any other work site to the site of laying and to stack along the route on timber skids. Padding shall be provided between coated pipes and timber skids to avoid damage to the coating. Suitable gaps in the pipes stacked shall be left at intervals to permit access from one side to the other. The pipes, specials, appurtenances so received on site shall be jointly inspected and defects recorded, if any, such as protrusions, grooves, dents, notches, damage to the internal coating etc. shall be pointed out immediately to the Engineer at the site and in the acknowledgement challans. Such defects shall be rectified or repaired to the satisfaction of the Engineer entirely at the Contractor's risk and cost.

1.11.3 Handling of Pipes, Special Appurtenances etc.

1.11.3.1 It is essential to avoid damage to the pipes, fittings and specials, etc. or their coatings at all stages during handling. The pipes and specials shall be handled in such a manner as not to distort their circularity or cause any damage to their surface treatment. Pipes shall not be thrown down from the trucks nor shall they be dragged or rolled along hard surfaces. Slings of canvas or equally non-abrasive materials of suitable width of special attachment shaped to fit the pipe ends shall be used to lift and lower coated pipes to prevent damage to the coating.

1.11.3.2 Great care shall be taken in handling the pipe right from the first operation of manufacture until they are laid and jointed. The Contractor will provide temporary props as described earlier in order to prevent any sagging of the pipes while they are stacked in their yard and while transporting to the site of delivery, i.e. laying. The props shall be retained until the pipes are laid and welded. If at any time these props are found to be dislodged or disturbed, the Contractor shall immediately reinstate them in such a way that the true shape of the pipe shell or specials is maintained to the satisfaction of the Engineer. No defective or damaged pipe or special shall be allowed to be used in the work without rectification to the satisfaction of the Engineer. Any damage to the coating shall be repaired by the Contractor at his own cost to the satisfaction of the Engineer.

1.11.4 Dents

1.11.4.1 Whenever any dent, i.e. a significant alteration of the curvature of the pipe shell is noticed, the depth of the dent shall be measured between the lowest point of the dent and the pipe shell curvature line. All dents exceeding 2 percent of the outer diameter of the pipe shall be removed by cutting out a cylindrical portion of the pipe and replacing the same by an undamaged piece of the pipe. The Engineer may permit insert patching if the diameter of the patch is less than 25 percent of the nominal diameter of the pipe. Repairs by hammering with or without heating shall not be permitted. Any damage to the coating shall also be carefully examined and rectified.

1.11.5 Marking

1.11.5.1 The component parts of the pipes shall be carefully marked for identification in the field. The marking shall be on the side which will be the inside of the pipe after bending.

1.11.5.2 The marking operation shall be conducted with full size rulers. Only blunt nose punches should be used.

1.11.5.3 The Coils used for fabrication of pipes shall be laid out in such a way that when the shells are completed one set of original identification markings for the material will be plainly visible. In case these markings are unavoidably cut out, they shall be accurately transferred by the Contractor to a location where these markings will be visible on the completed work.

1.11.5.4 After the hydraulic tests on the specials and other items, the number of the shell in the line as it will be erected and the direction of flow shall be stamped in a prominent manner on each piece.

1.11.5.5 A register shall be maintained in suitable Performa giving the following information for each shell tested:

(a.) Serial No.
(b.) Shell No.

(c.) Date of test
(d.) Thickness and specification of steel
(e.) Weight of shell tested
(f.) Maximum test pressure
(g.) Details of test performance
(h.) Details of radiographic examination of welds
(i.) Name of Engineer's representative witnessing tests

1.11.5.6 A copy of these details shall be furnished to the owner free of cost.

1.11.5.7 No separate payment will be made for these markings and the rates for the items concerned shall be deemed to include the cost of such markings.

1.12 LAYING OF PIPELINE

1.12.1 General

1.12.1.1 Unless specified otherwise, the pipeline shall be buried with minimum cover at top, as shown on drawings. No material shall be erected unless it has been previously passed by the Engineer.

1.12.1.2 Pipe shall be protected from outside with rock shield mesh/soft murum/Sand wherever required/as directed by Engineer-In-Charge. In such cases, the depth of soft murum/sand shall be 300mm above top of pipe. The mesh shall be manufactured from HDPE material with weight per meter not less than 750 grams. The size of mesh shall be as per requirement of engineer-in-charge. The mesh shall be of such strength to protect the external coating from impact of rock during back filling.. The height of falling of rock shall range from 3 to 5 mts over top of pipe. The mesh shall be spirally wrapped over pipe with suitable overlap and properly tied with non metallic ties. The mesh shall be spirally wrapped over pipe with suitable over lap. After field joints and at all specials also shall be wrapped by rock shield protection mesh

1.12.1.3 Erection of fabricated shells shall be carried out by the Contractor who shall equip himself, at his cost, with all necessary tools, machinery, labor etc. required for the purpose.

1.12.1.4 Welding
Except for routine welding of joints, no other work shall be done in the absence of Contractor's engineer, either during the day time or at night. Chipping shall not be kept in arrears for more than 15 joints.

1.12.1.5 Temperature
The components of the pipeline such as base Coils, top Coils and pedestals have been so designed that the centers of the Coils and pedestals shall coincide at the Mean Temperature (30o).

For this reason, all works such as fixing flanges, base plate etc. in true alignment and in correct position and tack welding pipes shall be done at the mean temperature.

For ascertaining the temperature, the Contractor shall provide mercury cups and fix them to the pipe shell from outside and shall also provide thermometers of the required type and range. No extra payment shall be made for this.

1.12.2 Saddle supports

1.12.2.1 Unless otherwise specified pipeline shall be underground. However at unavoidable reaches it shall be on R.C.C. saddles spaced at about 6 m center to center. The material and construction of R.C.C./Steel structures such as saddles, anchor blocks, crossings etc. associated with the work of pipe line shall conform with the relevant I.S. codes, good engineering practice and as directed by the Engineer. The pipes to be laid on saddle supports shall be erected at mean temperature. Saddle supports shall either be sliding type or fixed type. For both the types of supports a 10mm thick double plate shall be welded to the part circumference of the pipeline that will make contact with the saddle and another similar plate shall also be embedded in the concrete saddle with necessary arrangement to facilitate welding it to the double plate welded to the pipe, in case of fixed support. In case of sliding support, the pipe shall be allowed to slide freely over the plate embedded in the saddle. Alternatively to achieve fixity, the pipe shall be anchored by providing suitable anchor block. The rate for laying the pipe on saddle support shall include for laying, aligning, tack welding, provision of rigging screws with screw eyes etc., complete.

1.12.2.2 In addition to above, the pipe shall be held in position on saddles with two numbers 50mm x 8mm thick holding down traps fixed to the saddles with holding down bolts and nuts.

1.12.3 Erection of Shells

1.12.3.1 The erection shall be true to position, lines and grade of the trench prepared or as modified by the Engineer. The Contractor shall provide at his cost necessary saddles, pads, spider etc., all necessary instruments and other materials and labour required for proper erection of shells in position and for the Engineer in checking the correctness of the erection.

1.12.3.2 Alignment of sections at edges to be butt welded shall be such that the maximum offset is not greater than the values given below:

Thickness 't' (mm)	Offset in Longitudinal joints (mm)	Offset in Girth joints (mm)
Up to 12	0.25 t	0.25 t
12 to 20	3 mm	0.25 t
20 to 40	3 mm	5 mm
40 to 50	3 mm	1/8 t
Over 50	*Lesser of 0.0625 t or 10 mm*	Lesser of 0.125 t or 20 mm

1.12.3.3 The best of welders as selected from their work in the Contractor's workshop shall be selected for in-situ welding of the shells. The relevant provision under welding such as qualification standard for welding procedures, tests on welder's work and removal of defects etc., shall also apply to in-situ welding.

1.12.4 General Sequence of Operations

1.12.4.1 Before commencing the work of pipe laying, the Contractor shall study the L-section of the pipeline for the section concerned. He shall also study the details of laying i.e. underground or aboveground. The underground pipeline shall be laid on sand cushioning/ bedding as shown on the drawing. The difference in depth due to uneven excavations shall be made up by sand cushioning.

1.12.4.2 Pipe laying shall generally start from the fixity points on either side, the expansion joints if required for pipeline aboveground being provided last. Fixing points are at all anchor blocks. Where such blocks are not required for long lengths, fixity shall be achieved by fixing the

pipeline to the special type of R.C.C. or steel saddles as specified. The distance between successive fixity points shall not exceed 300 m.

1.12.4.3 Thrust and Anchor blocks shall be constructed before commencing the pipe laying work in any section. The construction of the blocks shall be carried out in 3 stages: in the first stage the lower part up to 150 mm below the invert of the pipeline including concrete chairs to support it shall be constructed; in the second stage the pipeline on this part of the block shall be laid; and lastly, the remaining block around and over the pipeline shall be constructed.

1.12.4.4 The fixity saddles and ordinary saddles if the pipeline is aboveground shall be cast-at least 3 weeks before the pipeline is laid on them. After all saddles between successive fixity points have been cast, a line plan showing the actual position thereof shall be prepared, after taking levels and measuring distances. In case of any errors in casting the pedestals, corrections shall be applied. The pipe laying work shall then start from the fixity points and shall proceed towards the expansion joints. The method of jointing the pipes and erecting them on previously cast R.C.C. saddles shall be determined by the Contractor depending upon the type of plant equipment and personnel available with them.

1.12.4.5 The pipe strakes shall be assembled in position on the saddles either by the cranes, portable gantries, shear legs or any other equipment approved by the Engineer. Normally, not more than two pipes shall be aligned, tacked and kept in position on temporary supports. The Contractor shall not proceed with further work, until the circumferential joints of these pipes are fully welded. During assembly, the pipeline shall be supported on wooden sleepers and wedges, with the free end of the pipeline held in position by slings to avoid deflection due to temperature variations during the day. In general, the assembly of pipe strakes and one run of welding shall be done during the day time while full welding including the external gouging and sealing runs shall be done after 5 p.m. or so. The Contractor shall maintain the continuity of the work by adding two more pipes on the second day in a similar manner, after full welding of the previous joints is completed during the night. While this new work is being done, the Contractor shall proceed with the work of providing permanent supports for the pipeline assembled and welded previously.

1.12.5 Fixing Expansion Joint

The work of laying pipeline at above the ground, laying starts from the fixity points and proceeds towards the expansion joints. It shall be continued until the gap between the pipe ends is less than the lengths of the expansion joint plus pipe strake length. At this stage, the exact gap between the pipe ends shall be measured at mean temperature of that locality. Let it be `X'. Similarly, the exact length of the pipe strake and the expansion joint bought at site shall be measured at the same temperature let these be `Y' and `Z' respectively. Normally, the length of the expansion joint (`Z') is standard.

(a) Case when `Y' plus `Z' is more than `X' or equal to `X' (i.e. fixing of expansion joint without strip)

At mean temperature the exact gap between pipes shall be measured. Free ends of pipes shall be brought in a correct line and level; lateral movement, if any, shall be corrected. Then the gap between the free ends shall be made equal to the exact length of the expansion joint by cutting one of the pipe ends.

Choice of the end to be cut must be made from the point of view of bringing the expansion joint to a central position.

The expansion joints are normally supplied without packing. The normal length of the expansion joint shall be reduced by about 100 mm by cutting the inside locks and inserting the inner strake by means of turn buckles. At mean temperature this expansion joint shall be inserted inside the gap (care being taken to keep the tapered portion on the down-stream side), and both ends shall be tack welded to the pipe ends, after pulling the expansion joint. (Tacks of these two joints shall be of longer length, approximately 100 mm long).

Welding of these two joints of the expansion joints shall be started only after it is ascertained by taking observations that the expansion joint is functioning properly. The procedure to be followed for taking observations as specified .

(b) Case when `Y' plus `Z' is less than `X' (i.e. fixing of expansion joints with strap)

The expansion joint shall be laid in locked position. Before laying the pipes adjacent to the expansion joint, the exact gap between the pipes shall be calculated by taking measurements of the first pipe (upstream of the expansion joint), and the second pipe (downstream of the expansion joint) at Mean Temperature.

If the gap is less than 100 mm, the second pipe shall be cut to make the desired gap of at least 100 mm. If the gap is more than 200 mm, suitable distance piece of not less than 600 mm shall be inserted after cutting necessary length of the first pipe.

The second pipe shall then be laid in position. Then a strap of length equal to three times the gap length shall be welded to the pipe, overlapping the second pipe by the gap length. The other end of the strip shall be kept free.

At mean temperature the other end of the strap shall be tacked to the first pipe, after checking of the line and level. Simultaneously, all the locks of the expansion joint shall be removed and chipped off properly.

Welding of the joints between the strap and the first pipe shall be started only after observations are over and it is ascertained that the expansion joint is functioning properly.

(c) Observations

Before fixing the expansion joint, two mercury cups - one on the left and the other on the right side - shall be fixed on the pipe near the upstream side of the expansion joint.

Immediately after the expansion joint in case (a) above or the strap in case (b) above is tack welded, observations for total expansion or contraction shall be started and continued for 48 hours round the clock. Similarly, the central and end fixity pedestals shall be kept constantly under observation.

The expansion and contraction shall be measured by making a temporary marking on the inner strake (on the upstream side) and measuring the distance between this mark and the edge of the gland of the expansion joint.

The observations shall be recorded in the following Performa;

Reading No.	Time	Shell temp on upstream side	Shell temp on downstream side	Atmospheric temperature	Dist between edge of gland and marking
1	2	3	4	5	6

1.12.5.1 In case the pipeline is laid in trenches as shown on the drawing, after welding and field testing, the trench shall be filled with selected material up to 300 mm above pipes. This backfill shall be provided in layers not more than 150 mm, with a density more than 70 to 80% of the standard proctor density. Samples shall be tested as directed by the Engineer. Remaining depth of trenches shall be filled with ground backfill material.

1.12.6 Specials

1.12.6.1 **General**

Specials, such as tees, Y-pieces, bends (single or composite), tapers, etc. shall necessarily be in steel and shall be manufactured as per standards and tested and laid in the same manner as the pipes. Small branches, single piece bends, etc. may be fabricated at site, care being taken to ensure that the fabricated fittings have at least the same strength as the pipeline to which they are to be jointed.

1.12.6.2 **Bends**

(a) Bends shall be fabricated taking into account the vertical and horizontal angles for each case.
(b) The bends shall have welded joints and the upstream and downstream ends of each bend shall have a straight piece of variable lengths as required.
(c) Bends shall be designed with deflection angle of maximum 10 deg. between segments.
(d) When the point of intersection of a horizontal angle coincides with that of a vertical angle, or when these points can be made to coincide, a single combined or compound bend shall be used, designed to accommodate both the angles. The combined bend should have a pipe angle equal to the developed angle, arrived at from appropriate formula.
(e) All joints in bends shall be thermally stress relieved as specified.
(f) Details of thrust collars anchor bolts, holding down straps, saddle Coils should be furnished together with full specifications in Contractor's fabrication drawing.

1.12.6.3 **Manholes**

(a) Manholes of 750-mm dia shall be provided at both the sides of butterfly valves and as directed by Engineer-In-Charge. Manholes in the pipeline shall be placed in suitable position in the top quadrant.
(b) The Contractor shall fabricate different parts of manhole in conformity with relevant IS Specification, well-established practices and as directed by the Engineer.

1.12.6.4 **Closing or Make up sections**

Closing or make up sections shall be furnished at appropriate locations on the line to permit field adjustments in pipeline length to compensate for shrinkage in field welded joints, differences between actual and theoretical lengths and discrepancies in measurements.

1.12.6.5 **Heads**

Test heads may be ellipsoidal, standard dished as per ASME code or hemispherical heads. They shall be welded in the shop and removed after the test. Allowance should be made in the length of the pipe section receiving the test head for the welding and removal of the head and preparation of the plate edges for the final weld after testing.

No separate payment will be made for such test heads. The rate quoted for the hydraulic test shall be deemed to cover the cost of such installations.

1.12.6.6 **Walkways, Stairs, Ladders, Hand Rails etc**.

Walkways, stairs, rungs, ladders, hand rails, etc. shall be provided as shown in the drawings and/or as directed by the Engineer. They shall conform to well established design and construction for each accessory concerned.

1.12.6.7 **Flanges**

Flanges shall be provided at the end of pipes or special where sluice valves, blank flanges, tapers, etc. have to be introduced. The flanges received from the manufacturers will have necessary bolt holes drilled. The Contractor shall assemble the flanges in the exact position by marginal cutting, if necessary, so as to get the desired position of the sluice valves, etc. either vertical or horizontal and shall then fully weld the flanges from both sides in such a way that no part of the welding protrudes beyond the face of the flanges. In case the welding protrudes beyond the flanges and if the Engineer orders that such protrusions shall be removed, the Contractor shall file or chip them off. If required and when ordered by the Engineer, the Contractor shall provide and weld gusset stiffeners, as directed on site. The drilling pattern shall be matching with the drilling pattern of flanges of valves.

1.12.6.8 **Blank Flanges**

Blank flanges shall be provided at all ends left unattended for the temporary closure of work and also for commissioning a section of the pipeline or for testing the pipeline laid. For temporary closures, non-pressure blank flanges consisting of mild steel Coils, tack welded at the pipe ends may be used. For pipes subjected to pressures, the blank flanges or domes suitably designed as per Engineer's requirements shall be provided.

1.12.6.9 **Stiffener Rings**

The Contractor shall provide stiffener rings wherever required by design. The Contractor shall weld the same to the pipes with one circumferential run on each side.

All fillet welds shall have a throat thickness of not less than 0.7 times the width of welding.

1.12.7 Field Hydraulic Test

After erection at site and after the concrete Thrust/anchor blocks have been constructed, the pipeline shall be subjected to a 100% hydraulic test.The pressure test shall be conducted in as per IS-5822.

1.12.7.1 During the test, the pipe shall be struck sharp blows with 1 Kg hammer. Water shall not spout, ooze or sweat either through joints-welded or bolted or the body of the pipe. If any leakage noticed shall be repaired by the Contractor, which shall include coating and repairing of the damaged portion. Repairs and replacements and further testing including the cost of the Coils and other raw materials shall be carried out by the Contractor at his own cost. If any leakages are observed during the defects liability period due to defective workmanship or material supplied by the Contractor, he shall repair the same to the entire satisfaction of the Employer, at his own cost.

1.12.7.2 GWSSB shall assist the contractor in identifying the source & in obtaining permission for drawl of water for field-testing of pipe. The contractor shall pay for the water and carry the water to the test location at his cost. The cost of hydraulic testing of the installation by providing necessary testing equipment, pumping the water, creating and maintaining pressure, and the necessary bulk heads and their fixtures, and their subsequent removal and restoring the installation to working trim shall be included in the rate for laying and testing of the pipe. GWSSB may also provide water for testing and civil construction work from its adjacent pipeline at a rate of Rs. 4/- per Kiloliter, if feasible. Contractor shall seek prior permission of deptt in writing and shall water meter at his own expense.

1.12.8 Progress in Laying

1.12.8.1 The tenderer shall submit along with the tender his detailed bar chart for manufacturing and laying of the pipeline. While preparing his bar chart, the tenderer shall plan his activities such that the laying of pipes shall closely follow the manufacturing schedule and no pipes shall remain stacked in factory or at site for a period more than two months.

1.12.8.2 It is mandatory that he shall submit an approach note on how he will carry out this Work within the contractual period and on the compatible resources in terms of construction equipment and other facilities that he shall utilize to complete the tendered Work.

1.12.8.3 **Field Destruction Test**

Contractor shall perform destruction test of any section of MS Pipeline which Engineer selects at every 5 KM pipeline laid and shall submit its result to him. The testing shall be done in the NABL approved laboratory in the presence of representative of the employer.

3 SPECIFICATION FOR GUINITING FOR UNDERGROUND PIPING

3.2 Protective cement mortar coating by gunite to External Surfaces

The external surface of MS pipeline shall be provided with 25mm thick cement mortar coating by guniting. Coating shall not commence before the expiry of three days after the completion of the lining unless otherwise it is establish that the lining has attained a working strength of not less than 100 kg/sq cm. A length of 150 mm at each end of the pipe shall be left ungunited to facilitate site welding. This portion shall be lined after laying, welding and field testing of the pipeline is completed satisfactorily. If the Contractor desires so, guniting the pipe externally after lowering them in the trenches will be allowed if the Contractor evolves a suitable method and the same is approved by the Engineer. But, no extra payment will be made for widening or deepening the trenches for this purpose.

Where the pipes / specials are to be gunited externally or encased in concrete, the external surface of the pipe shall be given a coat of cement wash. The pipe surface shall be blast cleaned to the Engineer's satisfaction. Immediately after the pipe / special is blast clean, the Contractor shall commence coating of the surface with cement wash.

3.3 Mix Proportion

The proportion of cement and sand shall be 1:2, when the mix is dry. The water cement ratio shall be least that will produce a workable mix. Sulphate resisting cement conforming to IS 12330 shall be used for coating.

3.4 Thickness of Coating

The minimum thickness of the coating shall be 250mm.

3.5 Reinforcement

Minimum reinforcement in the coating shall be three percent of the quantity of the MS pipe. The reinforcement shall be wire, wound spirally or wire fabric.

The coating shall be applied before any rusting occurs to the reinforcement. Longitudinal reinforcement is required in case coating is done by vibration. The wire reinforcement may be given a tension of 500 to 750 kg/sq cm. while wrapping on the shell before the coating is applied. Welded fabric 100mm x 100mm x 3.15 mm thick wire conforming to IS 432 or equivalent MS reinforcement as approved by the Engineer. The welded fabric used shall be bent to proper shape to conform to the surface of the fitting/ special/ pipe to be coated and shall be securely held 20mm away from the surface of the pipe / special / fitting by means of spacer blocks made from cement mortar (1:1) and binding wire. Spacers shall be placed at least 30cm center to center both ways. Adjacent sheets of fabric shall lap at least 80mm and shall be securely fastened together by binding wire at intervals not exceeding 300 mm.

3.6 Preperation of Surface

The external surfaces of all pipes, to be coated with cement mortar, shall be thoroughly cleaned by wire-brush.

3.7 Hand Cleaning

Before brushing, all oil and greases on the surface of the metal shall be removed thoroughly by flushing and wiping using suitable solvents and clean rags. The use of dirty or oily rags will not be permitted. All other foreign materials shall be moved by buffing or by scrapping and wire brushing. After cleaning, the special shall be protected and maintained free of all oil, grease and dirt that might fall upon the plate from whatever source until the plate has received its cement mortar coating.

3.8 Application of Mortar Lining by Guniting

The pressure in the lower chamber of 'Cement Gun' shall be sufficient to produce a nozzle velocity of 115 to 150m per second when a tip with 19mm opening is used. The compressor used shall be of an adequate capacity to maintain a pressure of atleast 2.8Kg/sqcm at the gun end. The nozzle shall be held at such a distance (65 to 100cm) and position that the stream of flowing materials shall impinge as nearly as possible at right angles to the surface being gunited. All deposits of loose sand shall be removed prior to placing any layer of gunite. Gunite shall be shot in one coat to the specified thickness. Every precaution shall be taken to prevent the formation of sand pockets and if any develop, they shall be cut out and replaced with satisfactory machine placed material. No hand patching will be allowed. The Contractor shall apply the coating in such a manner that no sloughing shall occur at any time during or following its application.

Gunite shall be placed in the top and sides of the pipe, then screeded to a uniform thickness and the ground lines or blocks removed. All rebound and waste materials shall then be removed by air blowing and gunite placed in the bottom of the fittings and screeded. No gunite shall be placed over rebound and in case of such condition arising, the contractor shall remove at his own cost any gunite so placed. Rebound material deposited in moulds shall be removed from the site of work. When completed, the lining shall be concentric with the barrel of an even thickness. The entire surface shall then receive a final flash coat of gunite and shall be steel trowelled to a true surface equal in smoothness to the spun lining in such a manner not to impair the bond between mortar and steel plate. The guniting and surface finishing shall complete in set and shall be applied continuously without the fuse of construction joints. In case, for any reason whatsoever, the cement does not adhere to the walls of pipes and sloughs off, swabbing the pipe with cement slurry shall not be permitted.

If for any reason it is necessary to interrupt the placing of the gunite for a length of time that will result in the material taking a permanent set, a square shoulder shall be formed at the ends of the sections and or elsewhere by shooting against a backing up strip or by cutting back with a trowel or other suitable tools the irregular edges of the material last placed to a clean unbroken surface perpendicular to the face that will provide a suitable connection or construction joint between such material and the material to be placed subsequently. When performing this work care shall be taken not to shatter or disturb the material remaining in place or disturb the embedded wire mesh. Before placing fresh material against the surface of such joints, it shall be carefully cleaned and wetted to insure a good bond between the fresh material and that previously to permit sprinkling, it shall be thoroughly wetted by sprinkling and maintained in a moist condition.

3.9 Curing

Immediately upon the completion of lining of special fittings, the fittings shall be closed tightly at each end by bulkheads. After the mortar has set, but not later than twelve (12) hours after application of the lining, curing shall be commenced by the water spray method and continued thereafter for 21 days The water spray method shall consist of sprinkling the mortar lining with water by means of sprinkled heads placed within the barrel of fittings, of such

capacity to keep the entire surface of mortar lining continuously wet throughout the entire period of curing and storing.

The application of exterior coating shall begin not less than seventy two hours after the completion of interior lining but in any event, such water spray curing shall be continued inside without interruption during the application of exterior coatings and thereafter until the fitting is loaded for transportation to the trench regardless of the lapse of time after loading. Each fitting shall be closed at both ends during transportation and storage along the trench and the Contractor shall continue the interior water spraying and it shall be scheduled that all the fittings will be laid within 24 hours after such water spray has been discontinued. The Engineer at his discretion may order chemical curing as per manufacturer's specification, if in his opinion water quantity available may fall short for curing. Such chemical curing shall not be paid as extra item and shall be declared to have been considered while quoting the tender amount.

The Contractor shall protect all cement mortar from damage during handling and transportation. After the internal mortar has been cured, internal bracings shall be placed at the ends of the fitting and elsewhere, if necessary without damaging the mortar lining to preserve the roundness of the barrel of the pipe.

All such bearings except those that may interfere with the joining operation shall remain in position until the fitting has been installed and back filled.

The required testing of gunniting works as per relevant IS/BS. Absorption of water shall be between 8 to 10%.

3.10 Tolerances

Tolerance for straight pipe and fittings shall conform with the requirements of IS:3589 or as amended.

3.11 Straightness

Finished pipe sections shall be truly straight with walls parallel to the axis of the pipe and be not out of the alignment . Tolerance toward this shall be

permitted as per the stipulation of relevant IS specification.

a) Length

Straight pipe shall not vary from the specified overall length or effective length by more than plus or minus 1.0 percent; where exact or cut lengths are specified the tolerance on length shall not exceed plus 15mm or minus 0 mm.

b) Circumference

Tolerance toward this shall be permitted as per the stipulation of relevant IS specification.

c) Outside Diameter

Tolerance toward this shall be permitted as per the stipulation of relevant IS specification.

Notwithstanding the pipe section within the above mentioned tolerances shall be cause for rejection.

Handling of Pipes & Specials

Coated pipes and specials that are to be stored on supports shall bear on the uncoated ends only. If bearing on coating is employed the supports shall be not less than 20cm (8 inches) wide and so arranged to prevent damage to the coating.

During handling of the pipes and fittings, coating shall be protected not less than

20 cm wide and placing strips of heavy belting or other approved sheet materials not less than 20cm wide under all ropes or fastening.

LOWERING AND JOINTING

The pipe shall be lowered into the trenches by removing only one or two struts at a time. It shall be seen that no part of the shoring is disturbed or damaged and, if necessary, additional temporary struts may be fixed during the lowering operations. It shall also be necessary to see that the outside coating of pipe is not damaged in anyway during the lowering and assembling .After the pipe is lowered into the trench, it shall be laid in correct line and level by using the leveling instruments, sight rails, theodolite, etc. Care shall be taken to see that the longitudinal joints of two consecutive pipes at each circumferential joints are staggered by 90°. While assembling the pipes, the ends shall have to be brought close enough to leave a uniform gap not exceeding 4mm. If necessary, a marginal cut may be taken to ensure a close fit of the pipe faces. For this purpose, only experienced cutters who can make uniform and straight cuts, shall be permitted to cut the faces of the pipes. No extra payment shall be made for such marginal cutting. There shall be no lateral displacement between the pipe faces to be joined. If necessary, spiders from inside and tightening rings from outside shall be used to bring the two ends in perfect contact and alignment. It may also be necessary to use jacks for this purpose. In no case shall hammering or longitudinal slitting be permitted. When the pipe is properly assembled and checked for correct line and level, it shall be firmly supported on wooden beams and wedges and tack welded. Some portion of the trench may be refilled at this stage so as to prevent the pipeline from losing its alignment. The tack welded circumferential joints shall then be welded fully. Only experienced welders, who shall be tested from time to time shall be permitted to carry out the welding work.

On completion of the pipe jointing and external protection, the trench shall be cleaned of outside coating rebound. The welding shall be filled and compacted in 150mm layers with the bedding material. Backfilling shall be carried out as detailed here under.

Precautions against Floatation

When the pipeline laid underground or above ground in a long narrow cutting gets submerged in water collected in the trench of cutting it is subjected to an uplift pressure due to buoyancy and is likely to float if completely or partly empty. In the design of pipelines, provision is to be made to safeguard against floatation providing sufficient overburden or by providing sufficient dead weight by means of blocks, etc. Factor of safety for calculations for check against floating shall be taken as 1.2.

In the case of works extending over one or more monsoon seasons, however, special care and precautions are necessary during the progress of work on this account. The Contractor shall close down pipe laying operations well in time for the monsoon. The work of providing blocks, refilling the

earth to the required level, compacting the same, etc. shall always be done as soon as the pipeline in the cutting has been laid.

The Contractor shall see that the water shall not be allowed to accumulate in open trenches. Where work is in an incomplete stage, precautionary work, such as blank-flanging in the open ends of the pipeline and filling the pipeline with water etc. shall be taken up as directed by the Engineer.

Such works shall be to the Contractor's account and no separate payment shall be made for the same. The Contractor's rate for pipe laying shall be deemed to include such precautionary measures against floatation.

Protection of the pipeline against floatation during the Contract Period shall be the responsibility of the Contractor. Should any section of the pipeline float due to his negligence, etc. the entire cost of laying it again to the correct line and level shall be to his account.

CLEANING, DISINFECTIONING AND COMMISSIONING OF THE PIPELINE

Upon completion of a newly laid main, the main shall be disinfected as directed by the Engineer.

The main shall be flushed prior to disinfection except when the tablet method is used. After initial flushing, the hypochlorite solution shall be applied to the water main with mechanically or electrically powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solution may be fed with a hand pump.

In the case of main of large diameter, water from the existing distribution system or other approved source of supply shall be made to flow at a constant measured rate into the newly laid pipe line. The water shall receive a dose of chlorine also fed at a constant measured rate. The two rates shall be proportioned so that the concentration in the water entering the pipeline is maintained at no less than 300 mg/l. The chlorine shall be applied continuously and for a sufficient period to develop a solid column of 'Slug' of chlorinated water that will as it passes along the line expose all interior surfaces to a concentration of at least 300 mg/l. for at least 3 hours. As the chlorinated water flows past tees and crosses related valves and hydrants shall be operated so as to disinfect the appurtenances.

In the case of newly laid mains in which scrupulous cleanliness has been exercised the tablet method can be adopted and in this method, the initial flushing is dispensed with. The calcium hypochlorite tablets are placed in each section of pipe and also in hydrants, hydrant branches and other appurtenances. The tablets shall be attached by an adhesive and must be at the top of the main. The main shall then be filled with water and the water shall remain in the pipe for at least 24 hours.

After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the mains is not higher than that generally prevailing in the system or less than 1 mg/l.

After final flushing and before the water main is placed in service, a sample or samples of water shall be collected from the end of the line and tested for bacteriological quality and shall show the absence of coliform organisms. If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory, samples are obtained before the main is placed in service.

The Contractor is expected to carry out the disinfection work as a part of laying the pipes and his rates for lying the pipes should include the disinfection and other connected works till the main is placed in service, unless otherwise specified in the schedule.

DISTANCE INDICATORS AND MARKINGS

The Contractor shall supply and fix indicators on either side of major crossings along the buried pipe line. Indicators shall consist of 10 cm x 10 cm precast concrete posts 1.25 meter long, set 0.75 meter

into the ground and painted white above ground level. The description shall be written in blue at one face of the precast post.

In case of the pipeline laid above ground details such as chain age, Invert levels of pipe, appurtenance number, pedestal / saddle number, culvert number, anchor / thrust block number etc., shall be suitably marked either on the pipeline or the supporting structure etc., in distinct color. The Bidder / Contractor shall include the cost of this in his rates for the other items.

SAND BEDDING:

The sand bedding of minimum 300 mm thickness and level shall be provided below pipe, prior to laying the pipe in trenches. It shall be compacted with a light hand rammer. Any reduction in thickness due to compaction shall be made up by adding sand during ramming. For the purpose of the bedding under this item only screened fine sand of grain size not larger than 2mm shall be used. The sand shall be clean, uncoated and free form clay lumps, injurious amounts of dust, soft particles, organic matter, loam or other deleterious substances.

If the sand supplied is unclean it shall be washed. In no case shall sand containing more than 3.5 % by dry volume or 5% by wet volume of clay, loam or silt be accepted. Tests specified for determining silt in sand and organic impurities as described in IS:383 shall apply. Sieved and washed sand shall be stored on the works in such a manner as to prevent intrusion of any foreign matter, including coarser particles of sand or any clay or metal or chips. Tests as indicated above shall be performed if called for by the Engineer at the expense of the Contractor.

During the work of providing sand bedding and laying the pipeline over it, loose material from the sides or edges of the trench shall be prevented from falling inside the trench, by providing shoring and taking other measures. Also where necessary, trench shall be kept dry by pumping out seepage water continuously.

REFILLING OF TRENCHES:

On completion of the pipe laying operations in any section, for a length of about 100m and while further work is still in progress, refilling of trenches shall be started by the Contractor with a view of restricting the length of open trenches. Pipe laying shall closely follow the progress of Trench Excavation and the Contractor shall not permit unreasonably excessive lengths of trench excavation to remain open while awaiting testing of the pipeline. If the Engineer considers that the Contractor is not complying with any of the foregoing requirements, he may prohibit further trench excavation until he is satisfied with the progress of laying and testing of pipes and refilling of trenches. The excavated material nearest to the trench shall be used filling. Care shall be taken during backfilling, not to injure or disturb the pipes, joints or coating. Filling shall be carried out simultaneously on both sides of the pipes so that unequal pressure does not occur. Walking or working on the completed pipeline unless the trench has been filled to height of at least 30cm over the top of the pipe except as may be necessary for tamping etc., during backfilling work.

The remaining portion of the trench may be filled in with a mixture of hard and soft material free from boulders and clods of earth larger than 150mm in size if sufficient quantity of good earth and murrum are not available. The trench shall be refilled so as to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place. The top 300mm layer or fertile agricultural soil shall be kept aside during excavation and shall be laid in layers near ground level during refilling.

To prevent buckling of pipe shell of diameters 1200mm and above, pipes shall be strutted from inside while the work of refilling is in progress, for which no separate payment shall be made.

Strutting shall be done by means of strong spiders having at least 6 arms which shall be sufficiently stiff to resist all deformation. Spiders shall be provided at a maximum interval of 2m & shall be welded in such a way that internal coating does not get burnt.

The Engineer shall, at all times, have powers to decide which portion of the excavated materials shall be for filling and in which portion of the site and in what manner it shall be so used.

If any material remains as surplus it shall be disposed of as directed by the Engineer, which includes loading, unloading, transporting and spreading as directed within all lead. If the Contractor fails to remove the earth from site within 7 days after the period specified in a written notice, the Engineer may arrange to carry out such work at the Contractor's risk and cost or may impose such fine for such omission as he may deem fit. Particular care shall be taken to keep the trench dry during the entire refilling operation.

If suitable material for refilling is not available for excavation the Contractor shall bring earth, murrum of approved quality as directed by the Engineer.

No mechanical plant other than approved compacting equipment shall run over or operate within the trench until backfilling has reached its final level or the approval of the Engineer has been obtained.

Subsidence in filling in : Should any subsidence take place either in the filling of the trenches or near about it during the maintenance period of 12 months from the completion of the Contract Works, the Contractor shall make good the same at his own cost or the Engineer may without notice to the Contractor, make good the same in any way and with any material that he may think proper, at the expense of the Contractor. The Engineer may also, if he anticipates occurrence of any subsidence, employ persons to give him timely notice of the necessity of making good the same, and the expenses on this account shall be charged to the Contractor.

BOX PUSHING THROUGH EMBANKMENT

Providing and casting reinforced concrete approved design mix design mix Box of the size as per GAD, including providing and casting steel cutting edge for front shield, MS rear shield R.C.C. M-20 for thrust bed, thrust wall for pushing the box below railway embankment under railway / roads under running traffic condition as per contractors own design / drawing including arrangements for intermediate jacking station with provision of intermediate shield and its connections with the box drag sheets as may be required for smooth controlled pushing etc. complete in all respects, including cost of necessary excavation with its all lead & lift for constructing thrust bed at designed level as directed by Engineer-in-Charge including providing all temporary works as required & approved by Railways authority, required protection of existing road pavement / railway tracks including providing water tight joints in R.C.C. box segments using CC grout with epoxy paint on exposed facing and providing R.C.C. saddles in the box as per details given with drawing for supporting pipe in the box as directed, including all plans and machinery, equipments, all labour, materials & all temporary works in all respects, dismentaling and removal of temporary work, restoring ground to its original profile on completion of work.

The work also includes sealing of box at both ends after completion etc. as directed by engineer-in-charge.

SPECIFICATIONS FOR CASTING RCC BOX & PUSHING THROUGH EMBANKMENT

In order to avoid interference to railway traffic / excavation on existing roads intercepted on pipeline alignment, BOX PUSHING technique is envisaged in preference to any other conventional methods for the laying of pipeline through such railway & road crossings intercepted.
The R.C.C. box segments shall be cast using concrete grade of approved design mix in suitable segments as per the approved design, and pushed across the embankment by hydraulic jacks, of suitable capacities excavating manually the soil under the FRONT SHIELD of the box.

The thrust bed required for box pushing shall be of required width and of length and thickness as per design approved and laid along the longitudinal axis of proposed box. The thrust bed is envisaged in reinforced concrete

using grade M-20 and designed to resist the reaction induced due to jacking force while pushing the box inside the embankment. The reaction due to jacking force shall mainly be resisted by frictional resistance between thrust bed and the earth. However, additional keys provided at the bottom of the bed shall be made use of to develop more resistance due to passive pressure of the earth.

The concrete below the bottom of each pin pocket shall be done first for positioning them. Aligning these pin pockets is very important aspect while casting the thrust bed in order to avoid any lateral shifting of the box with respect to it's axis. Therefore, these boxes shall be held in position by welding MS bars between boxes in longitudinal and lateral directions. While concreting for entire thrust bed is carried out, two recesses shall be left along the entire length of the thrust bed at top for housing rails. Leveling of these rails shall be done by providing suitable MS packing Coils at suitable spacing. These recesses shall then be filled with screed mortar. Also, 50 mm thick screed shall be laid on top of the thrust bed and leveled such that the top of rails shall remain 2 mm protruding above top level of the thrust bed. The pin pockets shall be covered with precast cover slab before screeding. The thrust bed shall be laid in a slope of 1:700 to avoid lifting of box during pushing.

In order to facilitate jacking and steering, it is envisaged to cast the box in segments of suitable lengths. The first box shall be provided with FRONT SHIELD and REAR SHIELD. The front shield shall consists of M.S. Plate with suitable stiffeners. Anchor bars, welded to the Plates shall be embedded in the concrete of the box. The front shield shall be 1.0 M wide on all four faces with 0.50 M width embedded in box concrete. Similarly, rear shield shall be provided at the rear end of each box. Half the width of rear shield shall be embedded in box concrete with outer face being flush with outer surface of the box. For the front 0.50 M length of box, the thickness of top and bottom slab and both sides shall be reduced by 30 MM. so that rear end of the first box and at front end of remaining box pockets, suitably lined with 6 mm thick M.S. Coils shall be provided to house hydraulic jacks for intermediate jacking. Two pockets shall be provided in the side walls of box, just below top Haunches and two shall be provided in bottom slab of box, next to Hauches.

The box is designed as a normal box but subject to longitudinal thrust while pushing.

8 mm thick M.S. Plates shall be laid over rails placed in thrust bed to form bottom of box along the length. The bottom surface of these Coils shall remain flush with the bottom of the box. These Plates shall be anchored in bottom slab concrete with welded anchor bars. With this arrangement, while pushing the box over the thrust bed, the contact between steel to steel surfaces shall reduce friction. Before casting the box, polythene sheets suitably greased shall be laid on the top of thrust bed & bottom of box to prevent contact between thrust bed and bottom of box and facilitate pushing with very smooth, frictionless surface between the thrust bed and bottom of the box.

To withstand reactions of jacking force, jacking pins are provided with M.S. bar handle to facilitate the lifting when required. The overall dimensions of the pins shall ensure smooth insertion and lifting inside pin pockets.

A jacking rig, fabricated from M.S. Plates and structural steel shall be provided to ensure proper alignment of jacking force. One end of the jacking rig shall have saddles to house hydraulic jack. The clear width inside rig shall be more than pin pocket to ensure smooth sliding of rig. Spacers fabricated from M.S. Plates shall be used for filling gaps between hydraulic jack and jacking pin while pushing. These spacers shall be meant to rest against jacking pin at one end and jack ram at the other end.

After completion of casting of box, pushing operation shall commence with the rigs laid on top of the thrust bed with one end of the rig resting against face of the rear end of bottom slab of the first box. The hydraulic jacks shall be properly housed in the rig so that one end of jack shall rest against the end plate of the rig. The other, ram side of the jack shall rest against face of jacking pin. When the jack shall be operated, the ram shall be pushed against the jacking pin. This will make the box to move in the direction of thrust away from jacking pin. When the full displacement of ram be obtained, the jacks shall be closed and spacers shall be inserted between the jacking pin and the jacks. the jacks shall be operated again and the box shall be pushed in the direction of thrust. When the rig travel to expose next row of pin pockets, the jacking pin shall be removed and installed in the next row of pin pockets. This process shall be repeated till the front shield shall cut into the embankment for about 1.0 M.

The excavation at the front end of the box shall be carried out manually within front shield. the muck shall be removed from the box. When about 0.50 M of excavation shall be done, the jacks shall be operated again so that front shield shall be pushed for 30 or 40 cms further inside the embankment. Again, the excavation shall be continued till the entire length of first box is fully pushed inside the embankment. When rear end of the first box shall be very close to the embankment, the second box shall then be cast and after adequate curing, pushed to lock inside the rear shield of the first box. Hydraulic jack shall be housed in intermediate jacking pockets and an intermediate jacking station shall be opened up. The operation of the jacks in the intermediate jacking station shall be similar to that in the initial stage. However, in this case, the ram shall rest against plate lining in pockets. After opening the intermediate jacking station, the intermediate jacks shall be operated while the rear end of 2nd box shall be made to anchor against the jacking pin through the jacks.

In General following sequence shall be adopted in carrying out the job :

a) After casting thrust bed, polythene sheets suitably greased shall laid on the top of thrust bed as above explained to prevent contact between thrust bed and bottom of box.

b) The reinforcement cage required for base slab with reinforcement for side walls shall be placed in position on bed. The precast blocks or chairs for provision of cover shall be provided under the cage.

c) The base slab and side walls up to top of bottom haunch would be concreted with M-25 grade concrete in one operation leaving the top of side wall rough.

d) The reinforcement cage for side wall shall be laid in proper position. The lap length shall be provided properly. The side walls shuttering shall be provided by proper checking of alignment & vertically up to bottom of top haunch.

e) The surface of hardened concrete shall be thoroughly hacked, swept clean, wetted and covered with a layer of neat grout. The neat grout shall be applied to the top and this shall be followed by a 10 mm thick layer of mixed the same proportion as that of and sand in concrete and concreting shall be resumed immediately thereafter. The first batch of concrete shall be rammed against the old work to avoid formation of any stone pockets particular attention being paid to corners and closed spots and the concreting of side walls shall be carried out up to the bottom of top haunch.

f) The reinforcement cage for top slab shall be laid properly on centering and chairs or precast units for providing cover shall be laid under cage. The centering shall be checked in alignment and props shall be of sufficient strength.

g) Concreting of top slab shall be carried out in the same manner as per 5 above.

h) Pushing of the completed segments of the box shall be commenced as per the procedure described in above paras till the entire length of the box in the embankment is built up.

i) After completion of jacking, pressure grouting of concrete shall be carried out of fill joint between segments to make then water tight and the inside face of the joint treated with smooth finishing and box indicators shall be placed at both ends of box showing necessary details of box and communication. Both ends shall be closed with BB Masonry keeping provision of air vents.

CROSSING: GENERAL SPECIFICATIONS

At public highways, or at such other crossings as are shown in the construction drawings issued by the company the pipeline shall be installed in MS casing pipe conforming to the specifications given herein.

(a) The casing pipes shall be installed in accordance with the details given in drawing and the casing, bushing and insulators, etc., shall be installed on the carrier pipe as detailed in drawings. Casing pipe size shall be as per approved drawing of sanctioning authority, Casing shall be installed with even bearing throughout its length and shall slope towards one end, as specified or desired by the engineer-in-charge. The ends of the casing shall be sealed to outside of carrier pipe in accordance with the details given in drawing.

(b) Before installation, holes for installing vent pipes shall be cut and burrs if any shall be removed. The welding of both carrier pipe and casing pipe shall be done in accordance with the welding specifications, given herein. Before installing the casing pipe, it should be cleaned of all internal obstructions and during installation care should be taken to keep the inside clean.

(c) The section of carrier pipe to be placed in any casing shall be closed at each end, hydrostatically tested preferably with dead weight tester for at least two hours. Only on successful completion of this test, shall the carried pipe section be inserted in the casing pipe. The installation of casing may open cut as circumstances may permit or require as directed by the engineer-in-charge.

(d) The installation of casing in bended section of the carrier pipe shall be performed by meter bends of the casing pipe provided that the length of each meter cut out of casing pipe shall be such as to provide a clearance of at least 1-1/2" between the inside of the casing pipe and the outside of the coated carrier pipe.

(e) Excavation for casing installation shall be immediately backfilled at the completion of the work with suitable solid matter and packed thoroughly to prevent seepage of water into the excavation.

ROAD AND IRRIGATION CANAL CROSSINGS :

(a) At road and canal crossings the work shall be performed to the specifications of local authorities or such public bodies as may be in charge (S) of roads and canals to be crossed.

(b) In case, however the minimum requirements of the governing agencies are less than those set out in the drawing or the specifications given herein, then the requirements given in the drawings and the specifications given for encased line shall be followed.

(c) Where as the casing pipe in the case of encased line to be laid normal by boring, tunneling, engineer-in-charge may at his discretion permit open-cuts to be made for the installation of casing provided, however, that the TENDERER shall procure the necessary permit / license for the same from competent authority. At locations wherein the open cut methods are permitted, the TENDERER shall pass the carrier pipe through the casing located in the trench after the approval of the engineer-in-charge in writing , if Open Cut method is not permitted by authority, pipe is to be laid through Push Through Method. and care shall be exercised to avoid damage to pipe coating and wrapping during this operation. The TENDERER shall produce a certificate in writing from concerned authorities for its satisfactory restoration and payment therefore.

(d) At all crossings the carrier pipe shall be laid straight without bends so that if necessary the pipe at a later date may be replaced without cutting the casing. The carried pipe shall extend at least 2 meters beyond the end of casing pipe at either end.

(e) At road crossings the TENDERER shall eliminate unnecessary bending of pipe to conform to the contour of ground by gradually deepening the ditch at such approaches as directed by the engineer-in-charge. Where the installation of the casing has been made by open cut TENDERER shall install suitable

temporary bridge work ensuring the safety of the traffic aids and safeguards for protection of the public safety, or he shall provide suitable diversions as desired by the engineer-in-charge.

(f) At all railways pipeline crossings shall be bored with horizontal boring machine.

(g) The method of carrying out a cased crossing by boring for various crossings on this pipeline route shall be jointly inspected by the representative of the COMPANY and TENDERER for each category of work prior to commencement of actual work.

(h) Pipeline under Road Track and irrigation canal an applicable portion of the right-of-way shall be encased in accordance with the specification. This item of work shall include, necessary clearing and grading required therefore, trenching to the depths and widths required, welding of casing and carrier pipes, testing, lowering in, installation of vent assembles, end seals, insulator and all other fittings that may be required, backfilling, clean up, complete restoration to the original condition and further strengthening and protective works as may be required. The work shall be carried out in accordance with the drawings and as directed by the engineer-in-charge. For various operations mentioned above, the specifications pertaining to these operations shall apply in addition to the specifications given herein.

The TENDERER shall be permitted to use William Sons type Neoprene seals in place of concrete end seals for the crossings. The item shall be procured by the TENDERER himself as per the provisions under the appropriate head of work in case TENDERER so desires. The representative of the COMPANY may also be associated to determine the quality of the material and its delivery schedule from the open market. However, the particular work defined under the proper head shall not be delayed on account of non-availability of Neoprene end seals. In such case, concrete seals may be provided.

On both ends of pushing concrete supports are to be provided as per direction of engineer-in-charge.

LOFC : LIST OF OPERATION OF FABRICATION AND CONTROL

Each LOFC must contain the following information as a minimum (all clearly marked and separated):

a) Company name and references relating to the order;

b) All technical and other information required in order to define the items covered.

- The area of application will be limited to that item or those items considered in fabrication and control as a natural unity.
- Details of plants, layout, capacity, production rate, testing equipment, yard facility

c) A numerical sequence of operations with description will be built-up in a logical way of work progress.

- The first operation will be the control over the incoming material(s) and documents.
- The last operation will be the control over the final documentation.

The following operations have to be included (not limited to):

- Procedure prior to the commencement of production shall be approved by PURCHASER
- Each step which call for own quality control (eventually QA);
- Each applicable examination as part of this specification;
- Document control-stamping and final documentation.

d) Each operation will be followed by the applicable specification or procedure number (with the latest revision).

e) Columns to be provided for possible interventions of :

the manufacture's fabrication control;
the manufacturer's quality control (eventually QA);
inspection Agency;
and place of intervention if not by the manufacturer.

The interventions will be indicated per operations with H or w and/or R.

H = hold point - no further steps may be undertaken before the intervention of the designated responsible takes place.

W= witness point - the designated responsible has to be notified of the operation in advance, but production will continue whether the intervention took place or not.

R= point for which a control report or a recording has to be made.

The manufacturer will rill in his own H, W and R points. The inspection Agency will do the same in its designated column, but this will not implicate a relaxation or wearing of the requirements of the manufacturer's controls.

Each intervention has to be signed and dated by person acting as controller. Only the original documents will be presented for this purpose.

f) One column to be provided for report or record number (point marked R) and one for the review or these documents by the Inspection Agency.

g) Two extra columns may give reference to non-conformity report if any and to the resolution give to it.

Completion of the LOFC does not automatically rise to a release o the material or it must be stipulated otherwise in the contract.

The steps indicated in the LOFC must be executed following the sequence as stipulated in LOFC.

5 DUCTILE IRON PIPES

5.1 Applicable Codes:

The manufacturing testing, supplying, at work sites of Ductile Iron pipes shall comply with all currently applicable statutes, regulations, standards and codes.
In particular, the following standards, specified herein shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of specifications conflict with the requirements of the codes and standards, this specification shall govern.

IS: 8329	Specification for Centrifugally Cast (spun) Ductile Iron pressure pipes for water, gas and sewage specification.
IS: 1387	General requirements for supply of metallurgical materials.
IS: 1500	Methods for Brinell hardness test for metallic materials.
IS:9523	Ductile Iron fittings for pressure pipes for water, gas and sewage.
IS: 12820	Dimensional requirements. of rubber gaskets for mechanical Joints and push on joints for use with cast Iron pipes and fittings for carrying water, gas and sewage.
ISO: 4179	Ductile iron pipes for pressure and no pressure-Centrifugal cement mortar lining - General requirements.
ISO: 2531	Ductile iron pipes, fitting and accessories for pressure pipe lines.
	IS: 12288 - Code of practice for use & laying of Ductile iron pipes.

5.2 Manufacturing:

5.3 General

DI pipes shall be systematically checked for any manufacturing defects by experienced supervisors and a very high standard quality shall be maintained.

5.3.1 Owner / Engineer shall at all reasonable times have free access to the place where the pipes are manufactured for the purpose of examining and testing the pipes and for witnessing the test and manufacturing.

5.3.2 All tests specified either in this specification or in the relevant Indian Standards shall be performed by the supplier/contractor at his own cost and in presence of Owner/Engineer if desired. For this, sufficient notice before testing of the pipes shall be given to Owner/Engineer.

5.3.3 If the test is found unsatisfactory, Owner/Engineer may reject any or all pipes of that lot. The decision of Owner/Engineer in this matter shall be final and binding of the contractor and not subject to any arbitration or appeal.

5.4 Materials

5.4.1 The general requirements relating to the supply of material shall be as per IS:1387.

5.5 Dimensions:

5.5.1 The internal diameter, thickness and length of barrel, dimensions of pipes shall

be as per the relevant tables of IS.8329/IS: 9523 for different class of pipes.

5.5.2 The tolerances for pipes regarding dimensions and deviations from straight line shall be as per relevant IS codes.

5.5.3 The standard weight of uncoated pipes and the permissible tolerances hall be per relevant IS codes.

5.6 Workmanship and Finish

5.6.1 The pipes shall be stripped, with all precautions necessary to avoid warping or shrinking defects. The pipes shall be free from defects, other than any unavoidable surface imperfections which result from the method of manufacture and which do not affect the use of the pipes in the opinion of Engineer.

5.6.2 The pipes shall be such that they could be cut, drilled or machined. The hardness of the external unmachined surface shall not exceed 230 HBS.

5.6.3 In the case of spigot and socket pipes and fittings for lead joints, the socket shall be without the centering ring.

5.6.4 In the case of flanged pipes the flanges shall be at the right angles to the axis of the pipe and machined on face. The bolt holes shall be drilled and located symmetrically off the center line. The bolt hole circle shall be eccentric with the bore and bolt holes equally spaced. The flanges shall be integrally cast with the pipes and fittings and the two flanges of the pipes shall he correctly aligned.

5.7 Testing

5.7.1 Mechanical Tests:

Mechanical tests shall be carried out during manufacture of pipes as specified in relevant IS codes. The results so obtained shall be considered to represent all the pipes and fittings of different sizes manufactured during that period and the same shall be submitted to Owner/Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes shall be as per relevant IS codes.

5.7.2 Brinell Hardness Test

For checking the Brinell hardness, the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS 1500.

5.7.3 Retests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

5.7.4 Hydrostatic Test

For hydrostatic test at works, the pipes shall be kept under test pressure as specified in relevant IS codes for 15 seconds, shall be struck moderately with a 700 g hammer for

confirmation of satisfactory sound. They shall withstand the pressure test without showing any leakage sweating, or other defect of any kind. The hydrostatic test shall be conducted before coating the pipes.

5.8 Coating

5.8.1 All D.I. pipes shall be delivered with internal lining and external coating.

5.8.2 Coating shall not be applied to any pipe unless its surface is clean dry and free from rust.

5.8.3 All DI pipes shall be mortar lined on internal surface as specified in ISO: 4179 and externally coated with bituminous paint as specified in IS: 8329.

5.9 Marking

5.9.1 Each pipe shall have cast stamped or legibly and indelibly painted on it with the following appropriate marks:

a) The nominal diameter.
b) Class reference.
c) Mass of pipe.
d) Date of' manufacture and
e) Manufacturer's name, initials or identification mark.

5.9.2 Marking shall be done as per IS: 8329.

5.10 Transporting of Pipes

All pipes manufactured in the factory and temporarily stacked in the Contractor's yard shall be transported to the site of laying after cleaning them internally etc. The item of transport covers the cost of loading in the factory, transporting to the site of laying or to stacking yard selected by the Engineer in its vicinity and unloading and stacking them carefully in such a manner that the material so kept is not easily disturbed or rolled away from the place of stacking. The loading in the factory shall be carried out by means of either a crane, gantry or shear legs, so as not to cause any damage to the finished material. Similarly, while unloading and stacking, great care shall be taken to ensure that the material is not damaged or dented. The contrivances to be used for unloading will be different in different situations and in each case the one approved by the Engineer shall be adopted. The material stacked at site shall be jointly inspected by the Engineer and the Contractor and defect or damage noticed shall be repaired to the satisfaction of the Engineer before payment is admitted.

The stacking ground, both in the Contractor's yard and at the site of laying shall be selected in such a way as not to get waterlogged during monsoon. If this cannot be done, the pipes shall be supported on sleepers to avoid contact with wet earth.

As explained in earlier paragraphs, materials such as pipes, tapers, etc. may be transported to the site of laying as soon as the material is finished in all respects with the permission of the Engineer.

5.11 Procedure for Receiving DI Pipes:

5.11.1 Handling of Pipes,

It is essential to avoid damage to the pipes, or their coatings at all stages during handling. The pipes shall be handled in such a manner as not to distort their circularity or cause any damage to their surface treatment. Pipes shall not be thrown down from the trucks nor shall they be dragged or rolled along hard surfaces. Slings of canvas or equally non-abrasive materials of suitable width of special attachment shaped to fit the pipe ends shall be used to lift and lower coated pipes to prevent damage to the coating.
Great care shall be taken in handling the pipe right from the first operation of manufacture until they are delivered to the store. No defective or damaged pipe shall be allowed in the work without rectification/replacement to the satisfaction of the Engineer. Any damage to the coating shall be repaired by the Contractor at his own cost to the satisfaction of the Engineer.

5.12 Laying of Ductile Iron Pipes and Fittings / Specials

5.12.1 Scope

The specification covers laying of DI pipes and DI fittings/specials for overground/underground works.

5.12.2 Applicable codes

The laying of pipes and fittings/specials shall comply with all currently applicable status, regulation, standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred to. In all cases, the latest revision of the standards/codes shall be referred to. If requirements of this specification conflict with the requirements of' the standards/codes, this specification shall govern.

5.12.3 Codes of practice

IS:8329 Centrifugally cast (spun) Ductile Iron pressure pipe for water, gas and Sewage.
IS:3764 Excavation Work - Code of Safety.
IS:12288 Code of Practice for use and laying of Ductile iron pipes.

5.12.4 Carting & handling

Pipes and fittings/specials shall be transported from the factory to the work sites at places along the alignment of pipeline as directed by Owner/Engineer and as specified by manufacturer. Contractor shall be responsible for the safety of pipes and fittings/specials in transit, loading/unloading. Every care shall be exercised in handling pipes and fittings/specials to avoid damage. While unloading, the pipes and fittings/specials shall not be thrown down from the truck on to hard surfaces. They should be unloaded on timber skids with steadying ropes for by any other approved means. Padding shall be provided between coated pipes, fittings/specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervals in order to permit access from one side to the other. in case of spigot socket pipes, care should be taken regarding orientation of pipes while unloading. As far as possible pipes shall be unloaded on one side of the trench only. All pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for recantation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded.

Dragging of pipes and fitting/specials along concrete and similar pavement with hard surfaces shall be prohibited.

5.12.5 Storage

Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom layer to keep the stack stable. The stack shall be in pyramid shape or the pipes laid lengthwise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stock shall not exceed 1.5m. Fittings/specials, shall be stacked under cover and separated from pipes.

Rubber rings shall be stored in a clean, cool store away from windows, boiler, electrical equipment and petrol, oils or other chemicals. Particularly in the field where the rubber rings are being used it is desirable that they are not left out on the ground in the sun or overnight under heavy frost or snow conditions.3

5.12.6 Laying

5.12.6.1 Excavation

Before excavating trench the alignment of pipeline shall be approved by Engineer. The excavation shall be carried out in accordance with the specifications mentioned under Section 4, Parts 1 and shall be done such that it does not get far ahead of laying operations.

To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for the traffic to use the roadways. The relevant Indian standards and the rules and regulations of local authorities in regards to safety provisions shall be observed.

Suitable fencing shall be provided along the sides of trenches and pits. The posts of fencing shall be of timber securely fixed in the ground not more than 3 in apart and they shall not be less than 75 mm in diameter or less than 1.2 m above surface of the ground. There shall be two rails, one near the top of the post and the other about 450 mm above the ground and each shall be from 50 mm to 70 mm in diameter and sufficiently long to run from post to post to which they shall be bound with strong rope. The method of projecting rails beyond the post and tying them together where they meet will not be allowed on any account. All along the edges of the excavation trenches a bank of earth about 1.2m high shall be formed where required by Owner/Engineer for further protection.

The road metal and also the rubble packing shall first be stripped off for the whole width of the trench/pit and separately deposited in such place or places as may he determined by Owner/Engineer. During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately. The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench and pit, or as may be necessary to prevent the sides of the trench pit to slip or fall, or at such a distance and in such a manner as to avoid covering fire hydrants, sluice valves, manholes covers etc. and so as to avoid abutting the wall or structure or causing inconvenience to the public and other service organisations or otherwise as Owner/Engineer may direct.

Contractor shall take into account additional excavation if any as Owner/Engineer may require in order to locate the position of water pipes, drains, sewers etc. or any other works which may be met with, in or about the excavation of trenches/pits while quoting the rates for excavation of trenches/pits while quoting the rates for excavation. Such service lines if met with during excavation shall be properly maintained by Contractor, by means of shoring, strutting, planking over, padding or otherwise as Owner/Engineer may direct, and shall be protected by the Contractor from damage

during the progress of the work. All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure/pipe line of water, gas, sewage etc.

If the work for which the excavation has been made is not completed by the expected date of the setting of monsoon or the setting in of rain whichever is earlier, or before the day fixed by Owner/Engineer for filling in any excavation on account of any festival or special occasion, Contractor shall backfill such excavation and consolidate the filling.

Utmost care shall be taken to see that the width of the trench upto ground level is not more than that specified in 'Data sheet – B'. If any extra width is provided in the pipezone, the Contractor shall have to provide remedial measures in the form of lime concrete or rubble masonry otherwise at the discretion and to the satisfaction of Owner/Engineer. If rock is met with, it shall be removed to 15 cm below the bottom of pipes and fittings/specials and the space resulting shall be refilled with granular materials and properly consolidated. Bottom of trenches/pits shall be saturated with water well rammed wherever Owner/Engineer may consider if necessary to do so.

Wherever a socket or collar of pipe or fitting/special occurs, a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe may have a fair bearing on its shaft and does not rest upon its socket. Such grip shall be of sufficient size in every respect to admit the hand all around the socket in order to make the joint, and the grip shall be maintained clear until the joint has been approved by Owner/Engineer.

When welding is to be carried out with the pipes and specials in the trench, additional excavation of not more than 60 cm in depth and 90 cm in length shal1 be made at joints in order to facilitate welding.

The excess excavated material shall be carried away from site of works to a place upto a distance as directed by Owner/Engineer. This shall be done immediately so as not to cause any inconvenience to the public or traffic. If the instructions from Engineer are not implemented within seven days from the date of instructions to cart the materials and to clear the site, the same shall be carried out by Owner/Engineer and any claim or dispute shall not be entertained in this respect.

The contractor shall make proper provision for protecting the work by fencing, watch and ward lighting at right on in an other manner as may be directed by Engineer.

5.12.6.2 De-watering

During the excavation, if subsoil water is met with Contractor shall have to provide necessary equipment and laborers for dewatering the trenches/pits by bailing out water or water mixed with clay if pumping out subsoil water is found to be necessary, Contractor shall provide sufficient number of pumps for the same. In both the above cases the excavation shall be done to the required level and the pipes shall be laid to proper alignment and gradient. Contractor shall also make necessary arrangement for the disposal of drained water to nearby storm water drain or in a pit if allowed by Owner/Engineer. In no case the water shall be allowed to spread over the adjoining area. Before discharging this water into public sewer/drain, Contractor shall take necessary permission from the local authorities.

5.12.6.3 Special foundation in poor soil

Where the bottom of the trench and subgrade is found to consist of material which is unstable to such a degree that in the opinion of Owner/Engineer, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe

properly, a suitable foundation for the pipes, consisting of piling, limbers or other materials, in accordance with relevant drawings and as instructed by Owner/Engineer shall be constructed.

5.12.6.4 Wooden shoring

Contractor shall suitably design polling bards, waling and struts to meet different soil conditions that might be encountered in excavating trenches/pits. The horizontal and vertical spacing of struts shall be prevented from collapse but also easy lowering of pipe in trenches shall be ensured without creating undue obstructions for the excavation of the work. Any inconvenience and/or delay that might be caused in lowering pipes in trenches as a result of adopting improper spacing of struts by Constructor shall be his sole responsibility. No part of shoring shall at any time be removed by Contractor without obtaining permission from Owner/Engineer. While taking out shoring planks the hollows of any form must simultaneously be filled in with soft earth well rammed with rammers and with water.

Owner/Engineer may order portions of shoring to be left in the trenches/pits at such places, where it is found absolutely necessary to do so avoid any damage which may be caused to buildings, cables, gas mains, water mains, sewers etc. in close proximity of the excavation, by pulling out the shoring from the excavations. Contractor shall not claim, on any reason whatsoever, for the shoring which may have been left in by him at his own discretion.

5.12.6.5 **Steel plate shoring**

Where the subsoil conditions are expected to be of a soft and unstable character in trench/pit excavation, the normal method of timbering may prove insufficient to avoid subsidence of the adjoining road surface and other services. In such circumstances Contractor will be required to use steel trench sheeting or sheet piling adequately supported by timber struts, waling etc. as per the instructions manner and method directed by Owner/Engineer. Contractor shall supply, pitch, drive and subsequently remove trench sheeting or piling in accordance with other items of the specification.

5.12.6.6 **Boning staves and sight rails**

In laying the pipes and fittings/specials the centre for each manhole/chamber or pipeline shall be marked by a peg. Contractor shall dig holes for and set up two posts (about 100 x 100 x 1800 mm) at each manhole chamber or junction of pipelines at nearly equal distance from the peg and at sufficient distances therefrom to be well clear of all intended excavation, so arranged that a sight rail when fixed at a certain level against the post shall cross the centre line of the manhole/chamber or pipe lines. The sight rail shall not in any case be more than 30 m apart, intermediate rails shall be put up if directed by Owner/Engineer.

Boning staves of 75 mm x 50 mm size shall be prepared by Contractor in various lengths, each length being of a certain whole number of metres and with a fixed tee head and fixed intermediate cross pieces, each about 300 mm long. The top-edge of the cross piece must be fixed below the top edge of the tee-head at a distance equal to the outside diameter of the pipe of' the thickness of the concrete bed to be laid as the case may be. The top of cross pieces shall indicate different levels such as excavation for pipe line, top of concrete bed, top of pipe etc. as the case may be.

The sight rail of size 250 mm x 40 mm shall be screwed with the top edge resting against the level marks. The centre line of the pipe shall be marked on the rail and this mark shall denote also the meeting point of the centre lines of nay converging pipes. A line drawn form the tip edge of one rail to the top edge of the next rail shall be vertically parallel with the bed of the pipe, and the depth of

the tee letting down the selected boning staff until the tee head comes in the line of sight from rail to rail.
The post and rails shall be perfectly square and planed smooth on all sides and edges. The rails shall be painted white on both sides, and the tee-heads and cross-piece of the boning staves shall be painted black.
For the pipes converging to a manhole chamber at various levels, there shall be a rail fixed every different level. When a rail comes within 0.60 m of the surface of the ground, a higher sight-rail shall be fixed for use with the rail over the next point.
The posts and rails shall in no case be removed until the trench is excavated, the pipes the laid Owner/Engineer gives permission to proceed with the backfilling.

5.12.6.7 Bedding

The type of bedding for pipes shall be as per Data Sheet - B.

DATA SHEET – B

	Item No.	Specification
1	Width of trench	
	OD – Outer Diameter of pipeline in m	OD + 0.9 m
2	Bedding for pipes	As per drawing

5.12.7 Laying of Pipes and Fittings/Specials

All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure/pipeline of water, gas, sewage etc. After excavation of trenches, pipes shall not be lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches are approved and measured by Owner/Engineer. Pipes and fittings/specials shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes and fittings/specials shall be made by Contractor. In no case pipes and fittings/specials shall be dropped. Slings of canvas or equally non-abrasive material of suitable width or special attachment to fit the ends of pipes and fittings/specials shall be used to lift and lower the coated pipes and fittings/specials. The pipes and fittings/specials shall be inspected for defects and be rung with a light hammer preferably while suspended to detect cracks. If doubt persists, further confirmation shall be done by pouring a little kerosene/dye on the inside of the pipe at the suspected spot. No sign of kerosene/dye should appear on the outside surface. Pipes and fittings/specials damaged during lowering or aligning shall be rejected by Owner/Engineer. Manufacturers recommendations are to be followed for laying pipes.
All the pipes are to be laid perfectly true both in alignment and to gradient specified. In case of spigot and socket pipe the socket end of the pipe shall face upstream, except when the pipeline runs uphill in which case the socket ends should face the upgrade. The laying of pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centered in the socket and the pipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. pipes and fittings/ specials which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes and fittings/specials of proper dimensions to ensure such uniform space. Precautions shall be

taken to prevent dirt from entering the jointing space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by Owner/Engineer. During the period that the plug is on, the Contractor shall take proper precautions against floating of the pipe owing to entry of water into the trench. Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted the deflection allowed at joints shall not exceed 2 1/2^{o}. In case of pipes, with joint to be made with loose collars, the collars shall be slipped on better the next pipe is laid. The pipes shall be laid such that the marking on pipes appears at the top of the pipes.
The cutting of pipe for inserting valves, fittings or specials shall be done in a neat and workman like manner by using tools and taking precautions as per manufacturers'' recommendations without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. For this purpose, pipe cutting machine shall be used.

5.12.8 Repairs of Damaged Cement Mortar Linings

The mortar lining is strongly bonded with the pipe wall at all places. However, near the spigot end due to rough handling of pipes or on account of incidental shock loads the mortar lining may get damaged over a small area. Such damages if taken place shall be immediately identified and repaired before installation. When repairing damaged cement-mortar-lining, the following shall be adhered to:

5.12.8.1 Materials required

(a) Standard Cement (of the same quality as in the lining)

(b) Argillaceous Sand (size of coarse grains max. 1.6 mm)

(c) Acrylic Emulsion for cement mortar

(d) Potable water

5.12.8.2 Preparation of the areas to be repaired

The damaged lining shall be removed with hammer and chisel, with due care without disturbing the surrounding lining. Contractor shall supply protective spectacles for workmen to prevent penetration of cement fragments into their eyes.

5.12.8.3 Composition of repair mortar

The proportion of the materials will be as follows:

5.12.8.4 Dry mixture of mortar:

One part of cement
One part of sand

5.12.8.5Emulsions:

One part of acrylic emulsion
Four parts of potable water
Firstly the dry sand and the dry cement shall be mixed separately. The acrylic emulsion shall be added to the water stirring constantly (The container for acrylic emulsion should be resealed at once after use and stored in a cool place)Small quantities of the treated water shall be gradually added to the cement and sand mixture mixed thoroughly. Care shall be taken not to prepare too large quantity of cement to avoid premature hardening.

Any loose sand from the areas to be repaired shall be brushed off. Moisten the areas under repair and surrounding areas with water but avoid water accumulations. Mortar is to be applied to cleaned areas and the lining surface is to be smoothened.

5.12.8.6**After - Treatment of repaired areas**

In order to ensure faultless hardening of cement it is recommended that the repaired area to be covered temporarily with plastic sheet. In the case of diameters exceeding DN 300 it is possible that after cutting off a piece the new spigot end has become out of round. On account of the elastic and plastic properties of ductile iron, it is possible to re-round these pipe ends. This shall be done on site by means of a hydraulic or mechanical jack, acting from inside and pressing outwards or by using a press acting from outside the pipe and pressing inwards by the contractor. In order to avoid damage to the cement mortar lining it is recommended that hardwood ads of a shape to match the pipes internal diameter be used. The re-rounding device should remain in place during assembly. If necessary the manufacture may consulted for resounding.

5.12.9 Thrust Blocks

Thrust blocks shall be provided, to counteract hydraulic thrust, at requisite places as per design as directed by Engineer In-charge.

5.12.10 Jointing

Jointing for pipes and fittings/specials shall be done in accordance with the relevant specifications for DI pipes and DI fittings and as recommended by manufacturer.
The recommended bolting torque to be followed for assembling flanges as specified in manufacturer instructions.

5.12.11 Testing And Commissioning

Testing and commissioning of pipes shall be done in accordance with the relevant specification.

5.12.12 Backfilling

Trenches shall he backfilled with approved selected excavated material only after the successful testing of the pipeline as directed by engineer. 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 the optimum moisture content as possible. Filling of the trench shall be carried out simultaneously on both side of the pipe in such a manner that unequal pressure does not occur. Backfilling shall be done in layers not exceeding 30 cm. Each layer shall be consolidated by watering, ramming, care being taken to avoid damage to the pipeline. Where timbers are placed under the pipeline to aid alignment, these timbers shall be removed before backfilling.

5.12.13 Reinstatement Of Road/Footpath

Reinstatement of road/footpath shall be done as per the requirements of local authorities and the relevant specifications after completion of work.

5.12.14 Clearing Of Site

All surplus materials, and all tools and temporary structures shall be removed from the site as directed by Owner/Engineer and the construction site left clean to the satisfaction of Owner/Engineer.

5.12.15 Cleaning, Disinfectioning And Commissioning Of The Pipeline

Upon completion of newly laid main, the main shall be disinfected as directed by the Engineer.

The main shall be flushed prior to disinfection except when the tablet method is used. After initial flushing, the hypochlorite solution shall be applied to the water main with mechanically or electrically powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solution may be fed with a hand pump.

In the case of main of large diameter, water from the existing distribution system or other approved source of supply shall be made to flow at a constant measured rate into the newly laid pipeline. The water shall receive a dose of chlorine also fed at constant measured rate. The two rates shall be proportioned so that the concentration in the water entering the pipeline is maintained at no less than 300 mg/l. The chlorine shall be applied continuously and for a sufficient period to develop a solid column of 'slug' of chlorinated water that will as it passes along the line expose all interior surfaces to a concentration of at least 300 mg/l for atleast 3 hours. As the chlorinated water flows past tees and crosses related valves and hydrants shall be operated so as to disinfect the appurtenances.

In the case of newly laid mains in which scrupulous cleanliness has been exercised the tablet method can be adopted and in this method, the initial flushing is dispensed with. The calcium hypochlorite tablets are placed in each section of pipe and also in hydrants, hydrant branches and other appurtenances. The tablets shall be attached by an adhesive and must be at the top of the main. The main shall then be filled with water and the water shall remain in the pipe for atleast 24 hours.

After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the mains is not higher than that generally prevailing in the system or less than 1 mg/l.

After final flushing and before the water main is placed in service, a sample (s) of water shall be collected from the end of the line and tested for bacteriological quality and shall show the absence of coliform organisms. If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory, samples are obtained before the main is placed in service.

The Contractor is expected to carry out the disinfection work as a part of laying the pipes and his rates for laying the pipes should include the disinfection and other connected works till the main is placed in service, unless otherwise specified in the schedule.

5.12.16 Method of Measurement

The measurement shall be recorded in running meter of pipe length laid along the centerline of axis of pipeline including specials surcharge tee, enlarge, reducer and bend, correct up to 0.01 m length.

5.12.17 Payment

As per payment schedule in price bid.

2 DRAIN PUMP:

For dewatering the stuffing box leakage one number portable horizontal submersible mono set is to be provided with impeller of cast Iron. It shall be with double mechanical seals to prevent ingress of moisture in to the motor. It shall be complete with automatic level switch, common pipe of 40 mm steel pipe for the pump to connect it to the nearest drain. Discharge capacity of drain pump shall be 10 m3/hr against 10 Mtrs head.

3 ELECTROMAGNETIC FLOW METER WITH TRANSMETER & TOTALISER

(For 200 mm dia. &above)

3.7 SCOPE :

This specification covers design, supply, installation, testing and commissioning of Full bore Electromagnetic type flow meter with transmitter and totaliser with all required accessories.

- Full bore electromagnetic flow meter shall consist of flow tube, flow transmitter, flow indicator & integrator and any other item required to complete the system. To avoid the effects of disturbances in the velocity profile, a straight and uninterrupted run, upstream as well as downstream from the location of the flow meter shall be provided, as recommended by the flow meter manufacturer and in line with the applicable standards (5D upstream & 2D downstream minimum). Contractor shall finalize the exact location of flow meter in consultation with Engineer.
- An expansion bellow (SS 316) type dismantling joint shall be provided adjacent to the flow meter to facilitate easy insertion / removal of the flow tube.
- Flow measurement shall not be affected by physical properties of water viz., temperature, pressure etc., within given limits. Contractor shall provide compensating electronic circuits, if required.
- A lockable & tamperproof enclosure shall be provided for the flow transmitter cum computing unit.
- Flow meters shall be suitable for the water turbidity at site during various seasons. Flow tube shall be rugged in construction and shall be suitable for continuous operation. Flow tube shall have waterproof construction and shall be suitable for installation on underground /above ground pipe lines.
- Flow transmitter shall accept inputs from flow tube, process the signals and shall provide an output proportional to the flow rate. The output shall be 4-20 mA with HART (version 6 or above), RS-485/Modbus.
- Necessary accessories, as required, shall be provided for installation of flow meters.

3.8 Technical specifications:

3.8.1 Flow Sensor

The sensor shall be suitable for being directly buried or above ground and shall have a degree of protection to IP 68 or IP 67. The sensor shall have PN16 flanged end connections. Flange material & type shall be as per piping requirement.

The sensor shall be suitable for an operating pressure of 16 bar gauge and a system test pressure of 25 bar gauge.

The metering tube shall be suitably lined to withstand abrasion of the fluid. The lining shall be of Neoprene/ Polyurethene / EPDM. The electrodes for sensing the voltage induced in the liquid shall be made of type SS 316.

The coil housing shall be fabricated from corrosion resistant material with epoxy painting, capable of submerged/ buried/ above ground operation.

The sensor shall be supplied complete with a factory-fitted umbilical cable for communication with the electronic display unit. The cable length shall be determined by the contractor for each meter location, but shall be not be less than 15 meters long so that it can be cut on site to suit the selected location for the electronic display unit. The construction of the signal connectors and cable shall protect the water meter from electromagnetic interference and shall be suitable for buried/above ground use and outdoor installation. The cable shall be protected by a suitably robust polyethylene sleeve to prevent accidental damage.

The Contractor shall provide all sundry items such as grounding electrodes and/or grounding rings (SS material) necessary for satisfactory operation of the sensor.

3.8.2 The Electronic Display Unit

The enclosure of the electronic display unit shall have a degree of protection to IP 67.

The display unit shall have a configurable password protection for accessing the flow meter menu.

Power supply for flow transmitter shall be 230V AC, 50 Hz / 110V AC, 50 Hz.

The unit shall have backlit LCD displays to show the following parameters, as selected by the operator:

- Cumulative/totalized flow
- Instantaneous flow rate
- Instantaneous velocity
- Peak day flow
- Date and time

i. The user shall be able to configure the electronic display unit to display:

- Flow rate in m3/h or l/s

- Velocity in m/s
- Cumulative /Totalized Flow in ML.

ii. There shall also be status indicators for each of the following conditions:

- Fault
- Empty pipe

iii. DIGITAL FLOW INDICATOR & FLOW INTEGRATOR

Digital flow indicator and flow integrator shall be modular in design. It shall consist of two separate dedicated back-lit LCD/LED displays for flow rate indication and total flow indication. It shall accept 4-20 mA DC input from flow transmitters. It shall have a battery back up for flow totaliser. The flow indicator and flow totaliser shall have a facility on PCB for changing the multiplying factor. The flow indicator cum flow integrator will be provided with 4-20 mA retransmission signal for flow rate and RS-232 communication port for the pulsed output signal for integrated flow.

4 PRESSURE MEASURING SYSTEM

4.7 Pressure Gauges

(a) Pressure gauges shall comply with IS 3624/ BS 1780. Glycerine filled dial shall be provided where the gauge is subjected to pressure pulsation and / or vibrations. The internal components shall be of stainless steel, bronze or any corrosion resistant materials other than Aluminum. It may be mounted directly on the main system pipe work.

(b) The minimum diameter for round pressure gauges shall be 150 mm unless specified otherwise or where the gauge forms part of a standard item of equipment.

(c) The zero and span of pressure gauge shall not change by more than ±0.1 % of the span per 0C changes in ambient temperature.

(d) 150 mm dia. size dial pressure gauge of direct reading and moving iron type shall be supplied. It shall have gauge cock & snubber arrangement and shall be suitable to operate on 0 to 20 Kg / cm2 pressure range.

(e) Over range protection shall be 50% above maximum pressure.

Pressure gauges shall be provided on discharge of each pump and on discharge header.Pressure gauge shall be bourdon type with a dial size of 150 mm in diameter and calibrated for the required range. The gauge shall be supplied complete with impulse tubing, two valve manifold with drain cock/calibration valve, fittings etc. as applicable. The pressure gauges shall have an accuracy of ± 1% full scale and weather protection class IP 67. All wet parts material shall be SS 316

5 MANUALLY OPERATED CHAIN PULLEY BLOCK

Design, Manufacturing, Testing, Supply, Installation, Testing and commissioning of Chain Pulley Block in pump house with lifting chain, hand chain, lifting hook, hanging hook, chain sling and geared traveling trolley with mounting girder.

5.7 General Requirements & Specification

a) The chain pulley Block shall be manufactured confirming to IS: 3832.

b) The chain pulley Block shall be tested at 1.5 times load as per IS: 3832.

c) The load chain of chain pulley shall be having 7.0 meter lift or as per requirement of pump-house. The span girder shall be as per ISBM-250 x 125 mm and length shall be as per pump house width.

d) Hooks shall be manufactured from forged steel to with stand shock loads, free to swivel under load and confirming to IS: 8610.

e) All gears are cut and machined from special alloy steel and case hardened having full depth of addendum confirming to AGMA standard.

a) Brake shall be of mechanical type, as per mfg. std. of chain pulley block acting at any load position & shall be shoe and friction disc type.

6 EOT CRANE

6.7 Design:

The crane shall be electrically operated with all accessories including crane rails and fixtures and shall conform to IS: 15560 or relevant internationally approved standards. The crane is to be designed in accordance with IS: 807, IS: 3177 / 1965 code of practice for design manufacturing erection & testing of structural portion of the crane & IS: 3177 code of practice for design of over travelling crane. In the design of components adequate factor of safety as per relevant code is allowed. Impact, fatigue, wear, stress concentration factors etc. have to be considered whenever applicable. All accessory and auxiliary electrical equipment including drive motors, electrically operated brakes, controllers, resistors, conductors, insulators, current collectors, pendant push button station, protective devices, operating devices, cables, conduits etc. necessary for the safe and satisfactory operation of the crane shall be provided.

6.8 Steel:

Steel conforming to IS: 2062 or equivalent is to be used in the manufacturing of the main load bearings members.

6.9 Brakes:

Electromagnetic, hydraulic thruster type brakes are to be provided in the hoisting, L.T. & C. T. Motion. The brakes shall be automatically released when the motor circuit is ON & shall be applied when the motor circuit is OFF. This feature has to work to ensure safety in case of power failure.

6.10 Bearings:

All moving parts of the crane are to be supported on anti frication type ball / roller bearings of

required size & reputed make.

6.11 Coupling:

Flexible / Universal / Geared couplings are to be provided between all gear boxes & motors.

6.12 Power:

The crane is suitable for operation of 415 V ± 6 %, 3 phase 50 cycles A C supply.

6.13 Crab:

The frame work shall be from all welded construction fabricated from rolled steel FRAME section and plates. The hoist & cross travel mechanism is to be mounted on this frame.

6.14 Hoist:

Hoist mechanism shall consist of motor brake, gear box, rope drum & bottom block.

6.15 Rope Drum:

The rope drum shall be made from mild steel fabricated construction having right & left hand spiral grooves properly machined to suit the hoisting ropes. The drum shall be such that there is not more than one layer when rope is fully wound, and length of the drum shall be such that each lead OD drum when hook is at its lowest position & one spare groove for each rope lead when the hook is at its highest position.

6.16 Wire Rope:

Wire rope shall be made from best quality & grade plough steel fiber core normally in 6x37 construction having Tensile strength of 160 / 175 Kg / sq mm. The wire rope shall have minimum factor of safety in accordance with IS 3177 depending on the class of the duty of the crane. Make of wire rope will be as per relevant IS & of reputed make.

6.17 Bottom Block:

The hook shall be of single plain shank type conforming to IS: 3815 and made of forged steel or equivalent supported on thrust bearings.

6.18 Rope Sheaves:

They are made from C.I. running on drum with provision of adequate guards to prevent the rope from leaving the sheaves.

6.19 Limit Switches:

Two number shunts / Roller type reputed make is to be provided to prevent the over lowering and over hoisting

6.20 Cross Travel Machinery:

Cross travel machinery shall consist of suitably rated motor as per relevant IS and totally enclosed dust proof gear box, break etc.

6.21 Wheels:

The wheel of the trolley and the end carriages shall be made from forged steel & shall be double flanged straight thread type fitted with antifriction bearings

6.22 Bridge Girders:

The girders shall be plate welded box / ISMB type construction designed to sustain all stresses arising due to vertical and lateral forces.

6.23 **Trolley Track**:

Suitable square steel section tracks are to be provided for travel of the trolley. These shall be welded on the girders.

6.24 End Stoppers For Cross Travel Trolley:

Steel end stoppers are to be provided on either side of the bridge to limit the motion of the trolley.

6.25 Platform:

M S chequered plate / anti skid plate platform shall be provided for full length on one side of the bridge girder.

6.26 End Carriages:

End carriages shall be fabricated from rolled steel section / plates with adequate diaphragms and stiffeners to give a rigid construction. The girders with gusset plates are to be set on the end carriages and jointed with bolts in rimmed holes. Rubber buffers shall also be provided on either side of the end carriage.

6.27 Long Travel Mechanism:

The driving machinery for the long travel motion can be either single motor drive or twin motor drive depending on manufacturers' standards.

6.28 Paintings:

The structural parts of the crane shall be thoroughly cleaned and shall be applied with one coat of red oxide and followed by two coats of enamel paints before dispatch. Exposed machinery parts such as wheels, bright bars, etc. are also to be coated with rust protective paints.

Technical Data Sheet

Sr. No.	Particulars	Description
1	Item	EOT Crane with Electrical Hoist
2	Location	Indoor
3	Number required	As per price bid
4	Type	Single Girder as specified
5	Class of hoist	Class – II, as per IS: 3177 / 77
6	Capacity	As per price bid/ site requirement
7	Lift	As per site requirement
8	Span	As per site requirement
9	No. Of Falls	02
10	Travel Speed	As per relevant IS / Manufacturers' Standards
	Longitudinal	As per relevant IS / Manufacturers' Standards
	Cross Travel	As per relevant IS / Manufacturers' Standards
	Hoisting Speed	As per relevant IS / Manufacturers' Standards
	Creep Speed	As per relevant IS / Manufacturers' Standards
11	Fixed Girder	To be provided Minimum 250 x 125 mm ISMB

Sr. No.	Particulars	Description
12	Type of Suspension	Wheel suspension
13	Track	Manufacturers' Standards
14	Brakes	Manufacturers' Standards
15	Method of Operation	Pendent Push Button
16	Drum & Sheaves	Mild steel, drum grooving construction as per IS: 3938
17	Hook	Forged steel, confirming to BS: 2903 / BS: 3033 / IS: 3815 with thrust bearing / latch & antilock arrangement
18	Shaft	High tensile steel
19	Wire rope	Construction 6 x 36 FMC as per IS & reputed make
20	Gear	Manganese Chromium Alloy Steel
21	Trolley	MS frame, Wheel EN – 9
22	Rail Size	Manufacturers' Standards
23	Bay Length	Manufacturers' Standards
24	Type of motor	Induction Motor of Hoist duty
25	Supply Neutral	Effectively earthed
26	Rated Voltage	415 V
27	Supply Condition	415 v ± 5 % voltage variation, 50 Hz ± 5 % Frequency Variation
28	Motor HP	
	Hoisting	Manufacturers' Standards
	C T	Manufacturers' Standards
	L T	Manufacturers' Standards
29	No of phase & frequency	3 phase & 50 Hz
30	Synchronized Speed in rpm	Maximum 1500
31	Motor Standard	As per IS 325
32	Method of Starting	Direct On Line
33	Class of Insulation & Temperature Rise by Thermometer Resistance	Class – B, 65^0 c, 75^0 c
34	Hazardous area division	NA
35	Atmosphere	Dusty and Humid at times
36	Type of cooling	Fan Cooled
37	Degree of Protection	IP – 55
38	Starter Panel	As per requirement

Sr. No.	Particulars	Description
39	Cable from Crane / Hoist Motor to Starter Panel	As per requirement

7 H.O.T CRANE

7.7 SCOPE:

This specification covers design, material and construction Features, manufacture, inspection, testing, installation and commissioning of Hand Operated Traveling crane with Mechanical chain pulley block at Pumping Station.

7.8 CODES AND STANDARDS:

The design, material construction, manufacture, inspection, testing and performance of Hand operated chain pulley block and trolleys shall comply with all currently applicable status, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable relevant standards.

7.9 DESIGN REQUIREMENTS:

Crane bridge shall consist of single girder and wheeled trolly, steel used by vendor shall be tested quality steel confirming to IS: 226. Where plate used shall confirm to IS: 2062. All material used shall be of recent manufacture, free from defects, mill scales, laminations, pitting, rust, etc. All welds shall be free from defects like blowholes, lack of penetration, slag intrusion etc. The bridge shall be designed to carry the load specified in accordance with IS : 807.

Hand operated crane, shall be complete with chain pulley block, chain drum, chain, hook, necessary gearing, sleeves, brakes for chain and travel motions, travel stops, and other accessories to meet the full requirements of the client.

The chain pulley block will be required to operate in the local climatic conditions. All the parts of the chain pulley block and trolley shall be designed to withstand such atmospheric conditions without any deterioration.

The wheel diameter and rail size shall be suitable to take the wheel load.

7.10 FEATURES OF CONSTRUCTION:

The Chain pulley block shall have the following requirements:

GEARS:

Gears shall be from solid cast or forged steel blanks or shall be of stress-relieved welded steel construction or built-up from steel billets and welded together to form a one-piece gear section.

BEARINGS:

All anti-friction bearings are to be of reputed male. Bearings shall have a minimum life expectancy of 8000 hours and may be ball, roller, or removable bronze- bushing type.

ROTATING SHAFTS:

Shafts and axles shall have ample strength and rigidity and adequate beating surfaces for their duties.

LUBRICATION:

A grease lubrication unit with hand operated grease pump shall be provided for anti-friction bearing.

WHEEL:

The long travel bridge wheels shall be rim toughened, heat-treated carbon or alloy steel. shall be single flanged. The wheels shall have antifriction bearings. The wheels shall be machined on their treads to match the runway rail section.

Axle and shaft shall be made of carbon steel and accurately machined and properly supported.

HOOKS:

Hooks shall be solid, forged, heat-treated alloy or carbon steel of rugged construction and provided with a standard depress type safety latch. They shall have swivels and operate on ball or roller thrust bearing with hardened races. Lock to prevent hooks from swiveling shall be furnished.

BRAKES:

Chain pulley block shall be equipped with mechanical type brakes having torque capable of holding 150 % of the full rated hook load.

7.11 TESTS AND TEST CERTIFICATES:

Overload tests at 150 % of the rated load shall be carried out and test certificates shall be furnished for hook, chain pulley block.

FOLLOWING ACCESSERIES SHALL BE PROVIDED WITH E.O.T. /H.O.T. CRANE

1. Cross travel mechanical stoppers shall be provided.

FOLLOWING INFORMATION SHALL BE PROVAIDED AFTER THE AWARD OF CONTRACT

2. Detail dimensional outline drawings.

3. Material test certificates for the following:

4. Overload test for Hook & chain pulley block

Executive Engineer (Mech.)

Vadodara Municipal Corporation

Signature & Seal of the Bidder
Name and Address:

6.20.8
DETAILED TECHNICAL SPECIFICATIONS (DTS) FOR ELECTRICAL WORKS AND DG SETS

1. **SCOPE OF WORK:**

1.1. The scope of services covers the design, detailed engineering, preparation of construction drawing, manufacture, acceptance testing at manufacturer's works or at any accredited agency, supply, packing, forwarding and delivery from manufacturer's works/ place of storage to erection site including transit insurance, unloading, storage at site, moving from place of storage to place of installation, assembly, erection, testing, commissioning & performance demonstration and handing over along with all necessary spares of original ratings & specifications on Design, Build & Operate basis. Inland and overseas transit insurance, transport, testing at site shall be Contractor scope. Tender Bill of Quantities (BOQ) and Drawings are for reference purpose only which is the minimum requirements for the water supply system including raw water Intake, various Headwork/ Sub-Headwork with/ without water treatment facility as applicable; Contractor to ensure that design & equipments are as per specification requirements.

1.2. The Contractor shall prepare design calculations based on parameters/ design criteria indicated in the specifications. The Contractor shall prepare detailed engineering and construction purpose drawings to make his/ her own estimate of ratings & quantities (minimum requirements as per price schedule, technical data sheets, reference drawings & other relevant details) for entire electrical systems including all items, systems such as equipments, cables/ cabling system, lighting, ventilation, earthing, lightning protection, main & auxiliary power distribution, instruments, civil works required for completion of Works.

1.3. Contractor shall take due care of the site Seismic conditions while design of all equipments/ components used in entire electrical systems covered in this specification. Contractor shall furnish list of additional design parameters considered in design to fulfill above requirement.

1.4. Design and detailed engineering of the materials procured by Contractor is included in scope. Contractor shall submit design drawings/ calculations of each system which is included in scope to Purchaser/ Purchaser's representative for final review/ approval. All design documents/ calculations prepared by Contractor shall be as per ISO documentation i.e., with duly singed by qualified authorities and stamped. Design documents/ calculations prepared by Sub-Contractors shall be approved by Contractor and stamped copy of approval along with no-deviation sheet from Sub-Contractor shall be submitted by the Contractor to Purchaser/ Purchaser's representative for final review/ approval.

1.5. Expert or manufacturer supervision for SUB-Contractor supplied material shall be provided by Contractor and included in offer.

1.6. Contractor shall be solely responsible for any shortages or damages in transit for his supply scope, handling and/ or in storage of any materials and erection of the equipment, supply of erection tools at site. Contractor shall ensure that it will not affect any activity or project schedule. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

1.7. Contractor shall identify activities and mile stones of the work forecasted for next month with optimistic and pessimistic dates of work completion. Contractor shall prepare program evaluation and review techniques to identify critical path of project and activity sequences. The

project schedule shall be prepared and updated fortnightly in MS Project.

1.8. Nothing in this specification shall be constructed to relieve the Contractor of his/ her responsibilities towards following best engineering practices established in the country.

1.9. Obtaining approval including load sanction/ release from Madhya Gujarat Vij Company Limited (MGVCL), Gujarat Energy Transmission Corporation (GETCO)/ Gujarat Electricity Board (GEB), No Objection Certificates from MGVCL /GETCO/ GEB, Electrical Inspector (CEIG), relevant government agencies, statutory authority, as applicable is included in Contractor's scope.

1.10. All necessary legal fees required for various applications to MGVCL/GETCO/ GEB/ Electrical Inspector (CEIG), relevant government agencies, statutory authorities shall be paid by the Purchaser. The MGVCL/GETCO/ GEB deposit required to be paid for load sanction/ release shall also be borne by the Purchaser.

1.11. The Contractor's scope shall include measurement of soil resistivity at site by Wenner's four electrode method as per IS: 3043-1987 (Reaffirmed in 2006) at minimum four locations at site. The earthing shall be designed for the actual mean soil resistivity value obtained.

1.12. Even if all components of a system included in this specification are not explicitly identified and/ or listed herein, these shall be supplied under this contract to ensure completeness of the system and facilitate proper operation and easy maintenance of the plant. Any and all other works not indicated above but necessary/ required to complete the system in all aspects, are included in the Contractor's scope.

1.13. The Contractor shall include start up spares, essential spares, recommended spares and a set of special tools necessary for operation, routine maintenance of equipment supplied for a period as specified in this contract.

1.14. Whether specifically called for or not, all accessories required for normal and satisfactory operation (as deemed by the Purchaser) of the equipment shall be considered to be a part of the Contractor's basic scope of supply and/ or work and no claims whatsoever, for extra payment on these grounds, will be accepted.

1.15. Contractor should visit site and get him/ her ascertained regarding the scope of work for the complete Electrical works before submission of quote/ offer for the following pumping stations for 24 x 7 Water Supply for Vadodara Municipality.

a) Sayaji Head-works

b) Vadiwadi Head-works and

c) Akota Head-works

1.16. Contractor's scope shall include design, engineering, manufacture, supply, testing, commissioning and handover of following electrical equipment/ systems as per tender specifications, BOQ, reference drawings and other relevant details for the following pumping stations for 24 x 7 Water Supply for Vadodara Municipality

a) Sayaji Head-works

b) Vadiwadi Head-works and

c) Akota Head-works

1.16.1. Tariff metering equipment as applicable (as per MGVCL/GETCO/ GEB requirement) & electric supply connection including necessary liaison works (Tariff metering equipment & electric supply connection shall be provided by MGVCL/GETCO/ GEB for which necessary liaison shall be done by the Contractor).

1.16.2. 415 V Metal Enclosed Switchgears including Power & Motor Control Centre (PMCC) including Starter Panels, PDBs, Sub DBs, Lighting DBs, Receptacles for utilities. Local Start/ Stop Push Button Stations shall be provided near those motors which are not controlled from a Local Console/ Panel.

1.16.3. LV Capacitor Banks with control panel consisting of automatic power factor correction (APFC) relay to improve the plant power factor up to 0.99. APFC panels shall be provided on both bus sections of the PCC/ MCC.

1.16.4. Cabling system shall consists of various HV/ LV grade, XLPE/ PVC insulated, multi-stranded Al/ Cu, GI round wire/ flat strip armoured power, control cables, GI ladder/ perforated type Cable Trays & associated accessories including support structures.

1.16.5. Provision for continuous monitoring of electrical Power & Energy parameters like Voltage, Current, Power Factor, Frequency, Kilo Watts, Kilowatt-Hours etc.

1.16.6. Earthing for HV/ LV equipments and lightning protection system for all buildings in the plant premises. The general design shall be on the basis of following codes and standards (their latest amendments) in line with design criteria & specification requirements.

a)	IS 3043	:	Code of practice for Safety Earthing
b)	IS/ IEC 62305	:	Code of Practice for the protection of buildings and allied structures against lightning.
c)	CEA guidelines 2010	:	Measures related to safety & electric supply.

1.16.7. Lighting system for all indoor & outdoor areas of plant(s). The lighting system will be controlled by lighting panels installed in respective plant/ station areas, which will be fed from the main lighting DB.

1.16.8. DC System:

a) 24/ 30V or 110V DC in built DC power pack unit shall be provided wherever applicable.
b) 24/ 30V or 110V DC Battery & Battery Charger (with inbuilt DCDB) shall also be provided wherever applicable.

1.16.9. Diesel Generators with AMF & Synchronising Panel.

1.16.10. All necessary and supplementary items & equipment required for completeness, safe & efficient operation of the system, even though these may not have been mentioned in this specification. Spares & consumables for successful commissioning, establishment of performance guarantee and five years of trouble-free & safe operation of the plant.

1.17. Submission of drawings & documentation as specified under ''General Technical & Particular Requirement'' section for Electrical equipment/ systems.

1.18. Contractor's scope shall also include all civil works required for electrical equipment/ structure such as equipment foundations, indoor & outdoor trenches, equipment support structures, two pole structures, flow meter chamber, control rooms, all excavation works including those for earthing, cabling etc, de-tanking area, soak pits, burnt oil pits, chamber etc.

1.19. It is not the intent to completely specify all details of design and construction herein. Nevertheless, the Electrical system shall conform to high standard of engineering, design and workmanship in all respects and shall be capable of performing satisfactorily in continuous commercial operation under the specified environmental conditions.

1.20. Purchaser reserves the right to issue addendum to the technical specification to indicate modification/ changes in the requirements, if so required at a later date.

2. PROJECT INFORMATION:

2.1. SITE/ ENVIRONMENTAL CONDITIONS:

2.1.1. Ambient temperature : 45ºC (site specific)

2.1.2. Relative Humidity : 5 - 95%

2.1.3. Area Classification : Non Hazardous / Hazardous

2.1.4. Seismic Data : As per IS 1893 (latest Issue)

2.2. NOMINAL SYSTEM VOLTAGE:

2.2.1. Incoming AC power supply voltage to the plant premises is derived based on Load Demand as per GERC norms as follows:

Contract Demand	**Supply Voltage**
Not exceeding 100 KVA	415V
Exceeding 100 KVA & up to 4000 KVA	11 KV, 22 KV and 33KV
Exceeding 4000 KVA	66 KV & above

2.2.2. Plant Power/ Control Supply Distribution Voltage:

Plant Power Distribution Voltage:	415V, 3 Phase, 4 Wire, 50 Hz, AC
General Lighting & Space Heating:	240V, 1 Ph, 2 Wire, 50Hz, AC
Control, Protection & Emergency Lighting:	24/ 30 or 110V, 2 Wire DC (as applicable)

2.2.3. Voltage Transformer Secondary: 110 V, 3 Ph, 50 Hz, AC

2.2.4. Voltage Variation: ± 10%, Frequency Variation: ± 5% and Combined Voltage & Frequency Variation: ± 10%

2.3. SYSTEM EARTHING:

2.3.1. 66 kV, 3 Ph AC system : Neutral Grounding Resister

2.3.2. 11 kV, 3 Ph AC system : Neutral Solidly Earthed

2.3.3. 415 V, 3 ph, AC system : Neutral Solidly Earthed

2.3.4. 240 V, 1 ph, AC system : Neutral Solidly Earthed

3. DESIGN CRITERIA FOR ELECTRICAL EQUIPMENT/ SYSTEMS:

3.1. GENERAL:

3.1.1. The design criteria, given below has to be followed by the Contractor for designing/ sizing of electrical equipments covered under Contractor's battery limits; However it is to be noted by the Contractor that, following this design criteria does not relieve the Contractor from adherence to the standards, regulatory requirements & best engineering practices.

3.2. ESTIMATION OF LOAD/ MAX DEMAND: The following considerations are to be followed to arrive at the maximum electrical demand.

3.2.1. Load Factor

a)	Main motors	:	0.9
b)	Auxiliary load (valve actuators, Crane/ Hoist, etc.)	:	0.4
c)	Lighting load	:	1.0

3.2.2. Diversity Factor

a)	Main motors	:	1.0
b)	Auxiliary load (valve actuators, Crane/ Hoist, etc.)	:	1.1
c)	Lighting load	:	1.1

3.2.3. Power factor of Motors : As per the Manufacture's Data sheets

3.2.4. Efficiency of Motors : As per the Manufacturer's Data sheets

3.3. INCOMER SIZING/ SELECTION:

3.3.1. The capacity of the incomer(s) will be calculated based on the total simultaneous maximum demand (calculated based on the load factors and diversity given above, PF, efficiency).

3.3.2. Additional 20% contingency shall be considered for deriving incomer sizing.

3.3.3. % voltage dip at motor terminal shall not exceed 15% i.e. with the use of appropriate starter & considering largest motor starting & base load (all other loads except the highest rating motor are running); the % voltage dip during starting at motor terminal shall not exceed 15%.

a) The Voltage dip and fault level calculations needs to be calculated based on following actual data collected from nearest Substation and Grid.

i. The fault level of HV bus from which power supply will be taken to the plant.

ii. Impedance of HV Overhead Line Conductor/ HV Cable interconnecting the HV bus of Substation and HV switchboards of the Plant

b) For the per unit calculation purpose, minimum starting current for various types of starter applications shall be considered as following:

i. DOL Starter – 6 times the rated current.

ii. Star- Delta Starter – 3 times the rated current.

iii. Auto Transformer Starter (ATS) – 3 times the rated current.

iv. Soft Starter – 3 times the rated current.

3.4. SWITCHGEAR SIZING/ SELECTION:

3.4.1. Switchgear shall be sized/ selected considering the following:

a) Rating suitable for carrying full load current of the equipment.

b) Suitability for Short Circuit Rating for 1 sec duration.

c) Switchgear for motors shall be suitable for motor duty application.

3.4.2. Switchgear for all the motor feeders shall be as per Type-2 co-ordination.

3.4.3. Motor starter selection shall be done as follows:

a) Direct On Line (DOL) Starter – For motors rated up to 5.5 kW

b) Star- Delta Starter - For motors rated above 5.5 kW to 15 kW

c) Auto Transformer Starter (ATS) - For motors rated above 15 kW to 75 kW

d) Soft Starter – For all low/ medium voltage motors above 75 kW rating.

e) In-panel de-ration of minimum 20% or as provided in Manufacturer's catalogue, whichever is higher shall be considered.

3.4.4. Bus Bar Sizing:

a) The Contractor shall furnish calculations after award of contract, establishing the adequacy of the bus bar sizes to meet the continuous and short time current ratings as calculated.

b) The bus-bars shall be sized considering the following criteria:

i. Sleeving made of insulating material on all bus bars.

ii. Design ambient temperature 50ºC.

iii. Final temperature of the bus-bars complying with requirements of IS 8623 & IEC 60947. Reduced temperature rise limit by 5K (for indoor panels) & 10K (for outdoor panels) to that of mentioned in IS 8623 & IEC 60947 shall be considered to satisfy the final temperature.

iv. Bus bars being inside the panel; De- ration for enclosure and ventilation.

v. Bus bar suitability for carrying rated current continuously.

vi. Configuration of bus bars and Proximity effect

vii. Bus bars shall withstand the short time rating of the panel for 1 sec duration.

3.5. POWER FACTOR IMPROVEMENT: APFC Panel shall be sized considering following design criteria:

3.5.1. Minimum 8 steps in an APFC relay shall be considered.

3.5.2. Capacitor shall be All Poly Propylene (APP), double layer type.

3.5.3. Fixed type capacitor bank, with manual & auto switching and components as indicated in reference electrical Single Line Diagram(s) shall be provided in each mains incomer (LV) panel for transformer no load compensation.

3.5.4. For each bus section of the Main LV PCC/ MCC panel, separate APFC panel- based on above design criteria to be provided. Other requirements of APFC panel & its components shall be as per requirement provided in this specification.

3.5.5. Total capacity & capacitor bank sizes shall be as given in Table below:

Capacity	5 kVAr	10 kVAr	15 kVAr	25 kVAr	50 kVAr	100 kVAr
* kVAr	# Nos.	# Nos.	# Nos.	# Nos.	# Nos.	# Nos.

(*) = Contractor has to calculate the capacitor rating based on the system power factor (0.85 or actual, whichever is lesser - to be corrected for 0.99. Rating of APFC panel shall be based on 50% of running load on each bus section & not on the connected load basis. Number of stages/ steps in a particular APFC panel shall be decided by the Contractor such that minimum 8 steps & maximum 16 steps shall be provided in a particular panel. CT changeover scheme when only one transformer is running to be considered.

3.6. CABLE SIZING: The Contractor shall ensure that cable and wires associated with the power distribution and control systems, plant wiring and all other installations throughout the Works are adequately rated for their use.

3.6.1. The following main aspects shall also be considered while deciding the final size of the cables-

a) Supply voltage and frequency

b) All cables shall be selected to carry the corresponding full load current under site conditions.

c) Route length and disposition of cables

d) Maximum allowable temperature rise under normal full load condition based on the material of cable insulation (XLPE/ PVC).

e) Maximum short circuit current duration (fault clearing time) and final temperature of cable during short circuit current flowing through the cable.

f) For Cables emerging from ACB outgoing, fault clearing time shall be considered as 0.16 second (for Tie feeders if any it shall be 0.5 second)

g) For Cables emerging from MCCB outgoing, fault clearing time shall be considered as 0.01 second

h) Cable from metering kiosk to PCC incomer, fault clearing time shall be 1sec

i) Contractor to note that, the above fault clearing times are minimum to be considered & fault clearing time shall be considered as per actual relay co-ordination study.

j) Appropriate de-rating factors as per cable manufacturer's catalogue and enlisted below shall be considered for sizing the cable:

   i. Ambient Air Temperature (minimum 50ºC).

   ii. Ambient ground temperature (minimum 40ºC to be considered)

   iii. Laid in Air/ ducts/ directly in ground etc.

   iv. Depth of cable burial (minimum 750 mm for LT and 900 mm 11kV HV)

   v. Thermal Resistivity of Soil (minimum 150ºC Cm/ W to be considered)

   vi. No. of cables in a group-touching each other or separated by a distance

   vii. No. of cable trays in tier

   viii. Any other de-ration factors as applicable & as per Manufacturer's catalog.

k) % voltage dip at motor terminal shall not exceed 15% i.e. with the use of appropriate starter & considering largest motor starting & base load (all other loads except the highest rating motor are running) The Voltage dip calculations, minimum starting current for various types of starter applications shall be considered as following:

   i. DOL Starter – 6 times the rated current.

   ii. Star- Delta Starter – 3 times the rated current.

   iii. Auto Transformer Starter (ATS) – 3 times the rated current.

   iv. Soft Starter – 3 times the rated current.

l) In running condition, cumulative voltage drop (at 100% rated load) shall not exceed 5% (measured at load end) for the LV loads.

m) LV cables shall be 1.1 kV grade, multi-stranded Copper/ Al conductor, XLPE insulated, colour coded, inner and outer extruded PVC sheathed, galvanized steel round wire/ flat strip armoured cables.

n) Cables up to & including 4.0 sq.mm shall be Cu multi-stranded conductor with galvanized steel round wire armoured & balance cables shall be Al multi-stranded conductor with galvanized steel round wire/ flat strip armoured.

o) Single core cable shall have non magnetic material armouring.

p) Control cables shall be Cu multi-stranded conductor with galvanized steel round wire/ flat strip armoured. For cables above 7 cores, minimum two spare cores shall be considered.

3.7. ILLUMINATION SYSTEM: Illumination for various indoor & outdoor areas shall be conforming to the requirements mentioned below:

3.7.1. All lighting fixtures for indoor and outdoor shall be of LED only.

3.7.2. The illumination levels to be considered for the design of lighting system for various areas shall be as following. These are the illumination levels achieved at Work plane. Work plane height shall be considered as 0.76 m from FGL.

Area	Illumination Level (Lux) - Average values
Office rooms	300
Switchgear rooms	250
Control rooms	300
Chemical and general stores	150
All other indoor areas	150
Outdoor platforms and walk ways	50
Outdoor plant areas	20
Switchyard & Transformer Area - General - On Equipment	 10 30
Roads	15

3.7.3. Critical lighting shall be designed such that at all junctions, exit passages & strategic locations the Lux level shall be maintained above 10 Lux. Installite fixtures with built in battery backup shall be considered.

3.7.4. Lighting design shall be performed using DiaLux Software Version 4.5 or its latest version/ Original Equipment Manufacturer (OEM) validated software. The Validation Report along with software and data files shall be acceptable to Purchaser/ Purchaser's representative.

3.7.5. Various design factors shall be considered as following:

a) Maintenance Factor:
   i) Outdoor area : 0.6 (0.7 for LED)
   ii) Indoor areas : 0.7 (0.8 for LED)

b) Reflectance Factors:
   i) Wall : 30%
   ii) Ceiling : 10%
   iii) Floor : 30%

c) Uniformity (Min. / Avg.) : 50% Minimum for indoor and 30% for outdoor

3.8. EARTHING & LIGHTNING PROTECTION SYSTEM:

3.8.1. The safety earthing and lightning protection system will be generally on the basis of following codes and standards (including their latest editions).

a) IS 3043 -1987 (Reaffirmed in 2006): Code of practice for Safety Earthing.

b) IEEE 80 - 2000.

c) IS/ IEC 62305 - 2013: Code of Practice for the protection of buildings and allied structures against lightning.

d) CEA guidelines - 2010: Measures related to safety & electric supply.

3.8.2. The fault levels considered shall be as follows:

System Voltage	Fault level in kA (*)
66 kV	31.5 kA for 1 sec
11 kV	18.4 kA for 1 sec
6.6 kV	21.9 kA for 1 sec
415 V	50 kA for 1 sec

(*) Contractor to design on the basis of actual impedance and adequacy calculations for sufficiency of earth conductor size shall be provided.

3.8.3. Following factors shall be considered for sizing the earthing conductor:

a) Design Ambient Temperature : 50°C

b) Allowable temperature rise for steel welded joints : 500°C

c) Fault clearing time : 1 Second

d) Overall earthing resistance to be achieved as per IEEE std 80 – 2000 : ≤ 1 Ohm for transmission substation.

≤ 5 Ohm for distribution substation.

3.8.4. Measurement of soil resistivity shall be done using Wenner's four (4) electrode method as described in IS 3043 -1987(Reaffirmed in 2006) including its latest amendment.

3.8.5. The soil resistivity of the plant area has not yet been measured; the same should be carried out during detailed engineering by successful Contractor.

3.8.6. After soil resistivity measurement; length of conductor, number of earth electrodes and no. of test pits shall be finalized based on these design criteria & the requirements specified in earthing requirements.

3.9. DRAWINGS/ DOCUMENTS FOR REFERENCE:

3.9.1. The electrical Single Line Diagram(s)/ PLC system architecture for water supply project including raw water intake & various headwork/ sub-headwork with/ or without water treatment facility (as applicable) form part of this specification and should be used for reference purpose only.

3.9.2. The equipment/ switchgear component ratings & requirements shown in the reference electrical Single Line Diagram(s) are minimum requirements & after award of contract, Contractor has to get approval for the equipment selection with the approval for sufficiency calculations.

4. GENERAL TECHNICAL & PARTICULAR REQUIREMENTS FOR ELECTRICAL EQUIPMENT/ SYSTEMS:

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4.1. 415V METAL ENCLOSED SWITCH BOARDS:

4.1.1. Applicable Standards: The design, manufacture and performance of equipment shall conform to the latest standards specified below. In case of conflict between standards and this specification, this specification shall govern.

Metal enclosed switchgear- General requirements	IS: 3427
Factory Built Assemblies of SWGR and control gear for Voltages up to and including 1000V AC & 1200VAC	IS: 8623 / BS: 5486 / IEC: 439
Air Break Switches	IS: 13947-P3 / BSEN6049 / IEC: 947-3
Miniature Circuit Breakers	IS: 8828 / BSEN: 60898
Low Voltage Fuses	IS: 13703 / BS: 1362 / IEC: 269-1
Contactors	IS: 13947/ BSEN: 60947 4 / IEC: 947-1
Starters	IS: 13947/ BSEN60947-4/ IEC: 292-1 to 4
Control Switches & Push buttons	IS: 6857 / BSEN: 60947
Current Transformer	IS: 2705 / BS: 7626
Voltage Transformer	IS: 3156 / BS: 7625 / IEC: 44, 186
Indicating instruments	IS: 1248 / BS: 89 / IEC: 51
Marking and Identification of Conductors and Apparatus Terminals	IS: 11353 / BS: 159
A.C. Electricity Meters	IS: 722, 8530 / BS: 5685 / IEC 145,211
Degree of Protection	IS: 13947 / IEC: 947-P1
Selection installation and maintenance of switchgear and control gear	IS: 10118
Code of practice for phosphating iron and steel	IS: 6005 / BS: 3189
Specification for copper rods and bars for electrical purposes	IS: 613
Control transformers for switchgear and control gear voltage not exceeding 1000V AC	IS: 12021

4.1.2. Constructional Features: The switchgear shall be metal enclosed, modular type suitable for indoor/ outdoor installation, dust & burmin proof, self standing floor/ plinth mounting with a height not exceeding 2300 mm and shall have following features:

a) Panels shall be complying to Form-4 as per IS 8623: 1993, Part I/ IEC 439-1

b) Breaker up to 1250A shall be installed in two tiers and above 1250A, it shall be mounted in single tier.

c) Minimum clearance between live parts shall be phase to phase 25.4 mm & phase to neutral 20 mm at any location & shall be complying with the BIL for the panel.

d) Switchgear shall be divided into distinct vertical sections each comprising :

i. A completely enclosed bus bar compartment running horizontally.

ii. Enclosed vertical bus bars serving all modules in vertical section.

iii. A separate horizontal enclosure for all auxiliary power and control buses.

iv. Vertical cable alley of minimum 250 mm wide covering entire height

e) Operating devices shall be incorporated only in the front of switchgear.

f) Each shipping section shall have metal sheets at both ends

g) Cable alley shall be provided with suitable hinged doors

h) All doors shall be with concealed type hinges and captive screws

i) Each vertical section shall be equipped with a space heater controlled by thermostat

j) Each switchgear cubicle shall be provided with interior lighting with 11W CFL luminaries inclusive of lamp with door limit - on/ off switch.

k) A power socket (240 V AC, 5/ 15 A) shall be provided in the interior of each cubicle with On-Off switch.

l) All identical equipment and corresponding parts be fully interchangeable without any modifications

m) Main and Auxiliary Buses:

i. Switchgear bus bars shall be of uniform cross section throughout the length and made of Electric grade Aluminium (91 E- 63401)

ii. All bus bars shall be covered with heat shrinkable black PVC sleeves. Coloured polyester tapes for phase identification shall be provided at suitable locations.

iii. Bus bar shall be adequately supported to withstand stresses developed due to short circuits.

iv. Bus bar joints shall be provided with contact grease at the joints and shall be complete with tensile steel bolts, washers and nuts

v. The exposed bus live parts in the cable alley shall be totally covered against accidental contact by a shroud (and not by sleeve) to protect the workmen working on the switchgear.

vi. Vertical bus bars shall have Short Circuit rating same as main bus bar and shall be suitable for all connected load of vertical section.

vii. Neutral bus bar size shall be 50% of phase bus bar.

viii. Termination on bus bars at ACB, MCCBs shall be as per IEC60947-2. For terminations on MCCBs, where phase- phase and phase to earth clearance are not possible, Cu spreaders of suitable size shall be used along with the use of separators.

ix. Bus bar supports shall only be VMC irrespective of bus bar size. The span between the two insulators shall be adequate. Joint positions and insulators shall be properly adjusted so that they don't interfere.

x. For the Main PMCC, Contractor shall ensure that incoming feeders from transformer shall be suitably designed for terminating bus duct. Contractor shall consider the necessary arrangement (dummy panel, adapter panel, rear extension

etc.) if required, for terminating the bus-duct. Phase transposition, if required, will be done in the Main PMCC.

xi. Wherever Cu bus bars are provided, it shall be tinned copper & not bare Cu.

n) All mounting accessories like base channels, cross angles if required, nuts, bolts etc. shall be supplied by the Contractor.

o) All the indoor switchgear panels shall be suitable for IP-54 degree of ingress protection for the enclosure. Outdoor panels shall be with minimum IP-55, degree of protection

p) All panels shall be made up of CRCA sheet steel of following thickness -

i. Load bearing members: 2.5 mm.

ii. Doors and partitions: Doors - 2.0 mm, Partition - 1.5 mm.

iii. Mounting plate: 2.0 mm.

iv. Gland plate: 3.0 mm for both incomer and outgoing. For single core cable these plates shall be non magnetic.

q) All the panel wiring shall be done with PVC FRLS, multi-stranded copper wires

r) Feeder shall have hinged open-able (more than 105˚) type door with panel locks. All bus-bar covers and other panel covers shall be screw fixed.

s) Suitable barriers of FRP material shall be provided between two terminals connected to different voltage supplies.

t) All doors and detachable components shall be earthed with flexible green coloured (with Yellow coloured band) PVC sheathed 2.5/ 4.0 sqmm. multi-stranded Copper cable.

u) The equipment shall be given tropical and fungicidal treatment.

v) Each compartment & component shall be provided with name plates (with white letters on Black background) at front, inside & rear side.

w) Equipment nameplates shall be fixed by screws/ rivets and shall not be pasted.

x) Metallic Shrouding shall be provided for the isolation of main and vertical bus; as well as to avoid accidental contacts with live parts.

y) Drawing pocket shall be provided on the inside of incomer feeder door.

z) Provision for Top/ Bottom cable entry shall be made to suit the site condition.

aa) Lifting hooks/ eyes shall be provided in each shipping section of the equipment and shall be removable type.

bb) All the panels shall be provided with 20% extra power & control terminals.

cc) All unused contacts of the circuit breaker, protection, auxiliary, control relays shall be wired up to the terminal block.

dd) All terminals of different control voltages shall be separate from each other.

ee) Stud type terminals and ring type lugs shall be used for control cables.

ff) All the control/ power wiring shall be dressed neatly & the wire running through troughs shall be provided with covers

gg) Switchgear shall be easily extensible on both sides by the addition of vertical sections after removing the end covers. It shall be provided with a metal sill frame made of structural steel channel section properly drilled for mounting the switchgear along with necessary mounting hardware. Hardware shall be zinc plated or passivated. It shall be provided with labels on the front and rear indicating the switchgear designation.

hh) Any operating handle of switchgear shall not be more than 1800 mm and not lower than 300 mm from base of the panel.

ii) For individual feeder modules arranged in multi tier formation, it is essential that the modules are integral multiples of the unit size to provide for flexibility in changes if any at site. For safety isolation of the vertical bus bars, insulating barrier with cut outs shall be provided to allow the power slab contacts to engage with vertical Bus bars. A vertical cable alley shall be sufficiently wide for motor control modules and for circuit breaker control modules.

jj) A horizontal separate enclosure for all auxiliary power and control buses, as required shall be located so as to enable easy identification, maintenance and segregation from the main power buses. Tap off connections from these buses shall be arranged separately for each vertical section.

kk) All equipment associated with a single circuit shall be housed in a separate module compartment of the vertical section.

ll) For draw out type modules, only the handles of control and selector switches, push buttons, knobs & cut outs for lamps and meters shall be arranged on the front doors of the respective compartments to permit operation without opening the door.

mm) On circuit breaker controlled circuits, protective relays shall be mounted on the front door of the compartment. All other equipment pertaining to a circuit shall be mounted on the withdrawal chassis. All cut outs shall be provided with gaskets for the purpose of dust proofing.

nn) Current transformers shall not be directly mounted on the buses. Current transformer on circuit breaker controlled circuits shall be mounted on the fixed portion of the compartment.

oo) In breaker compartments, external cable connections shall be carried out in separate cable compartments for power and control cables.

pp) After isolation of the power and control connections of a circuit, it shall be possible to safely carry out maintenance in a compartment with the Bus bars and adjacent circuit live.

qq) The withdrawals chassis shall move on suitable guides and on suitably plated steel or stainless steel rollers or balls to facilitate easy withdrawal.

rr) Cable alleys shall be provided with suitable hinged doors. It shall be possible to safely carryout maintenance work on cable connections to any one circuit with the Bus bars

and adjustment circuits live. Adequate number of slotted cable support arms shall be provided for cleating the cables.

ss) Rear of single front switchgear shall be provided with removable panels. It shall be possible for one person to remove and fix the removable panel.

tt) All doors shall be provided with concealed type hinges and captive screws.

uu) The draw out contacts shall be only between copper/copper alloy/ aluminum fuses, which are silver or tinplated. The contact design shall be such that there should be no arcing/ deformation under the associated peak short circuit current.

vv) Switchgear shall be designed in such a way that all components equipment and Bus bars operate satisfactorily without exceeding their respective maximum permissible rise in temperature under ambient temperature conditions prevailing within the switchgear cubical, with reference to ambient temperature outside the switchgear cubical.

ww) Provision of ventilating louvers shall be provided with fine-screened brass or GI meshes to prevent entry of vermin and dust.

xx) The various types of modules indicating the control requirements of each type together with the list of component equipment required for each type shall be as follows:

i. Incoming circuit - Draw Out type air circuit breaker for above 630A/ Fixed type MCCB for 630A & below

ii. Outgoing feeder - ACB/ MCCB/ MPCB

iii. Auxiliary services - Starters, capacitors, Distribution Boards and other auxiliary load

yy) Physical size of compartment for each type of control and current rating shall be so chosen that all the basic and additional equipment can be housed in the compartment. No equipment associated with any particular circuit shall be permitted to be mounted in any other circuit module.

4.1.3. Power Distribution Board (PDB) configuration shall be two no. *A TPN MCCB I/Cs and six no. *A TPN MCCB O/G feeders. The O/G feeders shall be supplying to Sub DBs. The configuration of Sub Distribution Board (SDB) shall be *A FP MCCB I/C and 2 nos. 63A TPN MCB & 12 nos. 20A SP MCBs as outgoing feeders. (*A) shall be decided during detailed engineering.

4.1.4. Separate instrument's compartment for indicators of flow meter (s), energy meter, level & pressure controller (if any) shall be provided as per actual requirement of suitable size.

4.1.5. Control Voltages: Following control voltages shall be used in LV panels

a) All ACBs tripping/ Closing shall be suitable for 110/ 240V AC (24/ 110VDC) as applicable. The trip coil and closing coils of ACBs shall operate satisfactorily under the following conditions of supply voltage:

i. Closing coils- 85 % to 110 % of rated voltage

ii. Trip coils- 70 % to 110 % of rated voltage.

b) Indications/ Annunciator for LV Main PCC/ MCC- 110/ 240V AC (24/ 110VDC)

c) Indications for auxiliary DBs - 240V AC

d) Space heater, 5/ 15A socket, panel illumination lamp etc- 240V AC derived from AC bus

e) 240V AC, 110V AC and other voltages shall be segregated to avoid mix-up of voltages.

f) Control transformers suitably rated of voltage ratio 415/ 240/ 110 V on the Incomer/ Bus shall be provided. For the control transformers, fuses shall be provided on the 415 V side and MCBs on the 240/ 110V side. The control transformer shall be cast resin type only.

4.1.6. Painting:

a) All sheet steel work shall be paint through 7 tank electrostatic powder coating process in accordance with the required procedure and with the applicable standards. The switchgear enclosure shall be powder coated with shade as per RAL-7032.

b) The final finished thickness of paint film on sheet steel enclosure shall not be less than 80 microns. Finished painted appearance of equipment shall present an aesthetically pleasing appearance, free from dents and uneven surfaces.

4.1.7. Interchangeability:

All identical equipment and corresponding parts including chassis of draw out modules of the same size shall be fully interchangeable without having to carryout modifications. For trouble free interchangeability, the draw out arrangements shall be designed such that normal dimensional variations are taken care of by self-aligning feature of the modules.

4.1.8. Drawings & Documents:

Prior to fabrication of the switchgear, the Contractor shall submit following for Purchaser Representative's approval - the dimensional drawing and design calculations indicating bus bar size, short circuit rating of all the electrical component used, internal wiring, components mounting details etc. The Contractor shall submit manufacturers catalogues of the electrical components installed in the switchgear.

4.1.9. Inspection:

At all reasonable times during production and prior to dispatch of the switchgear to site, the Contractor shall arrange and provide all the facilities at their plant for inspection & testing of switchgear.

4.1.10. Earthing:

a) Al/ GI earth bus bars of adequate size shall be provided for the entire length of the panel. The framework of the enclosure shall be connected to this earth bus. Provisions shall be made for connection form this earth bus to the main earthing bus bar coming from the earth pit on both side of the switchgear.

b) The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bus bar. The armour of cables shall be properly connected with earthing clamp and the clamp shall be ultimately bonded with the earth bus bar.

4.1.11. Labels & Name Plate:

a) Engraved PVC labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.

b) A nameplate with the switchgear designation in bold letters shall be fixed at top of the central panel. A separate nameplate giving feeder details shall be provided for each feeder module door.

c) Inside the feeder compartments the electrical components, equipments, accessories like switchgear shall be provided with stickers shall suitably identify control gear, lamps, relays etc.

d) Engraved nameplates shall preferably be of 3-ply (Red-White-Red or Black-White-Black) lamicoid sheet however black engraved perplex sheet nameplates shall also be acceptable. Engraving shall be done with square grove cutters.

e) Nameplate shall be fastened by counter sunk screws and not by adhesives.

4.1.12. Danger Notice Plates:

a) The danger notice plate shall be affixed in a permanent manner on operating side of the switchgear.

b) The danger notice plate shall indicate danger notice in Gujarati, Hindi and English.

c) The danger notice plate, in general shall meet to requirements of local inspecting authorities.

d) Caution name plate, “Caution Live Terminal” shall be provided at all the points where the terminals are likely to remain live and isolation is possible only at remote end i.e. incomer to the switchboard.

e) The danger notice plate shall be made from minimum 1.6 mm thick steel sheet and after due pretreatment to the plate, the same shall be painted white with vitreous enamel paint on both front and rear surface of the plate.

f) The letters, figures, the conventional skull and bones shall be positioned on the plate as per recommendations of latest edition of IS 2551-1982.

g) The said letters, the figures and the sign skull and bonds shall be painted in signal Red color as per latest edition of IS 5 - 1978.

h) The danger plate shall have rounded corners. Locations of fixing holes for the plate shall be decided to suit the design of the switchgear enclosure.

4.1.13. Cable Entry:

a) The panel shall have provisions of cable entry from top/ bottom. The removable cable gland plate shall be provided to make entry dust and vermin proof.

b) The panel shall have provisions for fixing the multi-core cable glands.

c) The cable glands support plates shall be 3 mm thick.

d) Cable entries to the panel shall be from the bottom unless otherwise specified. Cable gland shall be double compression screwed type and made of brass.

4.1.14. Mountings:

a) All equipments in front of panel shall be of flush mounting type.

b) All equipment shall be so mounted that the removal and replacement may be accomplished individually without interruption of services of others.

c) All equipment inside the panel shall be so located that their terminals and adjustments are readily accessible for inspection or maintenance.

d) The centerline of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise the top lines of all meters, relays and recorders etc. shall be matched.

4.1.15. It is important to note that when pumping station is idle and transformer is required to be kept energized under no load/ part (miniscule) load condition, the necessary LV fixed capacitor bank (approx. 5% of transformer rating) shall be provided in PMCC (transformer LV incomer) panel and shall be manually/ automatically switched on to maintain power factor more than 0.95 but less than 0.99 (near unity). All the components for fixed type Capacitor bank (to be mounted in Main LV PMCC) panel shall be as indicated in typical electrical Single Line Diagram attached with the specifications. This is a complete responsibility of the Contractor to maintain the power factor under idle condition of pumping station. Any power factor adjustment charges levied by power utility shall be recovered from the Contractor along with 5 % lump sum administrative charge by the Owner.

4.1.16. Air Circuit Breaker (ACB):

a) All the incomers & bus coupler ACBs shall be 4P EDO type. All other ACBs shall be TPN EDO type.

b) All the ACBs shall have Ics=Icu=Icw=100%

c) Up to and including 630 A, Fixed Type FP/ TPN MCCB shall be considered, while above 630A FP/ TPN, fully draw out type ACB shall be considered in line with the electrical Single Line Diagram requirements.

d) All ACBs shall be provided with additional 6 NO + 6 NC contacts, exclusively for Purchaser's use.

e) All the ACBs (except for APFC panel) shall be provided with microprocessor based O/L+ S/C + inbuilt E/F protections.

f) ACBs/ MCCBs for APFC panel shall be provided with thermal magnetic based O/L+ S/C + E/F protections.

g) Each ACB shall be provided with – On, Off, Trip, Spring Charged, Trip Coil Healthy, Service & Test Position indication lamps.

h) For incomer feeders R, Y & B Phase indication lamps shall be provided.

i) All ACBs shall be Schneider make 'Masterpact NW'/ Siemens '3WL'/ L&T 'C Power' OR Equivalent from the approved make list.

j) Circuit breaker shall be horizontal withdrawal type, comprising three/ four identical poles operated through a common shaft.

k) It shall be suitable for switching duty of transformer and motors and other devices.

l) It shall be possible to push in and withdraw the breaker easily and without much effort. Insulating plugs and sockets for power as well as for control circuits shall be of robust design and fully self-aligning. Plugs and sockets for power circuits shall be silver faced, insulated with PVC or other insulating material.

m) The breaker shall have three distinct positions namely services, test and fully withdrawn positions. In test position, it shall be possible to operate the circuit breaker without energizing the power circuits. Separate limit switches each having a minimum of four (4) contacts shall be provided for both service and test position of the circuit breaker. These contactors shall be rated for 10 Amp, 240 volts AC.

4.1.17. Operating Mechanism:

a) The EDO type ACB shall be power operated by a motor charged spring operated mechanism & MDO type shall be manual type spring operated mechanism.

b) The operating mechanism shall have anti-pumping features under every method of closing. The operating mechanism shall normally be operated by Local/ Remote electrical control, when the breaker is in service position. Shunt trip coils shall perform electrical tripping.

c) The main poles of the breaker shall operate simultaneously. Also there shall not be any objectionable rebound of the moving contact in the fixed contacts.

d) The mechanism shall be such that any failure of auxiliary spring shall not prevent tripping. When the breaker is in closed position, failure of any auxiliary spring shall not cause damage to the CB or danger the operation.

e) A mechanical indicator shall be provided on the breaker operating mechanism to indicate open and closed position of the breaker. This shall be visible to a man standing in front of the cubical with the door closed.

f) It shall be possible to operate the breaker mechanically. This shall be possible only after opening the cubical door. Provision shall be made for local electrical control also when the breaker is in the test position by a control switch on the cubical doors.

g) All working parts of the mechanism shall be of corrosion resistance material. All split pins; bolts, nuts and other parts shall be properly pinned and locked to prevent loosening with repeated operation of the breakers.

h) Auxiliary switch containing 6 NO +6 NC potential free contacts rated for 10 Amp 240 V AC (Inductive breaking).

4.1.18. Spring Charged Mechanism:

a) Spring operated mechanism shall be complete with motor, opening spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.

b) The breaker operation shall be independent of the motor, which shall be used only for tensioning/ compressing of the spring.

c) The closing operation shall automatically charge the tripping spring. The closing, opening shall get charged immediately after a closing operation is performed.

d) Motor used shall be preferably universal type operated on AC supply. The Motor shall operate satisfactory at all values “between” 85% to 110% of rated voltage.

4.1.19. Mechanical/ Electrical Interlocking:

a) Mechanical interlock arrangement shall be provided between two incomer breakers. Interlocking arrangement shall be robust, heavy-duty type and sturdy in construction.

b) Interlocking between two-incomer breakers shall be provided in such a way that in normal condition bus coupler shall be in “ OFF “ position so that both the transformer can be kept charged and the total load can be divided equally between two circuits.

c) During fault, maintenance or any other abnormal condition while one of the transformer is not in working mode, the bus coupler shall be in “ ON “position so that total load can be supplied by the remaining transformer circuit.

d) Interlock shall be Mechanical and Electrical type. In case if one of the interlock fails the other way can be used for interlocking purpose.

4.1.20. Moulded Case Circuit Breakers (MCCB):

a) The MCCBs shall conform to IEC 947 & the latest applicable standards.

b) All MCCBs shall be of fixed type unless otherwise specified in the specifications elsewhere.

c) MCCBs shall be of four pole/ triple pole with neutral construction arranged for simultaneous four/ three-pole manual closing and opening and for automatic instantaneous tripping on short circuit.

d) All the incomer & bus coupler MCCBs for Main LT PMCC panels shall be FP type with microprocessor based O/L+S/C+inbuilt E/F release & all outgoings MCCBs shall be TPN with thermal magnetic based O/L+S/C+ E/F releases.

e) All MCCB’s shall be Schneider make Compact NSX/ Siemens- Sentron 3VL OR equivalent from the approved make list.

f) For achieving the Earth Fault protection in thermal magnetic (TM) based MCCBs, external CBCT, Earth Fault relay & shunt trip provision shall be considered as part of complete TM based MCCB.

g) The ON, OFF and TRIP positions of the MCCB shall be clearly indicated by using LED indications.

h) MCCBs shall be with Ics = Icu = 100%

i) MCCB shall be capable of withstanding the thermal stresses caused by overloads and locked rotor currents of values associated with protective relay settings of the motor

starting equipment and the mechanical stresses caused by the peak short circuit current of value associated with the switch gear rating.

j) All the MCCBs shall be of current limiting type and shall provide a cut off in 4-8 milli seconds for prospective currents during faults.

k) All the MCCBs shall be provided with rotary operating handle with door interlock.

l) MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings.

m) All MCCBs shall be provided with additional 2 NO + 2 NC contacts, exclusively for Purchaser's use.

n) All the switchgear selection for motor feeders shall be Type-2 co-ordinated.

4.1.21. Entire LV system shall be fuse less type & fuses shall be used only for VT/ Control Transformer primary side. MCBs shall be provided on secondary of PT/ Control transformer

4.1.22. Miniature Circuit Breaker (MCB):

a) MCB shall be hand operated, air break, quick make, quick break type.

b) Operating mechanisms shall be mechanically trip-free from the operating knob to prevent the contacts being held closed under overload or short-circuit conditions.

c) Each pole shall be fitted with a bi-metallic element for overload protection and a magnetic element for short-circuit protection. Multiple pole MCBs shall be mechanically linked such that tripping of one pole simultaneously trips all the other poles. The magnetic element tripping current classification shall be of the type suitable for the characteristics of the connected load. Where this is not specified, it shall be Type C.

d) The short circuit rating shall be not less than that of the system to which they are connected.

4.1.23. Direct-On-Line Starters: Direct on line motor starter shall have following components/ features:

a) Direct-on-line starters shall be suitable for Class AC-3 utilization category as per IS: 13947 (Part 4), unless otherwise mentioned in tender.

b) DOL starter shall have MCCB/ MPCB, Overload Relay with SPP, Contactor etc.

c) Type 2 Co-ordination shall be ensured.

4.1.24. Automatic Star-Delta Starters: Automatic star-delta motor starters shall have following components/ features:

a) Three sets of contactors one for the line, one for the star point and one for the delta, and a timer to automatically change the connections from star to delta.

b) Star Delta Starters shall consist of MCCB/ MPCB, Overload Relay with SPP, Contactors, electronic timer etc.

c) Star-delta contactors shall be electrically interlocked to permit starting of the motor in the proper sequence, namely star contactor closing, line contactor closing, timer energized

after time delay, timer contact de-energizing the star contactor, and delta contactor closing.

d) Star-delta starters shall be suitable for AC-3 utilization category as per IS: 13947 (Part 4), unless otherwise mentioned in tender.

e) Type 2 Coordination shall be ensured.

4.1.25. Reversing Starters: Motor Reversing starter shall have following components/ features:

a) Forward and reverse contactors, electrically interlocked with each other.

b) Reversing starters shall be suitable for Class AC-4 duty as specified in applicable standards, unless otherwise mentioned in tender.

4.1.26. Auto Transformer Starter (ATS): Auto Transformer starter shall have following components/ features:

a) Auto transformer shall be air cooled type having three (3) tappings of 50%, 65% and 80%. The same should be wound with Copper wire. The size of the wire should be determined to suit the associated motor rating. The tapping requirement indicated is minimum required & Contractor to ensure proper tapping selection based on motor starting requirement.

b) Stamping of reputed make and winding wire with 'B' class insulation should be used. This should also be suitable for minimum 6 starts per hour. Core shall be of CRGO material.

c) Maximum temperature rise should not be more than 115°C. Kordnoffer circuit (Closed Transition type) should be adopted in ATS panel. There shall be an acrylic/ Hylam sheet over & below the transformer. Also to absorb humming rubber sheet shall be provided below auto transformer.

d) Auto transformer shall be vacuum impregnated.

e) Testing of transformers should withstand full load starting current for six starts per hour, each kick of 15 seconds duration as per relevant IS.

f) ATS shall be provided with thermal overheat protector in each coil of transformer from overheating. Thermal overheat protector rating shall be 900ºC with 10% tolerance.

g) ATS shall consist of MCCB/ MPCB, Overload Relay, and Contactors etc.

4.1.27. Soft Starters: Fully automatic microprocessor based soft starters with built-in bypass terminals for pump control application shall be considered for the motors above 75 kW. The features/ requirements of the starters shall be as per following but not limited to:

a) The soft starter shall be designed, built and tested according to the latest editions of applicable IEC standards/ IEC 947-4-UL, CE.

b) Input Voltage – 3Ph, 415V, ±10%

c) Input Frequency – 50 Hz, ±5%

d) Control Voltage – 100 - 240 V AC

e) Ambient Conditions:

i. Temperature- 50 Deg C. (Operating range -5 to 70ºC)
ii. Relative Humidity of 5 to 95%

f) Control Method - Torque Control/ Reduced Voltage/ Ramp

g) Motor Protection - Thermal overload protection

h) Starter Protection - S/C, Phase imbalance, Phase failure, Phase reversal, O/ V, U/ V, Locked rotor, excessive starts per hour for application, Phase loss input/ output, Motor output loss.

i) EMC standard – IEC 61000-4-2 level-3, IEC 61000-4-3 level-3

j) Built-in communication port for RS 485.

k) Type 2 Co-ordination shall be ensured.

l) The soft starter shall be complete with the following acceleration and deceleration settings & display requirements as a minimum-

i. Starting Torque: Initial torque shall be adjustable from 0-100% of maximum locked rotor torque.

ii. Ramp Time: The time between starting torque and maximum torque shall be adjustable between 1 to 60 seconds. The time between maximum torque & stop shall be adjustable between 2 to 120 seconds

iii. The current limit feature shall have the following characteristics:

- The maximum allowed current during start shall be adjustable from 150% to 500% of soft-starter maximum current rating.

- Starting torque shall be fixed at 40% when utilizing the current limit function.

iv. Voltage Ramp start & Full voltage DOL start shall be possible.

v. For stop function – Linear torque control, Quadratic Torque Control, Voltage ramp control, soft break etc. functions shall be provided.

vi. The soft-starter shall be provided with a functional ground to remove and/ or minimize electrical noise injected on the soft starter control board.

vii. Normally open output relays shall be provided for faults and status indications.

viii. Normally closed contacts for fault relays shall be provided as an option.

ix. The soft-starter shall be provided with a 2-position dip switch to select between the normal in-line connection (3-lead motor) and inside the delta (6-lead or 12-lead delta wound motors).

x. The soft-starter shall be controlled completely through solid state design algorithms. No moving electromechanical contacts shall be allowed.

xi. All adjustments shall be made from the front of the soft starter through keyboard (soft keys)

xii. The Soft starter shall have in-built/ remote display with following display parameters.

- Three Phase Currents
- Three Phase Voltages
- Shaft Power in kW / HP (selectable)
- Motor thermal capacity
- Motor Energy consumption (kWh)
- Power factor
- Run time in hours

xiii. The Soft starter shall have following fault indications

- Line failure
- Phase imbalance
- Over temperature – Motor
- Over temperature – Soft Starter
- Shorted Thyristor
- Open Thyristior
- Locked Rotor
- Motor output loss
- Overload - Shaft Torque
- Underload - Shaft Torque
- Over voltage
- Under voltage
- Excessive Starts
- Phase reversal

xiv. Shaft Power measurement without the use of external electro mechanical sensors.

xv. Shaft overload and under load protection shall be available through the controller, even in a by-pass configuration.

xvi. When fault conditions are detected, the controller shall inhibit starting or shut down SCR pulse firing.

xvii. The standard feature pump control shall be implemented to provide closed loop control of a motor to match the specific torque requirements of centrifugal pumps for both starting and stopping. This shall aid in eliminating the phenomenon commonly referred to as “water hammer”.

xviii. The soft-starter shall be designed for three-phase control with two anti parallel SCRs in each phase. SCR-Diode combination shall not be acceptable.

- The PCB shall provide digital microprocessor control and supervision of all controller operation, including SCR pulse firing control.
- The PCB power supply shall be self-tuning to accept control power input from 100 to 240 or 380 to 500 V AC, 50/ 60 Hz.
- The SCR firing circuitry shall incorporate an RC snubber network to prevent false SCR firing.
- When fault conditions are detected, the controller shall inhibit starting or shut down SCR pulse firing.

xix. SCRs shall have the following minimum repetitive peak inverse voltage ratings:

- 200 to 525V: 1600 V
- 200 to 690V: 1800V

m) Soft Starter shall be ABB make PSTB 840-600-70/ Schneider make Alistart-48 or better from the approved make list.

4.1.28. Contactors: The power contactors used in switchboard shall have following features:

a) The contactors shall confirm to IS 13947 & the latest applicable standards

b) The power contactors shall be of, air break, single throw, triple pole, electromagnetic type.

c) The insulation class of contactor’s coil should be B or higher.

d) Operating coils of all contactors shall be suitable for operation on 110/ 240 V, single phase, 50 Hz, AC supply.

e) Contactors shall be provided with at least two pairs of NO and NC auxiliary contacts.

f) Contactors shall not drop out at voltages down to 70 % of coil rated voltage.

g) All the switchgear selection for motor feeders shall be Type- 2 coordinated.

h) Motor starters shall be complete with auxiliary relays, timers and necessary indications.

4.1.29. Relays:

a) Main protective relays shall be Numerical type. They shall be suitable for semi-flush mounting with only flanges projecting on the front with connections from the rear.

b) All relays shall be enclosed in rectangular shaped, dustproof cases and shall be suitable for flush mounting.

c) All protective relays shall be in draw out cases with built in test facilities.

d) Auxiliary relays and timers shall be rated to operate satisfactorily between 70 % and 110 % of the rated voltage

e) Test block and switches shall be located just below each relay for testing unless otherwise specified. All auxiliary relay and timers shall be supplied in non-draw out cases.

f) All protective relays shall be provided with at least two pair of potential free output contacts, exclusively for Purchaser's use.

g) Relay cases shall have adequate number of terminals for making potential free connections, to the relay coils and spare contacts. Paralleling of contacts if any shall be done at the terminals on the casing of the relay.

h) Each relay shall have provision for easy isolation of trip circuit for the purpose of testing and maintenance.

i) All relays shall with stand out a test voltage of 2 KV, 50 Hz RMS voltages for one minute.

j) Auxiliary seal in units provided on the protective relay shall be shunt reinforcement type.

k) 250 kW & above rated motors shall be breaker controlled with motor protection relay Siemens '7SK 80' OR equivalent from approved make list.

4.1.30. Thermal Overload Relays:

a) Starters shall be complete with a three element, positive acting, ambient temperature compensated, time lagged thermal overload relay with adjustable settings. The setting range shall be properly selected in accordance with the rating of the motor.

b) Thermal overload relays shall be hand reset type

c) 'Stop' push button of the starter and hand-reset device shall be separate from each other.

d) Overload relay hand reset push button shall be brought out on the front of the compartment door. Overload relay shall be provided with at least 1 'NO' and 1 'NC' or one changeover contact.

4.1.31. Timers:

Thermal/ Electronics timer for change over in star-delta and ATS panel should be provided.

4.1.32. Switch And Contactor Ratings:

Switch and contactor rating for various motor starter modules shall be selected by the

Contractor, based on the specifications. Contractor shall also select appropriate ratings & ranges for thermal overload relays. These details shall be subject to the Purchaser's approval.

4.1.33. Single Phasing Preventers:

a) Single phasing preventer relay shall be provided to protect motors against single phasing.

b) It should operate satisfactory from 320/ 480V. Timing range of delay start 0 - 45 seconds.

c) Toggle switch for Auto SPP by pass should be provided on front of unit.

d) The relay shall not operate for supply voltage unbalance of ± 5%. After sensing single phasing, the relay shall operate with a time delay of 2 to 3 secs.

e) The relay shall not operate for a 3- phase power supply failure. The relay shall be of the hand-reset type with a hand-reset push button. Resetting shall be instantaneous and independent of the adjusted time delay in the tripping of the unit. Visual indication for the operation of the relay shall be provided.

f) The relay shall be suitable for application to protect reversible and non reversible motors.

g) The relay operation shall be independent of the motor KW rating, the loading conditions prior to the occurrence of the single phasing and RPM of the motor.

h) The relay shall be of the fail-safe type and shall operate to trip the motor when the relay internal wiring is accidentally open circuited.

4.1.34. Power & Control Wiring Connections:

a) Terminals for both incoming and outgoing cable connections shall be suitable for 1.1kV grade Al/ Cu conductor XLPE armoured cable and shall be suitable for connections of solder less sockets for the cable size.

b) Main PMCC incomer feeder shall be suitable for bus duct connections using Aluminum Bus bars

c) Both control and power wiring shall be suitable for Bus Duct/ Cable termination as per guidelines mentioned in transformer specifications.

d) Both control and power terminals shall be properly shrouded. Power terminals shall be of stud type.

e) 20% spare terminals shall be provided on each terminal block. Sufficient terminals shall be provided on each terminal block so that not more than one out going wire is connected to per terminal.

f) Suitable barriers of enclosures shall preferably separate terminals strips for power and control from each other.

g) Wiring inside the modules for power, control, protection and instruments etc shall be done with use of 1.1 kV grades, multistranded Cu, PVC FRLS wiring.

h) Power wiring inside the starter module shall be rated for full current rating of respective contactor but not less than 4.0 Sq. mm. 2.5 Sq. mm copper wire shall be used for current transformer circuits.

i) Other control wiring shall be done with 1.5 Sq. mm copper conductor wires.

j) Wires for connection to the door shall be flexible. All conductors shall be crimped with solder less sockets at the ends before connections are made to the terminals.

k) There shall be control transformer for control power supply (110/ 240V AC) and separate control bus.

l) Particular care shall be taken to ensure that the layout of wirings is neat and orderly. Identification ferrules shall be filled to all the wirings terminations for ease of identification and to facilitate checking and testing.

m) Washers shall be used for all Copper and Aluminum connections.

n) Final wiring diagram of power and control circuit with ferrules nos. shall be submitted along with the panel as one of the documents against the contract.

4.1.35. Terminals:

a) The outgoing terminals and neutral shall be brought to a cable alley suitably located and accessible from the panel front.

b) The current transformer for instruments metering shall be mounted on the disconnecting type terminal blocks. No direct connection of incoming or outgoing cables to internal components of the distribution board is permitted; only one conductor may be connected in one terminal.

4.1.36. Wire Ways:

a) The horizontal PVC wire way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

4.1.37. Indicating Instruments:

a) All analogue indicating meters shall be 144 x 144 mm size taut band with 240º Scale. All indicating meters shall be provided as per enclosed electrical Single Line Diagram.

b) Ammeters for motor feeders shall have suppressed scale up to 6 times beyond full load.

c) Dials shall be parallax free and white with black numbers and letterings & pointer shall be of knife-edge type. Such instruments shall be provided with zero adjustor accessible from the front.

d) Instruments shall have an accuracy class 1.0 or better.

e) Instrument dials shall be white with black numbers and lettering.

f) Ammeter and current coils of wattmeter's and ammeters shall continuously withstand 120 % of rated current and 10 times the rated current for 0.5 second without loss of accuracy.

g) Voltmeters and potential coils of voltmeters shall withstand 120% rated voltage continuously and twice the rated voltage for 0.5 seconds without loss of accuracy.

4.1.38. Metering Instruments:

a) Multifunction meters shall be provided for incomers, main pump motor feeders and outgoing feeders of 250A & above. Size of the MFM shall be 96 x 96 sq. mm & provided with following metering features:

i. Current, Voltage, Energy (kWh), MD (kW, kVA), PF & Hz etc.

ii. MFM shall be L&T make 'Quasar'/ Siemens OR equivalent.

iii. MFM shall be with accuracy class 1.0 or better & having RS 485 communication port.

b) Multifunction meters shall be suitable for operation from the secondary of CTs and VTs. They shall be provided with a separate 3 phases, 4 wires type test terminal blocks for testing of meters without disturbing CT and VT secondary connections.

c) Current coils of meters shall have a continuous overload capacity of 120 % for both accuracy as well as thermal limits. Also the coil shall withstand at least 10 times rated current for 0.5 second without loss of accuracy.

4.1.39. Current Transformers:

a) Current transformers shall be of cast resin type. Insulation Class shall be Class 'E' or better.

b) Current transformer shall have a short time withstand rating equal to the short time withstand rating of the associated switchgear for one second for breaker feeders.

c) Unless otherwise specified, the minimum performance requirement of current transformers is as follows:

i. Measuring CTs -15 VA, accuracy class 1.0 or better.

ii. Protective CTs - 15 VA, accuracy class 5P20.

d) The above mentioned burdens are minimum required & it will be Contractor's responsibility to coordinate the current transformer burden with the requirements of relays, instruments and leads associated with that particular current transformer. Contractor has to provide sufficiency calculations for the same.

e) Current transformer (CT) shall have polarity markings indelibly marked on each transformer and at the lead terminations at the associated terminal block

f) CT shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit current

g) Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests.

h) Identification labels giving type, ratio, output and serial numbers shall be provided.

4.1.40. Voltage Transformers:

a) Voltage transformers shall be of cast resin type. Insulation Class shall be Class 'E' or better.

b) Unless otherwise specified, the minimum performance requirements of Voltage transformers are as follows:

i. Measuring VTs - 50 VA per phase and accuracy class 1.0

ii. Protective VTs - 50 VA per phase and accuracy class 3P.

iii. Dual purpose VTs - 100 VA and dual accuracy class 1.0/ 3P for metering and protection respectively. VA is per phase.

iv. The above mentioned burdens are minimum required & Contractor has to provide sufficiency calculations for the same.

c) All secondary windings of voltage transformers including open delta windings shall be rated for 110 V /√3, 110V/ 3 per phase.

d) Voltage transformer shall have a continuous over voltage factor of 1.2 and short time over voltage factor as follows:

i. 1.5 for 30 seconds in case of effectively earthed system.

ii. 1.9 for 8 hours in case of non-effectively earthed system.

e) Voltage transformers shall be complete with suitable rated primary, fuses. Primary fuses shall have a rupturing capacity equal to the rupturing capacity rating of the associated switchgear. All the secondary circuits of the VT shall be protected by MCBs.

f) It shall be possible to replace voltage transformers without having to de-energize the main bus bars.

g) The terminals of VT secondary and tertiary windings, which are required to be connected to earth, shall be earthed by an isolating link without a fuse.

h) Identification labels giving type, ratio, output and serial numbers shall be provided.

4.1.41. Push Buttons:

a) Push buttons shall have two normally open and two normally closed contacts unless otherwise specified. The contacts shall be able to make and carry 5A at 110V DC and shall be capable of breaking 1A inductive load at 110V DC. They shall be provided with inscription plates engraved with their functions.

b) Emergency stop' push buttons shall be of Mushroom type, lockable in the pushed position and shall be shrouded to prevent accidental operation. Key shall not be required for the operation of the push button.

c) The Internal wiring and terminal blocks shall meet the relevant requirements.

4.1.42. Auxiliary Transformers:

Any auxiliary voltage required for any of the component inside the switchgear shall be derived

from the main supply by providing adequately rated auxiliary transformer mounted inside.

4.1.43. Indicating Lamps: Indicating lamps shall be:

a) Clustered LED type and of low watt consumption.

b) Provided with series resistors.

c) Provided with translucent lamp covers of colors 'Red', 'Green' and Amber' etc. as required.

d) Indicating lamp shall be of the double contact, bayonet cap type rated for operation at either 110 V AC or at the specified AC/ DC system voltage as applicable.

4.1.44. Control & Selector Switches: Control and selector switches shall be:

a) Rotary type with enclosed contacts.

b) Adequately rated for the purpose intended (Minimum acceptable rating is 10A continuous at 230V AC and 1A (inductive break) 220V DC.

c) Provided with escutcheon plates clearly marked to show the positions.

d) Control switches shall be spring return to normal type & provided with pistol grip type handles.

e) Selector switches shall be maintained contact stay put type. Switches in ammeter circuits shall be of break type contact. Selector switches shall be provided with oval handles.

4.1.45. Space Heaters:

a) Adequately rated anti-condensation space heaters shall be provided, one for each control panel, for each switchboard and for each marshalling kiosk.

b) Space heater shall be of the industrial strip continuous duty type, rated for operation on a 240 V, 1 phase, 50 Hz, AC system.

c) Each space heater shall be provided with a single pole MCB with overload and short circuit release, a neutral link and a control thermostat to cut off the heaters at 350 C.

d) Space heater indicated in the breaker modules represents the space heater for each vertical section of the switchboard. Where breakers are mounted in two-tier formation, then only one space heater with associated MCB and thermostat is adequate for the vertical section

4.1.46. Cubicle Lighting/ Receptacle:

a) Each control cabinet, marshalling box, etc. shall be provided with interior lighting by means of 11 W CFL luminaries with door operated On/ Off switch.

b) A 240 V, 1 phase, AC receptacle (socket) plug point shall be provided in the interior of each panel with a MCB.

4.1.47. Routine and Acceptance Tests to be conducted by the manufacturer at their own risk and cost in presence of Purchaser/ Purchaser's representative during inspection & testing at

manufacturer's works:

a) Following Routine tests as per IS: 13947 and IEC: 60947 standards & other specified relevant IS standards shall be performed by the manufacturer and witnessed by Purchaser/ Purchaser's representative on LV Switchgear panel complete with the accessories.

   i. Dielectric test on main circuit.

   ii. Test on auxiliary and control circuit.

   iii. Measurement of insulation resistance of the main circuit.

   iv. Tightness of main circuit.

   v. Design and visual check.

   vi. Dimensional check and BOM verification.

   vii. High Voltage test on power & control circuit.

   viii. Functional & mechanical operation test of all components.

   ix. Measurement of thickness of sheet steel & paint.

   x. Verification of wiring as per approved schematic.

b) Following Type Tests reports as per IS: 13947 and IEC: 60947 to be submitted for the same rating & type of LV Switchgear panel conducted in past for review of Purchaser at the time of inspection & testing of equipment. Type test reports should be valid and not be older than the 5 years.

   i. Dielectric test on main and auxiliary circuit.

   ii. Temperature rise test.

   iii. Making and Breaking test of switching elements.

   iv. Degree of protection test.

   v. Short circuit withstand test.

   vi. Electromagnetic compatibility test.

c) Certified copies of all type and routine test certificates and Calibration Certificates of measurement instruments which are used during inspection shall be submitted for the Purchaser's review/ approval before dispatch of the switchgear.

4.1.48. Test Certificates:

a) Testing of switchgear shall be carried out at factory or at site as per standard in presence of Purchaser/ Purchaser's representative.

b) The test results shall be recorded on prescribed forms. The certificates for the test carried out at factory or at site shall be submitted in duplicate to the Purchaser/ Purchaser's Representative for approval. Components and equipment that are not fully

interchangeable are liable for rejection. Contractor shall replace all such non interchangeable equipment at his cost.

4.1.49. Drawings/ Documents: After award of contract, Contactor has to submit drawings/ documents for Purchaser's approval as mentioned below but not limited to:

a) General arrangement diagram showing dimensions of enclosure, length, widths and depth of enclosure and bill of quantity indicating the rating, make of each components and quantity.

b) Complete assembly drawings of the switchboard/ distribution board/ MCC showing plan, elevation and typical sectional views and location of cable boxes and control cable terminal blocks for external wiring connections, etc.

c) Foundation plan showing the location of channel sills, foundation, anchor bolts and anchors, floor plans and openings.

d) Schematic power and control wiring diagrams with bus bar rating with material, instrument & control transformers, switchgear rating, control interlocks, relays, instruments, space heaters details etc.

4.2. LOCAL PUSH BUTTON STATIONS:

4.2.1. Constructional Features: The constructional features of the local push button stations shall be as follows:

a) Metal enclosed, weatherproof, suitable for mounting on wall or steel structures. The enclosure shall be die cast aluminum or sheet metal of 2 mm thickness.

b) Dust and vermin proof.

c) Provide a degree of protection of not less than IP55.

d) Metal parts shall be given tropicalising treatment as per standards and painted with one coat of epoxy primer and two coats of light gray epoxy paint.

e) Provided with inscription plates of rear engraved Perspex with white letters on black background. The letter size shall be 6 mm.

f) Provided with two earthing terminals suitable for earthing wire /strip.

g) Provided with removable undrilled gland plate and cable glands for two nos. 5C x 2.5 mm² Copper conductor, XLPE insulated, armoured cable. The cable entry shall be from the bottom.

h) Earthing shall be provided by 8 SWG GI wire and connected to earthing system.

4.3. APFC PANEL WITH CAPACITOR BANKS:

4.3.1. Scope of this specification covers design, manufacture, testing at manufacturer's works, supply, packing, forwarding and delivery from place of storage/ manufacturer's works to erection site including transit insurance, unloading, storage at site, assembly, erection, testing, installation, commissioning and performance demonstration of the following equipment with associated accessories.

4.3.2. Capacitor Banks:

a) The type of capacitors shall be All Polypropylene type double layer conforming to IS 13585 - 1994 & having following specifications:

Supply	3 phase, 3 wire
Rated voltage	415 V
Rated frequency	50 Hz.
Permissible over voltage	1.1 Vn
Permissible over current:	1.5 In
Temperature category:	50º C

b) The capacitor shall be vacuum impregnated with liquid dielectric having high thermal stability.

c) The capacitors shall have Low Dielectric Loss of $\leq$ 0.5 W / kVAr.

d) Each capacitor bank shall be provided with the 7% detuned filter.

e) * kVAr is net reactive compensation required to maintain 0.99 PF at 415 V Bus, i.e. excluding compensation required for detuned filters.

f) Bushing should have high mechanical strength & method of fixing should be proper so that no leakage occurs.

g) Auto/ Manual switch shall be provided in the APFC panel. For manual switching, every capacitor bank feeder shall be provided with ON & OFF push buttons along with the ON & OFF indications.

h) Minimum current rating under site conditions, of circuit breakers, contactors and cables shall be at least 150% of rated capacitor current, to take care of harmonics.

i) Contactor for switching of capacitor banks shall have AC-6b utilization category according to IEC 60947-4-1 & sized accordingly.

j) All the components shall be suitable for capacitor duty application.

k) The capacitor banks shall be complete with all parts that are necessary or essential for efficient operation. Such parts shall be deemed to be within the scope of supply whether specifically mentioned or not. Capacitor shall be designed to improve the power factor to 0.99 lagging

l) It shall be complete with the required capacitors along with the supporting post insulators, steel rack assembly, Al/ Cu bus bars, Al/ Cu connecting strips, foundation channels, fuses, fuse clips, etc. The steel rack assembly shall be hot dip galvanized.

m) The capacitor bank may comprise of suitable number of single phase units in series parallel combination. However, the number of parallel units in each of the series racks shall be such that failure of one unit shall not create an over voltage on the units in parallel with it, which will result in the failure of the parallel units. The assembly of the banks shall be such that it provides sufficient ventilation for each unit.

n) Each capacitor case and the cubicle shall be earthed to a separate earth bus.

o) Capacitor shall conform to IS 2834.

p) The units shall be capable of continuously withstanding satisfactorily any overvoltage up to a maximum of 10 % above the rated voltage, excluding transients.

q) Each capacitor unit/ bank shall be fitted with directly connected continuously rated, low loss discharge device to discharge the capacitors to reduce the voltage to 50 volts within one minute upon disconnection, in accordance with the provisions of the latest edition of IS:2834.

4.3.3. Control Cubicles:

a) Capacitor and capacitor control shall be housed in a metal enclosed cubicle. Capacitor shall be housed in the lower compartment and capacitor control unit at the top compartment, the two compartments being segregated. Control cabinets shall be free standing floor mounted type and shall meet the requirements of Metering, Protection & related provisions for APFC panel as tabulated below:

Panel Name	Breaker Type	Protection	Metering	Indications	Other
APFC Panel					
Incomer	ACB (TPN, MDO/ EDO) OR MCCB (TPN, Fixed Type)	TM based O/L, S/C release , APFC Relay, E/F Relay with CBCT & Shunt Trip	Analogue A, V	R Y B, On, Off, Trip	ETPB, A/M SS, Annunciator
Outgoing	MCCB (TP, Fixed Type)	TM based O/L, S/C release	A, AS	On, Off, Trip	Start, Stop Push Buttons

b) APFC panel shall have Al/ Cu bus bars sized for appropriate SC rating for 1 sec & to carry continuous rated current.

c) All CTs/ VTs shall be cast resin type.

d) All the MCCB's shall be current limiting type. Necessary auxiliary contact block required is included in Contractor scope.

e) One contact of power factor correction relay shall be provided for annunciation "POWER FACTOR LOW". The relay shall switch-on/ off capacitor banks for loads from 5% to 100%. The annunciation window shall be with test, accept and reset push button & hooter.

f) Capacitor switching and automatic power factor correction panel shall be designed in such a way that power factor of 0.99 lagging shall always be maintained. Timings to cut in capacitors shall be provided in such a manner to facilitate capacitor discharging before next switching and shall also avoid hunting due to temporary fluctuations of load. The timer shall be provided in both auto and manual mode.

g) The Automatic power factor correction panel and capacitor panel are integral type, prewired including power connections. Due consideration shall be given for adding/removal of capacitor or other components and maintenance considerations. Contractor shall submit General Arrangement drawings of capacitor and capacitor control panel, with description of power factor control panel with its components.

h) For control circuit 415/ 240/ 110V AC control transformer shall be considered. VA burden to be decided by the Contractor.

i) Minimum clearance between live parts shall be phase to phase 25.4 mm & phase to neutral 20 mm.

j) Bus bars shall be sleeved with coloured heat shrinkable sleeves. All the Bus bar supports shall be VMC type only.

k) Degree of protection shall be IP-42 for the enclosure, epoxy painted, powder coated with colour shade RAL-7032 for exterior & interior with minimum thickness 80 micron.

l) All necessary auxiliary contactors are included in scope.

m) Contractor shall note that verification of double layer construction shall be done on any one of the capacitor bank during inspection by opening the capacitor bank at no extra cost.

n) The cubicle shall be fabricated out of 2.0 mm thick cold rolled sheet steel & shall comprise of :

   i. Isolating ACB/ MCCB

   ii. Contactors with overload element

   iii. Sequencing devices, timers and auxiliary relays for automatic sequential switching of capacitor units in and out of circuit.

   iv. Auto-manual selector switch

   v. Microprocessor based Automatic Power Factor Correction (APFC) Relay – minimum 10 stage relays.

   vi. Push button for opening and closing the power circuit

   vii. Red and Green lamps for capacitors ON/ OFF indication

   viii. Protective relays to protect the healthy capacitor units when one unit fails in a series connection

   ix. Space heater and cubicle lighting & receptacles.

4.3.4. Principle of Operation: On deviations from set power factor, the power factor controller shall

release command signals to switch on/ switch off capacitor bank stages and maintain the set power factor.

4.3.5. APFC Relay: APFC relay shall have following standard features:

a) The Automatic Power Factor Correction relay shall be of microprocessor based type and shall automatically switch ON/ OFF the capacitor banks to attain the value of “pf” close to the set value.

b) Switching shall follow first in first out (FIFO) method to ensure uniform use of all capacitor banks. At least eight steps shall be provided for switching.

c) To measure/ monitor power factor and VAR continuously. Status of switching step shall be displayed through LED.

d) Following adjustment shall be available in APFC Relay.

i. Power factor

ii. Dead band capacitive region with respect to set power factor (PF).

iii. Inductive region with respect to set PF

iv. Operating time for programmable switching steps.

v. Auto/ manual selector switch.

vi. Manual step control.

e) All control knobs, LEDs for display and selector switches shall be mounted on the front face of relay casing/ panel.

f) It should be fully programmable. There should be a choice for customer to select operating sequence up to 4 to 5 which will have maximum number of steps of capacitors equal to fourteen (14). The sequence shall be arithmetic 1, 2, 3…..13, 14.

g) Operating time selection of time interval designation between switching stages shall be possible using time selector switches. The device shall take care that any stage which has just been switched out will only be reconnected by the pulse counter, after 60 sec. has elapsed so that it has safely discharged. This is a requirement for 415 V capacitors

h) Loss of voltage element- This would prevent abnormal switching surges on loss of supply. Also it would control the switching On/ Off surges.

i) Dead band features- Relay response sensitivity adjustable using dead band so that hunting is prevented.

j) Auto/ Manual control- This would help testing and commissioning at site as well as ease in operation when either mode fails during service time.

4.3.6. Performance Tests:

a) Contractor shall carry out all routine tests as specified in relevant IS/ IEC standards on all major components and furnish copies of test reports for Purchaser’s approval.

Wherever required, Contractor shall conduct the necessary type tests in the presence of Purchaser/ Purchaser's representative.

b) Contractor shall also carry out all routine and functional tests as specified in the relevant IS on the assembled switchgear panels in the presence of the Purchaser's representative at works before dispatch and furnish copies of test reports for approval. If required stage inspection will be carried out by the Purchaser.

c) During inspection, Contractor shall furnish copies of routine test report for all bought out items for Purchaser's approval.

d) Primary Injection Test for various currents & time settings shall be provided in routine test.

e) All the components shall be tested for their entire operating range & certification for the same shall be provided at the time of inspection.

4.3.7. Maintenance Requirements:

a) As far as possible the switchgear shall be so designed that no special tools are necessary for installation and maintenance. However, if special tools are required, the Contractor shall supply one complete set of such tools along-with the equipment.

b) Contractor shall furnish detailed inter panel wiring diagrams, internal wiring diagrams, detailed component layout drawings to carry out maintenance work.

4.3.8. Drawings/ Documents Required:

a) Dimensioned general arrangement drawings of capacitor and capacitor control panel.

b) Justification for number of steps for switching.

c) Fully dimensioned general arrangement drawings of capacitor and capacitor control panel with elevation side view, sectional view and foundation details.

d) Complete schematic and wiring diagrams for capacitor control panel.

4.4. CABLES & CABLING SYSTEM:

4.4.1. The scope shall be inclusive of supply, installation, testing & commissioning of power, control cables, cable terminations, cable accessories, stripping of cable insulation, supplying and fixing of Aluminium lugs for aluminium cables & tinned plated copper lugs for copper cables and crimping the same to the conductor, supply and fixing of double compression cable glands including all labour supply and consumable material required for jointing/ termination. The rate shall also include the laying of cable in ground/ in cable trays / cleating to structure etc.

4.4.2. Applicable Standards:

The cables shall confirm to the latest applicable standards specified below. In case of conflict between standards and this specification, this specification shall govern.

PVC insulated cables (for voltage up to 1100 V)	:	IS: 694
HRPVC & PVC insulated cables heavy duty	:	IS: 1554

Cross linked polyethylene insulated PVC sheathed cables	:	IS: 7098
Low frequency cables and wires with PVC insulation and sheath	:	IEC: 189-1 & IEC-189-2
PVC insulation and sheath of electric cables	:	IS: 5831
Polyethylene insulation and sheath for electric cables	:	IS: 6474
Conductors for insulated electric cables	:	IS: 8130
Methods of test for cables	:	IS: 10810
Specification for drums of electric cables	:	IS: 10418
Specification for PVC insulated cables for electricity supply	:	BS: 6346
Specification for PVC insulation and sheath of electric cables	:	BS: 6746

4.4.3. Constructional Features:

a) HV power cables shall conform to 11kV Earthed grade (E), three core, stranded, Aluminium conductor, screened by extruded semi-conducting compound, cross-linked poly ethylene (XLPE) insulated, cores screened with non-magnetic metallic tape laid up with inner and outer extruded PVC sheath compound Type-ST2 and galvanized steel strip armouring. The cables shall generally conform to IS 7098-1985 with relevant parts thereof.

b) Armouring shall confirm to latest version of IS: 3975.

c) LV Power cables shall be 1.1kV grade, 4/ 3.5/ 3 Core, multi-stranded, Al/ Cu conductor, XLPE insulated, extruded inner & outer PVC sheath compound type ST2 and galvanized wire (up to 6 sq mm)/ steel strip (>6 sq mm) armoured cables. All single phase, Lighting cables, UPS cables shall have 100% Neutral.

d) All the control cables shall be 1.1kV grade, no. of cores (as per requirement/ application with minimum 2 spare cores for 7C & above) multi-stranded, Copper conductor, XLPE insulated, extruded inner PVC & outer PVC FRLS sheath compound type ST2 and galvanized steel round wire armoured.

e) All control cables shall be with following specific requirements:

i. Copper conductor stranded class 2.

ii. XLPE Insulated

iii. Provided with inner extruded PVC and outer PVC FRLS sheath of extruded black PVC compound.

iv. Galvanized steel armouring in the form of GI round wire.

v. Core identification shall be by printed numerals.

vi. The insulation over the individual conductor core will be colour coded.

vii. Minimum 2 spare cores for above 7C.

f) The DC power supply cable shall be two core, multistranded copper conductor, armoured cables with inner extruded PVC & outer PVC FRLS sheath. All control wiring shall be PVC FRLS insulated.

g) All the power, control cables used in the Hazardous area shall be flame proof type suitable for the intended application.

h) Earthing Cable shall be Single core multi-stranded Cu, 1.1 kV grade, XLPE insulated, un-armoured green coloured outer sheath with yellow strips/ band cable to be laid in trays, underground, trenches etc. as applicable.

i) Submersible Cables: Multi core flexible Cu conductor XLPE insulated & PVC sheathed heavy duty cable suitable for submersible application (in case of submerged pumps) shall be manufactured as per governing standards. High purity electrolytic grade, annealed Cu conductor shall be used. Cables shall be extruded inner & outer PVC sheathed. PVC compound shall be dielectric grade & shall be impervious to water, oils & grease etc. Similarly double PVC sheathing shall also be done as per IS: 5831/ 1984. Flexible inner sheath & high abrasion resistant flexible outer sheath is required for these cables. Double PVC sheathing shall be done so as to withstand abrasion & prevent ingress of water along the interstices of the cable. Core identification shall be by printed numerals. Conductors shall be as per IS 8130. Cable shall be constructed as per relevant IS/ IEC standards.

4.4.4. Cable Colours:

a) All cable cores shall be colour coded throughout their length and shall be so connected between switchboard, distribution board, plant and accessories, that the correct sequence or phase colours are preserved throughout the system.

b) The colour coding should be as follows:

i.	3 phase	Red, Yellow and Blue
ii.	single phase or dc supply	Red and Black
iii.	earth	Green/Green with Yellow coloured band
iv.	control	Gray (DC)

4.4.5. Cable Conductors;

a) Cables up to 4.0 sq.mm shall be Cu multi-stranded conductor with galvanized steel round wire armoured & balance cables shall be Al multistranded conductor with galvanized steel round wire/ flat strip armoured.

b) Single core cable shall have non magnetic material armouring.

c) Lighting final distribution circuits shall be of a minimum cross-section of 1.5 mm2.

d) Small control cables shall be of a minimum cross-section of 1.5 mm2.

e) Internal wiring of control panels shall be of a minimum cross-section of 1.5 mm2 flexible and multistranded.

f) Control cabling shall be of a minimum cross-section 1.5 mm2 for external use and 1.0 mm2 for internal use.

g) Cable Sizing shall be done as per design criteria specified in specifications.

4.4.6. Cable Numbering: All cables shall be allocated a unique number which shall be fixed to each end of the cable using a corrosion resistant label. Necessary loop at both ends shall be provided for future use and cables of different categories shall be tagged with the following subscripts and three digit number.

HV power	HV-P_ _ _
LV power	P_ _ _
Control	C_ _ _
Instrumentation	I_ _ _
Protection	PR_ _ _
Telecommunication	T_ _ _

4.4.7. Cable Terminations:

a) Cable Lugs

i. Cable lugs shall be of tinned copper, solder less crimping type for Cu cables & AL lugs for the AL cables.

ii. The current rating of the lugs shall be same as that of the respective cable conductors.

iii. Bi-metal strip/ Bi-metallic lug shall be used whenever two different metals are to be connected together.

iv. Double holes extended neck (long barrel neck) type lugs shall be used in case of cables above 185 sq. mm.

v. Anticorrosion/ anti-oxidation compounds shall be used for crimping lugs. This shall especially be ensured for Al cable terminations & bimetallic terminations shall be used wherever required.

vi. If termination is done with crimping tool employing crimping die then forming dies shall be used to make the sector shaped conductor into a round conductor before crimping the lugs on the conductor. The lug must not be crimped directly on the sector conductor. Before crimping the lug, the conductor shall be thoroughly cleaned and special jelly applied over it to prevent further oxidation.

b) Cable Glands

i. Glands shall generally be of the double compression hexagonal type brass glands. Earth continuity of brass glands shall be assured.

ii. Double compression type cable glands shall be used. Cable glands shall be brass casting, machine finished and Nickel-plated to avoid corrosion and oxidation. Rubber components used in cable gland shall be of neoprene.

iii. For single core cables, gland shall be with brass ring.

iv. Glands for single core cables shall be constructed from non-magnetic materials.

v. Cable glands shall be with metric threads.

vi. Where holes for cable entries are not provided it shall be the responsibility of the Contractor to mark out and drill such holes. Burrs and swarf shall be removed, care being taken to ensure that swarf and filings, etc do not enter the equipment.

vii. For non-hazardous areas cable glands in situations where moisture may be present shall be double seal weatherproof type, gland shrouds shall be used and entry shall be sealed.

viii. For dry indoor situations, standard industrial glands with shrouds are acceptable.

ix. For hazardous areas, glands conforming to EEE standard shall be used with double seal and shroud.

c) Trefoil Clamps for Single Core Cables:

i. All the single core cables shall be laid in trefoil formation only.

ii. The grouping & sequencing of three single core cables arranged in trefoil formation shall be done in such a way to ensure balanced current distribution.

iii. Trefoil clamp of suitable size & having non magnetic material shall be used.

iv. The Trefoil groups shall be held in trefoil clamps at an interval not exceeding 3.0 meters.

v. In addition to trefoil clamps as mentioned above, the tre-foil groups of cables shall be additionally tied by means of 3.0 mm dia. nylon cord clamp at an interval not exceeding 750 mm.

d) Wherever applicable, supply & installation provision of bimetallic strip for connection between Al to Cu strip & GI to Cu strip shall be provided.

4.4.8. Cable Drums:

a) Cables shall be supplied in non-returnable wooden drums. The wood used for construction of the drum shall be properly seasoned and free from defects and wood preservative shall be applied to the entire drum. All ferrous parts shall be treated with a suitable rust preventive coating to avoid rusting during transit or storage.

b) Before winding the cables on drums, Contractor shall obtain Purchaser's approval for the drum lengths. Cable ends shall be sealed by non-hygroscopic sealing caps.

c) Contractor has to ensure reference of an arrow and suitable accompanying wording which shall be stenciled on the sides of the drums indicating which way it should be rolled. The number on each drum shall be either branded at the end of the drum or stamped on the metal attached to an end of the drum. The cable shall be placed on the drum in such a manner that it will be protected from injury during transit. Each end of the cable shall be firmly and properly secured to the drum. The drum shall be securely blocked in position so that the cable will not be displaced during transit. Cable ends shall be sealed by non-hygroscopic sealing caps.

d) It shall be the Contractor's responsibility to prepare the drum cutting schedule so that cable wastage is minimum while cutting.

e) Contractor shall obtain Purchaser's approval for the drum lengths.

f) The following information shall be given on the drums as a minimum:

i. Drum identification number

ii. Voltage grade

iii. Type of cable.

iv. Number of cores and cross-sectional area

v. Cable quantity

vi. Purchaser's order number and item number

vii. Total weight of cable and drum

4.4.9. Tests Before and After Laying of Cables at Site: Following Routine & acceptance tests on each drums as per IS 10810, IS 7098 standard & other specified relevant standards shall be performed by the manufacturer and witnessed by Purchaser/ Purchaser's Representative.

a) For 1.1 kV Power & Control cables:

i. Dimensional & visual check

ii. Conductor resistance test

iii. Insulation Resistance Test

iv. High voltage test

b) For 11 kV power cables:

i. Design and visual check

ii. Conductor resistance test

iii. Very low frequency AC HV test (instead of DC test)

iv. Insulation resistance including P.I. at rated voltage

v. Capacitance and tan delta

vi. AC leakage current

vii. Partial discharge measurement

c) All HV cables shall be subjected to DC or AC (preferably DC) high voltage test after terminating but before commissioning as per Table 6.0 in IS: 1255 (Code of practice for Installation & Maintenance of Power Cables up to and including 33kV).

d) Cables shall be checked for insulation resistance before and after jointing. The voltage rating of the Megger for cables of different voltage grades shall be as indicated below.

Voltage Grade	Megger rating
1.1kV	500V
11kV	1000V
33kV	2500V

e) Following tests in the presence of Purchaser/ Purchaser's representative shall be carried out at site before commissioning of cables.

i. Insulation Resistance test between phases and phase to Neutral and phase to earth.

ii. Continuity test of all the phases, neutral and earth continuity conductor.

iii. Sheathing continuity test.

iv. Earth resistance test of all the phases and neutral.

f) Cable Gland:

i. Cable glands required for glanding all cables at both ends shall be supplied by Contractor.

ii. A minimum of 20% of cable glands shall be supplied as spare.

iii. Cable glands shall be of SS 316 and double compression type suitable for armoured cables.

iv. All cable glands shall be weatherproof to IP-66. Flameproof glands wherever required shall be supplied with Ex (d) certification suitable for Gas Groups IIA / IIB / IIC.

v. All cable glands shall be with LSF shrouds.

vi. For all field items and junction box end, NPT threaded cable glands shall be used and for control room / control panel end, cable glands shall be ET threaded types.

g) Junction Boxes:

i. In order to make the most economic use of cable tray and trench capacity, multicore / multipair cabling shall be utilised in order to connect instrumentation groups by using suitably located junction boxes.

ii. The junction boxes shall have weather protection suitable for the area in which they are to be installed and for the type of circuit.

iii. They shall be readily accessible for maintenance and clearly labeled.

iv. Junction box shall be constructed of die cast aluminium and provide degree of protection IP 65.

v. Wires and terminals for the digital and analog signals shall be segregated within junction boxes.

4.4.10. Drawings/ Documents Required:

a) As a part of the Bid, Contractor shall furnish the following :

i. General information

ii. Principal technical data

b) After award of contract it shall be the responsibility of Contractor to work out a detailed layout for the complete plant cabling system. The layout drawing shall be furnished for the approval of Purchase/ Purchaser's representative before commencement of installation including cable trays, cable racks/ trenches, accessories, tray supports, conduits etc.

c) Contractor to submit following drawings/ details after award of contract

i. Cable Sizing calculations

ii. Details of Installation of cables in trenches, on cable trays, directly buried etc at all locations inside the plant.

iii. Cable routing lay out inside and outside the plant with route marker provided at 30 meter interval.

iv. Bill of quantities of cables, lugs and glands.

v. HV Cable termination and mounting Kit Layout drawing.

d) Following Type Tests reports as per relevant standard to be submitted for the same rating & type of Cables conducted in past for review of Purchaser/ Purchaser’s Representative by the Contractor at the time of inspection & testing of equipment. Type test reports should be valid and not be older than the 5 years.

i. Annealing test

ii. Tensile test

iii. Wrapping test

iv. Test for thickness of insulation & sheath

v. Physical test for insulation & sheath

vi. Tensile strength and elongation at break of insulation and sheath

vii. Loss of mass test

viii. Ageing in air oven

ix. Shrinkage test

x. Heat shock test

xi. Insulation resistance test

xii. High voltage test

xiii. Flammability test

4.4.11. Cable Tray & Accessories:

a) Cable trays shall be of Galvanised Steel/ Fiber Reinforced Plastic and of ladder/ perforated/ solid type, complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories and hardware as detailed in the relevant drawings. All hardware (i.e. bolts, nuts, screws, washers, etc) shall be hot dip galvanized.

b) Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows etc., shall be fabricated from 14 gauge (2.0 mm thick) mild steel sheets. Cable tray covers shall be fabricated from 16 gauge perforated (1.60 mm thick) M.S. sheets.

c) The cable trays shall be supplied in standard lengths of 2500 mm and clear inside widths of trays shall be as follows:

i. Perforated type trays: 150, 300, 450 and 600 mm.

ii. Ladder type trays: 300, 450, 600 and 750 mm

d) Cable trays, accessories and covers shall be painted with one shop coat of red oxide zinc chromate primer and two site coats of aluminium alkyd paint for indoor use.

e) For outdoor use, cable trays, accessories and covers shall be either galvanized or made of aluminium as specifically mentioned in the layout drawings.

f) For use in corrosive atmospheres both indoors and outdoors, the cable trays, accessories and covers shall be as per serial no. (e) above.

g) The spacing of rungs for ladder type of trays shall be 250 mm unless otherwise noted.

h) All finished cable trays and accessories shall be free from sharp edges, corners, burrs and unevenness.

4.5. EARTHING & LIGHTNING PROTECTION SYSTEM:

4.5.1. Scope:

a) The scope includes collection of data, design of the system as per relevant National/International Standards preparation of layout drawing supply of earthing conductors, earth electrode, earthing strips installation and approval to the satisfaction of electrical inspector under this tender specification.

b) Earthing system shall be provided to ensure equipment safety, personnel safety and facilitate designed operation of protective switching during earth fault conditions in the associated system.

4.5.2. Applicable Standards: The earthing and lightning protection system shall conform to the CEA guidelines and the latest applicable standards indicated below:

a) Code of Practice for Earthing : IS: 3043

b) Code of Practice for the Protection of : IS: 2309

c) Building and allied structure against

d) Lightning.

e) Hot dip galvanizing : IS: 2629, 2633, 4759

f) Structural steel : IS: 2062 & 808

g) Welding : IS: 816

4.5.3. Earthing & Lightning system:

a) The design basis for designing earthing conductor is indicated under design criteria for electrical system. Earthing system shall be provided for complete plant i.e. pumping stations, switchyard and all electrical equipments as per the latest edition including all official amendments and revisions of IS-3043 and CEA guidelines.

b) All materials and fittings used in the earthing installation shall conform to the relevant Indian Standards or shall be approved by the Engineer's representative & CEIG.

c) Contractor has to carry out soil resistivity test at, at least 4 locations for which locations shall be provided by Purchaser's representative. Testing to be done at each site.

d) Soil resistivity shall be carried out by Wenner four electrode method as described in IS 3043. Contractor has to carry out the test in presence of Purchaser's representative & test shall be carried out keeping electrode spacing as 1, 2, 4, 6, 8, 10, 15, 25 M (each, along all 8 directions) as per normal practice and report has to be submitted. Polar curves shall be used for measurement of mean soil resistivity, which shall be used in finding earthing resistance at a particular location. Mean soil resistivity values shall be approved by Purchaser's representative.

e) The Contractor shall base his earthing calculations on actual measurement carried out by him in the presence of Purchaser/ Purchaser's Representative.

f) Galvanized Iron flat / wire shall be used as earthing conductor.

g) The conductor sizes & types shall be as per specified in the Technical schedules in Volume- II, Section A3. Contractor to note that, the sizes indicated are minimum required & earthing conductor sizes shall be approved by the Purchaser/ Purchaser's representative on the basis of adequacy calculations submitted by Contractor.

h) The underground joints in the system shall be properly welded or brazed and the bolted type connection shall be made with structures/ equipments. Petroleum jelly shall be applied to contact surface of the bolted joints, which will be covered with bituminous compounded and tapes.

i) Earthing conductor shall be protected against mechanical damages considering the installation conditions.

j) The earthing system shall comprise one or more earth electrodes, earthing grid or a combination of these in order to obtain the required earth electrode resistance of less than one (1) Ohms/ or as per IEEE Std 80 -2000.

k) For equipment earthing, two earthing leads will be used if rated voltage of the equipment is 250 volts & above and one earthing lead will be provided for equipment rated below 250 volts.

l) The earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm below FGL.

m) For each 11 KV DP/ FP Structure, minimum 2 nos. of CI plate type earthing electrodes shall be provided. The earth plate shall be buried in specifically prepared earth pit- 3 mtr. below ground with alternate layers of charcoal and salt, 40 NB GI pipe with funnel with a wire mesh for watering and bricks masonry block and CI Cover complete as per IS 3043 with necessary length of double GI earth flat 25x6 mm bolted with lug to the plate complete connected to the required point of DP with end socket as per direction and duly tested by earth tester conforming to IS as per drawing and specifications complete with 600 x 600 x 6.0 mm CI earth plate.

n) For each transformer neutral, minimum 2 nos. of Cu plate type earthing electrodes shall be provided. The earth plate shall be buried in specifically prepared earth pit 3 mtr. below ground with alternate layers of charcoal and salt, 40 NB GI pipe with funnel with a wire mesh for watering and bricks masonry block CI Cover complete as per IS 3043 with necessary length of double Copper earth flat 25x6 mm bolted with lug to the plate complete connected to the transformer neutral with end socket as per direction and duly tested by earth tester conforming to IS as per drawing and specifications complete with 600 x 600 x 3.15 mm Copper earth plate.

o) For other equipment & area, Earth electrodes shall be of heavy duty galvanized mild steel of not less than 40 mm NB and minimum 3000 mm long. Where multiple rods are used they shall be separated by a distance of not less than the driven length.

p) Each earth electrode pipe shall be welded at the top to a mild steel plate to which the earthing strips shall be connected. These connections shall each be housed in individual inspection chamber set which shall project 100 mm above the finished ground level and shall allow disconnection for testing of individual electrodes. The chamber shall be permanently marked `Electrical Earth'.

q) All materials used for the earth electrode installation shall be purpose made for the application and site conditions and shall be approved by the Purchaser’s Representative.

r) All civil works, such as excavation, boring, provision of charcoal & salt in adequate quantity, backfilling for the installation of the earth electrodes and the earth pit/ inspection pit shall be in the scope of Contractor.

s) After the earth installation has been completed the Contractor shall demonstrate to the Purchaser/ Purchaser’s Representative that the resistance of the electrodes to earth and the continuity of the earth network are within the limits specified. Any additional earth electrodes and test instruments required for the tests shall be provided by the Contractor.

t) Main Equi-potential Bonding Conductor: Main equi-potential bonding conductors shall be provided to connect the earth electrode system to conductive parts forming the Works.

u) Circuit Protective Conductors: An independent circuit protective conductor shall be provided for each circuit and may comprise one or any of the following as appropriate:

   i. a separate core within a multicore cable

ii. A separate conductor installed within a conduit or trunking. Steel conduit or trunking shall not be used as a circuit protective conductor.

iii. The metal sheath of an armoured cable. The sheath shall be bonded to the metal work of the apparatus and to the apparatus earth bar, if any.

iv. the copper sheath of a mineral insulated copper sheathed cable

v. An independent earthing conductor MS or GS run adjacent to the circuit it protects.

vi. The size of the circuit protective conductor shall be calculated in such a manner as not to take into consideration the contribution of any other parallel or fortuitous earth paths.

vii. The armoring of the supply cable shall not form the sole means of earthing a switchboard or large electrical load.

4.5.4. Important Instructions for Earthing:

a) Each pole of lightning arrestors shall be earthed with separate earth pit.

b) Two-earth conductor shall connect outdoor CT secondary winding to earth grid.

c) The switchyard fencing shall be earthed at every alternate block and the switchyard gate shall be earthed with flexible GI wire.

d) All the earthing material with laying etc. shall be included in the scope.

e) The entire plant will have an earth grid laid in trenches/ trays/ buried in the ground outside. The main earthing grid shall be embedded at a minimum depth of 600 mm below FGL which shall be connected to earth electrodes.

f) All interconnections of the earthing grid conductors will have welded type joints except at electrodes with disconnecting facility and at equipment with bolted connections. All indoor earthing grids will be suitably interconnected to the external earthing grid.

g) Each steel/ RCC column of the building will be interconnected to the floor-earthing grid. Steel columns, steel strips / conduits, cable trays etc. will not be used as earth continuity conductors.

h) Disconnecting type facility shall be provided between Earthing grid & each earth electrode.

i) All connection between the conductors shall be welded/ brazed type. Metallic pipe, conduit, structures shall be bonded to lightning protection conductors to prevent the side flashover. But no metallic pipe, conduit, structure shall be used as air termination conductor or down conductor.

j) The down conductors shall be fixed with embedded brass posts (on concrete columns) with nuts & bolts used for fixing the saddle/ clamp (direct drilling of down comer and fixing with screw shall not be acceptable).

k) Cleats for ‘earthing and lightning protection systems’ shall be of GI.

l) The lightning protective conductor shall not be connected with the earthing above ground however both the systems shall be interconnected below ground.

m) The earth pits may require boring & drilling in the soil & the same shall be considered in Contractor's scope.

n) Earth electrode with disconnecting facility shall be provided so that the resistance of the independent earth electrode may be measured.

o) Internal earth Bus of each panel shall be connected to both ends to the earthing system by means of earthing conductor.

p) Metallic frames of all current carrying equipment, structures supporting and adjacent to current carrying conductors, lightning protection system conductors, metallic structures, metallic stairs, hand rails, fences shall be connected to a single earthing system. Neutral points of various systems shall be connected to the dedicated treated earth pits and these earth pits shall be interconnected to each other below ground.

q) All connections in the equipment earth conductors buried in ground (or otherwise) shall be cad welded/ brazed, whereas connection at equipment end shall be of bolted type. All connections shall be of low resistance. All bimetallic connection shall be treated with suitable compound to prevent moisture ingression. For Bimetallic bolted connection, bimetallic washers shall be used. All bolted joints shall have minimum two bolts to ensure proper surface contact. Termination of stranded conductors at earth inserts shall be with ring type/ lugs.

r) Galvanized conductors shall be touched up with zinc-rich paint where holes are drilled at site for bolting to equipment/structure.

s) Suitable earth risers approved by the Engineer shall be provided above finished floor/ ground level, if the equipment is not available at the time of laying of the main earth conductor. The minimum length of such risers inside the building shall be 200 mm and outdoor shall be 500 mm above ground level.

t) Metallic conduits and pipes shall be connected to the earthing system unless specified otherwise.

u) All cable trays will be earthed at minimum two places by suitable sized GI flats to main earthing system earth conductor. The cable trays shall also be earthed at a regular interval of not more than 10 meters by 25 x 3 mm GS flat.

v) Earthing Pits:

   i. Adequate number of earthing pits shall be provided in conjunction with earthing grid for the earthing system. The minimum spacing between two adjacent earthing pits shall not be less than length of the electrode (minimum 3 m) and shall be kept 1500 mm away from footings of the structure.

   ii. Earthing pits shall be located in ground, which has a reasonable chance of remaining moist. Arrangement comprising of GI pipe with top funnel with wire mesh shall be made to facilitate pouring of water to keep earthing pit wet.

   iii. A galvanized iron strip of adequate size (as per calculations) shall be provided from plate electrode to about ground level to facilitate jointing with earth conductors. Each earth electrode ending at the pit shall be connected to suitable

linking strips to connect and disconnect the earthing suitably.

iv. Earthing chamber shall be of RCC/ brick chamber of 600 mm x 600 mm, with removable 6 mm thick MS chequered plates. The covers shall have holes for handling. Earthing pits (chambers) shall be painted Green and the earth-pit number shall be marked on it.

v. Earthing cables crossing other metallic structures such as conduits pipelines etc shall be minimum 300 mm away from such structures.

vi. Earthing conductors shall be protected against mechanical damage.

vii. All earth lead connections shall be as short and direct as possible and shall be without kink.

viii. The main earth loop in plant area shall be generally routed along cables. When equipments are located away from main earth loops, suitable sub-loops shall be run up to them for deriving connections for individual equipment. The entire earthing system shall fully comply with the CEA guidelines and requirements.

ix. The Contractor shall have to carry out any changes as desired by the Electrical inspector or the Engineer in charge, in order to make installation conforming to the CEA guidelines 2010.

4.5.5. Lightning Protection:

a) The lightning protection system need will be established by calculating the risk factor value of each building, structure etc. as per procedure given in IS 2309-1989 and if found necessary the same shall be provided by the Contractor.

b) For Lightning protection of Civil Structures including RCC Buildings, fixing of 25x6 mm GI earth strip to roof as per IS/ IEC std, saddle clamp, down comer connector etc. as required with all hardware shall be in Contractor's scope. Structural Columns (which are used as down comers for lightning protection system) bottom shall be connected to the earth pit with 25x6 mm bare GI strip.

4.5.6. Galvanizing:

a) Wherever galvanizing has been specified, the hot dip process shall be used. The galvanized coating shall be of uniform thickness. Weight of Zinc coatings for various applications shall not be less than those indicated below

Fabricated Steel	
i. Thickness less than 2 mm, but not less than 1.2 mm	340 gms/ sq.m
ii. Thickness less than 5 mm, but not less than 2 mm	460 gms/ sq.m
iii. Thickness 5 mm and over	610 gm/ sq.m
Fasteners	
i. Up to nominal size M10	
ii. Over M10	

	270 gms/ sq.m 300 gms/ sq.m

b) Burrs shall be removed before galvanizing. Any site modification of galvanized parts should be covered well by zinc rich primer and aluminium paint.

c) Contractor shall ensure to use calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards.

4.5.7. Drawings/ Documents Required:

The Contractor should prepare Layout drawings, after award of contract and before commencement of work for Purchaser's approval, showing the location of earthing grid, electrodes, interconnection grids and earthing leads to various equipment, down comers, isolating links etc. should be accompanied by design calculations.

4.6. LIGHTING & VENTILATION SYSTEM:

4.6.1. Scope

a) The scope of the Contractor shall include design, supply and installation of all equipment necessary for a complete lighting and receptacle system. The lighting system includes Lighting fixtures (indoor/ outdoor), lamps, lighting panels (LP), switchboards, Receptacles, JBs, cables/ wires for lighting/ receptacles, conduits etc. The supply of street light/ flood light poles as per IS 2713 or IS 3713 is also included in the Contractor's scope.

b) The various types of lighting fixtures with lamps shall be installed based on the mounting arrangement shown in the typical drawings enclosed with the specification. Installation scope shall include all material to mount the fixtures in proposed manner.

c) The various types of lighting fixtures as per specified in this specifications shall be assembled, installed, tested & commissioned by the Contractor.

d) The type of lighting fixtures and receptacles, illumination level and approximate quantity required shall be generally as per design criteria.

e) Lighting system installation shall be as per the tender specifications

f) It shall be the responsibility of the Contractor to work out complete detailed requirement of lighting and receptacle system for the whole plant and staff quarters including area lighting as per specification and accordingly procure and install them.

4.6.2. General Requirements: The Lighting system includes following items.

a) Lighting fixtures complete with Lamps and accessories. Only LED fixtures shall be used for both indoor & outdoor applications (Except for High mast lighting).

b) Lighting system equipment

c) Light control switches, receptacle units with control switch units, lighting wires, conduits, earth wires and other similar items necessary to complete lighting system.

d) Lighting fixture supports, street lighting poles and flood light towers/ poles.

e) Lighting main distribution board, lighting panels

f) Multi core cables for street, boundary and flood lighting

4.6.3. Lighting Layout:

a) It shall be the responsibility of the Contractor to work out a detailed layout for the complete plant in order to provide the levels of illumination as indicated in the relevant standards

b) The types of fixtures to be used in various areas are also indicated in the above mentioned drawing. The Contractor shall be responsible for measuring the levels of illumination and uniformity after installation and establish compliance with the specification.

c) The lighting system will comprise the following:

i. Normal A.C Lighting: Normal lighting in all indoor and outdoor areas will be operated on 230V, 1Phase, 50 HZ A.C supply

ii. Emergency Lighting: Emergency Lighting shall be designed such that at all junctions, exit passages & strategic locations, Lux level shall be maintained above 10 Lux. Emergency light fitting shall be 240 V self contained 2 x 10 W LED fixtue with built in Ni-Cd battery having charging facility and six hours back-up time. The emergency light fittings shall be provided at strategic locations of each house/ area. Emergency fixtures shall come in service when AC supply fails. Pump room and Electrical room shall be considered for Emergency lighting.

4.6.4. Applicable Standards: The design, manufacture and performance of equipment shall conform to the latest standards specified below. In case of conflict between the standards and this specification, this specification shall govern.

a) Lighting Fixtures & Accessories for General & High mast

Electrical lighting fittings general and safety requirements	:	IS: 1913/ BS: 4533
Code of practice for industrial lighting	:	IS: 6665
Code of Practice for Interior Illumination	:	IS 3646
Code of Practice for Lighting of Public Thoroughfares	:	IS 1944
Calculation of co-efficient of utilization	:	IS: 3646 (Part - III)

Testing procedure of photometric testing for LED luminaires	LM 79
Testing procedure on the lifespan of LEDs	LM 80
National Lighting Code	SP72
Method of Measurement of Lumen Maintenance of Solid State Light (LED) Sources	IS:16105

Method of Electrical and Photometric Measurements of Solid-State Lighting (LED) Products	IS:16106
Limits of Harmonic Current Emissions	IS 14700-3-2
DC or AC supplied electronic control gear for LED modules performance requirements	IEC 62384
Lamp control gear: particular requirements for DC or AC supplied electronic control gear for LED modules	IEC 61347-2-13
Environmental Testing: Test Z- AD: composite temperature/ humidity cyclic test	IEC 60068-2-38
Electro Magnetic compatibility (EMC)- Limits for Harmonic current emission-– (equipment input current ≤ 16 A per phase)	IEC 61000-3-2
EMC Immunity requirement	IEC 61547
LED modules for general Lighting-Safety requirements	IEC 62031
Classification of degree of protections provided by enclosures (IP Codes)	IEC 60529
Fixed general purpose luminaries	IEC 60598-2-1
General Lighting - LEDs and LED modules – Terms and Definitions	IS:16101 / IEC TS 62504
LED Modules for General Lighting Part 1 Safety Requirements	IS:16103(Part1)
LED Modules for General Lighting Part 2 Performance Requirements	IS:16103(Part2)
Safety of Lamp Control Gear, Part 2 Particular Requirements Section 13 D.C. or A.C. Supplied Electronic Control gear for Led Modules	IS:15885(Part2/Sec13)

Industrial lighting fittings with metal Reflectors	:	IS: 1777
Decorative lighting fittings	:	IS: 5077
Dust proof electric lighting fittings	:	IS: 4012
Dust tight electric lighting fittings	:	IS: 4013
Flood lights	:	IS: 10322/BS: 4533
Luminaries for street lighting	:	IS: 10322 Part 5
Water tight electric lighting fittings	:	IS: 3553/ BS: 4533, 5225(I)
High pressure mercury vapour lamps	:	IS: 9900/BS: 3677/ IEC: 188
Screw less terminal and electrical connections for lighting fittings	:	IS: 10322
High pressure sodium vapour lamps	:	IS: 9974
Emergency lighting units	:	IS: 9583
Ignition proof enclosures, dust-tight for elect. equipment	:	IS: 11005
Luminaries	:	IS: 10322(Part I to V)

b) Lighting System Equipment:

Arrangement for busbars, main connections and auxiliary wiring and marking	:	IS: 5578/ 11353/ BS: 159
Enclosed distribution fuse boards and cutouts for voltages not exceeding 1000V	:	IS: 2675/BSEN 60439
General requirements for switchgear and control gear for voltages not exceeding 1000 V	:	IS: 13947
Code of practice - installation and Maintenance of switchgear	:	IS: 10118/BS: 6423 BS 6626, BS 6867
Factory built assemblies of switchgear and control gear for voltages up to and including 1000 V AC and 1200 V DC	:	IS: 8623/BS-5486/ IEC: 439
Miniature air break circuit breakers for AC circuits	:	IS: 8828/BSEN 60898
HRC cartridge fuse links up to 650 V	:	IS: 9224/BS: 88/ IEC: 269
'D' Type fuses	:	IS: 8187
Current transformers	:	IS: 2705/BS: 7626/ IEC: 185
Voltage transformers	:	IS: 3156/BS: 7625/ IEC: 186
Direct acting electrical indicating Instruments	:	IS: 1248/BS: 89/IEC: 51
A.C. electricity meters	:	IS: 722/BS 5685
Electrical relays for power system protection	:	IS: 3231/BS: 142/ IEC: 255
Switches for domestic and similar Purposes	:	IS: 3854/BS: 3676
Three pin plugs and socket outlets	:	IS: 1293/BS: 546
Boxes for enclosure of electrical Accessories	:	IS: 5133(1)
Rigid steel conduits for electrical wiring	:	IS: 9537/BS: 31
Accessories for rigid steel conduits for electrical wiring	:	IS: 3837/BS-31
Flexible steel conduits for electrical Wiring	:	IS: 3480
Rigid non-metallic conduits for electrical installations	:	IS: 9537/BS: 4607(2)
Fittings for rigid non-metallic conduits	:	IS: 3419/BS: 4607(2)
PVC insulated cables for working voltages up to and including 1100 V	:	IS: 694
Tubular steel poles	:	IS: 2713
Specification for copper rods and bars for electrical purposes	:	IS: 613
Code of practice for phosphate iron and steel	:	IS: 6005/ BS: 3189
Fittings for rigid steel conduits for electrical wiring	:	IS: 2667
National Building Code of India (NBC)	:	NBC 2005

4.6.5. Other Design considerations for Lighting:

a) Lighting panels shall be provided in various areas and circuit wiring to the lighting fixtures shall be made from lighting panels. Lighting panel shall comprise of Four pole MCB + RCCB (100 mA) for incomer and SP MCB's for each outgoing single phase circuits.

b) The wiring for lighting circuits in indoor areas will be done by wires run in GI conduits. For outdoor lighting, wiring will be done by using armoured cables.

c) Lighting cable from Main lighting DB (MLDB) to Lighting panels shall be Al conductor, XLPE insulated, 1.1KV grade, laid in cable trays otherwise cleated along the wall/ column/ beam.

d) For lighting fixtures (Pump room) 1100V grade, 4C x 2.5 sq. mm. PVC insulated, multi stranded copper conductor armoured/ unarmoured cables shall be used.

e) For lighting fixtures (For Office, electrical room, toilets etc. areas) 1100V grade, FRLS PVC, multi-stranded Copper conductor wires of area not less than 1.5 sq mm laid in min. 20 mm dia GI conduit (above false ceiling) shall be used.

f) For 5/15A decorative sockets (For Office, toilets etc. areas) 1100V grade, FRLS PVC, multi-stranded copper conductor wires of area not less than 2.5/ 4.0 sq. mm. Cu laid in minimum 20 mm dia. GI conduit shall be used.

g) Wiring shall be concealed in wall below false ceiling with concealed switch board. Minor civil work like chasing wall, cut outs for conduit, switch board, Lighting Panel in wall, entries for tray, conduits etc. is in scope.

h) Lighting cable from MLDB to Lighting Panels and Lighting Panels to street light fixtures, shall be Al conductor, XLPE insulated, armoured, 1.1 KV grade, laid in cable trays otherwise cleated along the wall/ column/ beam and buried in the ground.

i) The point wiring for lighting/ receptacle/ exhaust fan/ wall mounted fan/ ceiling fan shall include conduits, conduit accessories, FRLS PVC insulated multistranded Copper conductor wires and earthing wires, pull boxes, ceiling rose, clamps, cleats, hardware, accessories, anchor fasteners etc. It shall include wiring from lighting panel to switchboard and receptacles & switchboard to lighting fixtures. Sheet metal switchboard embedded in wall shall be considered for receptacles and lighting switchboards on wall shall be considered for lighting.

j) For power sockets in wall/ furniture, PVC switch box of approved make with switch plate & accessories and 16 Amp piano modular switches and 5/15A sockets etc. as applicable shall be considered. For all types of point wiring the receptacles with switches shall be included in the point wiring rate.

k) Lighting switchboard consisting of (*) no. of 6A piano switch without indicator, 1 no. 6A piano switch with indicator, 1 no. white coloured cover plate for (*) module (4/ 6/ 8/ 12 module), 1no. 2/ 3 pin shuttered socket of 5/ 15A and metal flush box.

l) Decorative socket switchboard consisting of (*) no. of 16A piano switch with indicator, (*) no. 2/ 3 pin shuttered socket of 5/ 15A and metal flush box, 1 no. white coloured cover plate for (*) module (4/ 6/ 8/ 12 module).

m) Lighting fixtures and fans will be grouped on the circuit wherever required. However, separate circuits shall be used for receptacles wiring.

n) Lighting Control Philosophy as per mentioned below shall be observed. From each switch –

i. Max. 2 (3 in case unavoidable) normal LED light fixture.

ii. Max. 4 (5 in case unavoidable) for LED down lighters

o) All indoor, outdoor & street light fixtures shall be controlled directly from respective Lighting Panels, through MCB.

p) Each lighting panel/ Receptacle DB shall have minimum 2 spare circuits of 10/ 16A SPN outgoing feeders. A circuit consists of R, Y, and B Phase each.

q) Lighting for staircase shall be controlled with flushed modular switch. The conduit for main staircase shall be concealed. Lighting for all staircases shall be with 2 way switch

r) Contractor shall note that any chasing in walls or cutouts or openings such as fixing of LPs, DBs, switchboards, concealing conduit in wall etc. in walls required shall be made before plastering of brickwork wherever applicable and installation rates quoted shall be inclusive of chasing, cutting & making the plaster as per standard practice.

s) Lighting for street light fixtures/ flood light fixtures shall be carried out with cables. The supply of cables, junction boxes, street light poles & structural steel required for mounting fixtures/ LPs etc. are in the scope of Contractor. The cable wiring shall include supply & installation of cable required from LP to the junction box mounted on street lighting pole / near indoor fixture and also between junction box mounted inside pole/near indoor fixture to control gear box and same for flood lighting, supply and installation of all termination accessories such as lugs, cable glands etc. DBO Contractor's scope shall also include excavation, preparation of soil bedding, supply and installation of protection cover, back-filling, supply and installation of cable route markers etc.

t) Point Wiring for lighting/ raw power receptacle/ emergency lighting:

i. Point wiring covers the wiring between a circuit of the lighting panel to switchboard and then from switchboard to lighting fixtures connected to that circuit of the lighting panel.

ii. For receptacle circuits point wiring shall cover wiring between circuit of the lighting panel to receptacles connected to that circuit of the lighting panel.

iii. The scope of the Contractor shall include the supply, erection, testing and commissioning of the above LPs/ DB boards for supply of power to the various sockets required for computers, raw power points etc. The point wiring rate from these DBs shall include supply of wires, conduits, cleats/ clamps etc. as may be required and shall be in the scope of electrical Contractor.

iv. The conduit point wiring rate for exhaust fan shall include conduits/ casing capping, conduit/ casing capping accessories, Switch boards, PVC insulated wires and earthing wires, pull boxes, ceiling rose, clamps, cleats, hardware, sheet metal switchboards fabricated out of 16 SWG. sheet steel housing 5 Amp piano switches. It shall include wiring from EXHAUST FAN DB/ RDB to switchboard &

switchboard to exhaust fan as applicable. Neutral for individual circuit shall be run separate from DB to individual receptacles.

v. All mounting accessories like base channels, cross angles if required, nuts, bolts etc. shall be supplied by the Contractor under the scope of this contract.

vi. Required no. of 1-Ph & 3-Ph, industrial receptacles with respective 2P/ 4P ELCB (30mA) & 3/ 5 pin plug shall be provided for maintenance purpose.

vii. Receptacle & its ELCB shall be mounted in prefabricated CRCA box of 16 SWG, epoxy painted with shade 631of IS-5. Earthing studs shall be provided for connecting external earthing with receptacle box.

viii. The Configuration of Industrial receptacle units shall be as per following – Combination

- 240V, 1-Ph, 50Hz, 3 pin, 15A Industrial receptacles with RCBO (30 mA).
- 415V, 3-Ph, 50Hz, 32/63A Industrial receptacles with respective RCBO (30 mA).

u) Lighting Fixtures and Accessories:

i. General

Normal supply voltage, phase and frequency		240 V, 1 ph, 2 wire, 50 Hz,
Variation in supply		
Voltage (AC & DC)		±10 %
Frequency		±5 %
Combined voltage & frequency		±10 %
Design ambient air temperature		50^0C

ii. The Luminaires shall be designed so as to facilitate easy maintenance, including cleaning, replacement of lamps/starters etc.

iii. Connections between different components shall be made in such a way that they will not work loose by small vibration.

iv. For each type of Luminaires the Contractor shall furnish the utilization factor tables to indicate the proportion of the light emitted by the bare lamps which falls on the working plane.

v. All Luminaires shall be supplied complete with lamps suitable for operation on a supply voltage and the variation in supply voltage, frequency and combined voltage and frequency of ±10%, ±5% and ±10% respectively.

vi. The Luminaires and accessories shall be designed to have low temperature rise. The temperature rise above the ambient temperature shall be as indicated in the relevant Standards.

vii. The Luminaires shall have a sturdy and corrosion resistant high pressure Die cast Aluminium housing with weatherproof gasket for lamp and control gear

accessories. The Housing shall be Epoxy coated, without any cracks or thorough holes, made in a single piece of die-cast LM6 aluminium alloy. The luminaires shall be totally enclosed, dust tight and water proof.

viii. Heat sink used should be aluminium extrusion having high conductivity. The dimensions of luminaires shall be optimum and adequate to permit sufficient heat dissipation, through the body itself, so as to prevent abnormal temperature rise inside the lantern and consequential damage to the cover and gasket materials, LEDs, lenses and electronic drivers. Heat sink must be thermally connected to MCPCB/ LED light source.

ix. The Luminaire Housing shall be suitable for termination of Cable with Double Compression Cable Glands

x. The optical system shall consists of individual PC lenses on high power LEDs designed & tested to achieve typical street lighting distribution from the LED lantern. These lenses provided for individual LEDs are to be fixed on lens plate in order to have consistent light distribution from luminaires. Luminaires should conform to the photometric Distribution / requirements of Cut-Off / Semi Cut – off light distribution and optics as classified in IS 1944.

xi. Suitable number of LED lamps shall be used in the luminaires. The manufacturer shall submit the proof of procurement of LEDs from OEMs at the time of testing

xii. The Luminaires shall be provided with high tensile heat resistant toughened glass of minimum 0.8mm thickness or UV resistant polycarbonate cover fixed with stainless Steel screws.

xiii. An extruded silicon loop gasket shall be provided in the lantern body to ensure a weather proof seal between the cover and the metal housing to exclude the entry of dust, water, insects, etc. Luminaire should conform to degree of protection of IP 65 or above. Felt gasket will not be accepted.

xiv. Year of Manufacture, Batch No., Serial Number or Identification No. Luminaire Manufacturer's Name / Logo, Wattage and Frequency should be embossed on the housing.

xv. LED luminaires, should conform to the various National / International standards for safety & performance. Manufacturer should provide test reports as per LM 79 & LM80. Lumen maintenance report as per LM 80 guidelines shall be submitted for the LEDs used along with the BID.

xvi. Luminaires should conform to the IS standards for Safety & Performance and test certificates as per IS 16107 should be provided by the manufacturer. In case of luminaires are imported, the CONTRACTOR shall conform to test parameters as per UL or equivalent standards.

xvii. The electrical component of the LED and LED driver must be suitably enclosed in sealed unit to function in environment conditions mentioned earlier.

xviii. All the connecting wires inside the Luminaire shall be low smoke halogen free, fire retardant cable.

xix. Adequate protection against Overloading, Short Circuit, Over Voltage, over temperature, Under Voltage, String Open shall be provided within the Luminaires.

xx. Design of the thermal management shall be done in such a way that it shall not affect the properties of the diffuser.

xxi. The equipment should be compliant to IEC 60598-1, IEC 62031 and IEC/ PAS 62612 depending on the type of luminaire.

xxii. All the material used in the luminaires shall not contain any toxic material/ metal like mercury; shall be halogen free and fire retardant confirming to relevant standards.

xxiii. The Manufacturer shall have all the relevant testing facilities certified by an accredited laboratory and shall be offered for inspection to the Employer for verification of the required parameters and tests. CONTRACTOR shall confirm the same in the BID.

xxiv. The control gear shall comply with the provisions of IEC 61347-2-13, IEC 62031 and IEC 62384 as appropriate.

xxv. The LED lighting fixtures offered shall comply with the following requirements;

Sr. No.	Parameter	Design Requirement / Value
1.	Type	Dimmable LED Luminaires complete with all accessories for Street Lighting
2.	Rated Voltage	230 V
3.	Expected Frequency	50 Hz +/- 3%
4.	Operating Voltage Range	150 V to 270 V
5.	Power Factor	> 0.90
6.	Operating Temperature Range	0 Deg C to 50 Deg C
7.	Working Humidity	10% - 90% RH
8.	Driver Type	Constant Current based Electronic Driver
9.	Driver Efficiency	> 92%
10.	Driver Life	>20000 hrs.
11.	Protection required in Driver module	
a.	Short Circuit	To be provided by the contractor
b.	Over Voltage	To be provided by the contractor
c.	Over Temperature	To be provided by the contractor
d.	Under Voltage	To be provided by the contractor
e.	String Open Protection	To be provided by the contractor
12.	Luminaires IP Protection	Minimum IP 65 for Outdoor Fixtures
13.	Minimum Surge Protection	>4 KV
14.	THD	≤ 15%

15.	Power Factor	≥ 0.9
16.	Rated Minimum LED Life (L70)	50000 Burning Hours
17.	Rated Minimum Driver Life	20000 Burning Hours
18.	CRI	>70
19.	Junction temperature rise	< 85 Deg C
20.	Solder point temperature	< 70 Deg C
21.	Maximum temperature rise for Driver	<30 Deg C at 45 Deg C ambient
22.	Make of LED	Cree / Nichia/ Philips / Osram
23.	Make of Driver	Cree / Nichia/ Philips / Osram
24.	Operating Hours	Dusk to Dawn (max 12 Hrs.)
25.	Efficacy of Luminaires	>92lm/W
26.	Colour Temperature	5000K – 6000K
27.	Illumination Regulation	<5%
28.	Material used for following	
a.	Housing	Die cast aluminium/ extruded Aluminium body with powder coated finish
b.	Heat Sink	Aluminium extrusion
c.	Clip / Fasteners	Stainless steel.
d.	Diffuser	Toughened glass (0.8mm thick)/ UV stabilized Poly carbonate material
29.	Maximum temperature of Heat sink	<70 Deg C
30.	IK protection of Optic Cover	>IK05
31.	Wires used Inside Luminaires	Cu conductor, low smoke halogen free, fire retardant e-beam cable
32.	Cable gland IP protection	IP 65

xxvi. Each luminaires shall have a terminal block suitable for loop-in, loop-out and T-off connection by 230/ 415 V, 1 core, FRLS PVC insulated Copper conductor wires up to 4 sq. mm in size. In outdoor areas the termination at the luminaires shall be suitable for 1100 V, PVC insulated, Cu/ Al conductor, armoured cables of sizes up to 6/ 16 sq. mm conductor. Terminals shall be of stud or clamp type. The internal wiring should be completed by means of stranded Copper wire of minimum 1 sq. mm size and terminated on the terminal block. Terminal blocks shall be mounted with minimum two fixing screws.

xxvii. Mounting facility and conduit knock-outs for the luminaires shall be provided.

v) Earthing

i. Each luminary shall be provided with an earthing terminal suitable for connection to the earthing conductor of 12 SWG GI wire.

ii. Where separate control gear box is provided for housing the accessories the same shall be provided with an earthing terminal suitable for connecting earthing conductor of 12 SWG GI wire.

iii. All metal or metal enclosed parts of the luminaries/control gear box shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity.

iv. Earthing of each pole shall be carried out with one dedicated earth electrode. The earth electrode can either be a GI coil type or GI pipe/ rod type electrode. The GI rod/ Pipe electrode shall be 2.5 m deep and can be hammered directly into the ground where ordinary soil is present. For Hard strata, preparation similar to that mentioned in latest version of IS 3043 or the latest version of Rural Electrification Corporation (REC) manual can be carried out. For GI Coil earthing, preparation as per REC manual shall be followed. The earth electrode shall be connected with two 25X6 sq.mm GI strips to the two distinct earth boss on the pole.

w) Painting/ Finish:

i. All surfaces of the Luminaries/Control gear box housing accessories shall be thoroughly cleaned and degreased. It shall be free from scale, rust, sharp edges and burrs.

ii. When enamel finish is specified, it shall have a minimum thickness of 2 mils for outside surface and 1.5 mils for inside surface. The finish shall be non-porous and free from blemishes, blisters and fading.

iii. The luminaire housing shall be stove-enamelled/epoxy stove-enamelled-vitreous enamelled or anodised as indicated under various types of fittings.

iv. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg. over 1/2” dia. mandrel.

v. The finish of the luminaries shall be such that no brigHV spots are produced either by direct light source or by reflection.

vi. External control gear box provided for housing accessories shall be painted or galvanised.

4.6.6. Outdoor/ Street Lighting Luminaries:

a) LED luminaires:

i. Street light LED luminaires shall be outdoor weather proof type for illumination of main roads, traffic islands etc.

ii. The luminaires shall be of semi-cut off with cast aluminium housing, acrylic or prismatic cover, polished aluminium reflectors, complete with integral mounted control gear, neoprene gaskets and with rear pipe entry.

iii. The luminaires shall be suitable up to 70/150/ 250 watts LED lamps and for mounting heights from 4 metres to 12 metres.

b) Metal Halide luminaires (For High Mast Only As Applicable):

i. Street light MH luminaries shall be outdoor weather proof type for illumination of main roads, traffic islands etc.

ii. The luminaries shall be of semi-cut off with cast aluminium housing, acrylic or prismatic cover, polished aluminium reflectors, complete with integral mounted control gear, neoprene gaskets and with rear pipe entry.

iii. The luminaries shall be suitable up to 150/ 250 watts MH lamps and for mounting heights from 4 metres to 12 metres.

c) Post Top Lantern:

i. Post top lantern luminaries shall be generally outdoor weather proof type for illumination of walkways, gate posts, gardens etc.

ii. The luminaries shall have cast aluminium spigot finished with corrosion proof paint for mounting, opal acrylic or high density polyethylene (HDP) diffuser bowl, complete with integral mounted control gear, neoprene gaskets, earthing terminal etc.

4.6.7. External Light Poles-Street Light/ High Mast Flood Light (where applicable):

a) All the Poles shall be designed to withstand the maximum wind speed as per IS 875. The top loading i.e., area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BSEN 40-3:2000, pr EN-40-3-3.

b) These poles shall be coated with bituminous preservative paint on the inside as well as embedded outside surface. Exposed outside surface shall be painted with one coat of red lead oxide primer. After completion of installation two coats of aluminium paint shall be applied. One steel ladder shall be provided separately. The length of each step of the ladder shall be at least 300 mm and spacing between two adjacent steps not more than 300 mm.

c) The supply of poles shall be complete with fixing bracket/ necessary pipe reducer for fixing the fitting and also include the necessary associated pole mounted junction boxes. The required sizes of poles and the junction box shall be as indicated in the attached drawings.

b) The pole shaft may have Octagonal or Conical cross section and shall be continuously tapered with single longitudinal welding as applicable. There shall not be any circumferential welding.

c) All Octagonal or Conical pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations .i.e. from inside and outside.

d) The welding of Octagonal or Conical pole shaft shall be done by Submerged Arc Welding (SAW) or using high end MIG/ TIG Welding process. The welding shall be

carried out conforming to approved procedures. The welding shall be done as per qualified MMAW process approved by Third Party Inspection agency.

e) The Octagonal or Conical poles shall have integrated Junction box with open able door of adequate size (approximate 600mm length) at the elevation of 750 mm from the base plate.

f) The door shall be hinged type with mechanical interlock, dust proof, weather proof and vandal resistance and shall ensure safety of inside connections and components. The door shall be flushed with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.

g) The door of the integral Junction Box shall permit clear access to the components inside viz., termination strips, connectors, MCBs, cables etc.

h) The Octagonal or Conical pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

i) Material for Octagonal or Conical Poles shall be HT Steel Conforming to grade S355JO; Base plate shall be FE 410 conforming to IS 226/ IS 2062; and Foundation Bolts shall be of EN.8 grade.

j) Aesthetic appearance - All the grooves and carvings of the pole unit shall be free from any kind of distortion for a pleasing aesthetic appearance.

k) The Octagonal or Conical poles shall be hot dip galvanized as per is 2629/ IS 2633/ IS 4759 standard with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.

l) The Octagonal Poles shall be bolted on a pre-cast foundation with a set of foundation bolts for greater rigidity.

m) Top Mountings -The galvanized mounting bracket shall be supplied along with the Poles for Installation of the luminaires.

n) The Octagonal or Conical pole manufacturing & galvanizing unit shall be ISO 9001: 2000 & ISO 14001 certified to ensure consistent quality & environmental protection.

o) Electrical connections - Four way connectors shall be provided along with Slide lock suitable for connecting 1.1 kV grade, 4 C x 16 sq.mm Al cable. It shall also in-house 1 no. 6 amps DP MCB, 2.5 sq.mm connectors for looping with 2.5 Sq.mm Copper wires for connecting to the luminaire through 1.1 kV grade, 3 core X 2.5 mm² PVC insulated copper conductor flexible un-armoured Cable from the terminal block to the fixture within the pole. All the cables laid through the pipe shall be without any joint.

p) Two nos. Earth Boss shall be provided at the bottom of the pole (diagonally opposite) suitable for connecting 25X6 mm GI/ CU earth strip for earthing of the poles. Similar Earth Boss suitable for connecting 4 sq.mm copper wires shall be provided on the control plate inside the Junction Box for earthing of the electrical components.

q) Two nos. 50 mm NB HDPE sleeves of suitable length shall be provided through the foundation up to the Junction Box for entry of power cable.

r) The Contractor shall carry out all the relevant tests and inspection in the presence of the Employer or Third Party Agency, as may be selected by the Employer, before the dispatch of the poles at no extra cost to the Employer.

s) The CONTRACTOR shall inform the EMPLOYER at least Fifteen (15) days in advance, about the manufacturing schedule so that arrangement can be made for inspection. EMPLOYER reserves the right to waive the inspection at any stage.

t) All the material/ equipment/ accessories shall be supplied with manufacturer's test certificates.

u) CONTRACTOR shall submit the Proposed Product Catalogue, Detail Data sheet, spare parts list and drawing of Pole & Bracket along with the BID for each product quoted.

a) High mast shall be outdoor weather proof type for illumination of main roads and area lighting, wherever found necessary.

b) The high mast shall be continually tapered, polygon cross section, telescopically jointed steel fabricated construction. The mast shall be hot dip galvanised internally and externally. Weather proof door shall be provided near the base to permit access to winch, cables, plug, socket etc. The mast shall be designed for wind speeds depending upon wind pressure and direction as per relevant Indian Standards. Foundation bolts shall be included in the scope of supply.

c) The moving platform shall be of steel construction hot dip galvanised and designed to hold the number of flood light luminaires specified. The control gear boxes shall be cast aluminium weather proof type mounted on the moving platform. The moving platform shall be raised or lowered with the help of winch, pulley system and stainless steel wire ropes. The winch shall be suitable for hand operation or alternate by electric power.

d) The mast shall be suitable for mounting numbers of luminaires as required. The standard mast heights are generally from 16 to 30 meters.

e) CONTRACTOR shall arrange for all the tools and equipments including M20 concrete foundations shall be provided for all the poles. Approx dimension of the foundation for evaluation purpose is 600X600X1700 mm. However, CONTRACTORs shall design as per the stability requirement and Soil bearing Capacity of each location. The Poles shall be bolted on a pre-cast foundation with minimum four foundation bolts for greater rigidity.

4.6.8. Emergency Light Luminaries:

a) Emergency light fitting shall be 240 V self contained 2 x 11 W fixture with built in Ni-Cd battery having charging facility and six hours back-up time. The emergency light fittings shall be provided at strategic locations of each house / area.

b) Emergency fixtures shall come in service when AC supply fails.

c) Pump room and Electrical room shall be considered for Emergency lighting.

d) In addition to above emergency fixtures, every pump station shall be provided with two nos. of portable emergency luminary, which shall be with CRCA sheet steel enclosure, complete with metalized mirror reflector, leak proof re-chargeable battery rated for two hour discharge, battery charger, charger-on lamp, push button switches, automatic changeover switch/relay, two metre length cord with plug, mounting pads and other accessories required for satisfactory operation of the luminaries.

e) The luminaries shall be suitable for connection to 240 V, 50 Hz single phase supply. On failure of normal AC supply the luminary shall start automatically and on restoration of AC supply the luminary shall switch off automatically.

4.6.9. Accessories for Luminaries:

a) The Routine test on each of the offered Luminaire shall be carried out by the CONTRACTOR before dispatch. Following tests shall be carried out as Routine tests by the CONTRACTOR for the offered Luminaires;

(i) Visual and Dimensional check
(ii) Checking of documents of purchase of LED
(iii) Insulation resistance test
(iv) HV test
(v) Reverse polarity

b) The Acceptance test shall be carried out by EMPLOYER or EMPLOYER's Representative on a sample of the lot offered for Acceptance. The Lot shall be different from the lot from which the Type test samples have been drawn. The cost of the testing shall be borne by the CONTRACTOR. Following tests shall be carried out as Acceptance tests by the CONTRACTOR for the offered Luminaires;

(i) Visual and Dimensional check
(ii) Checking of documents of purchase of LED
(iii) Insulation resistance test
(iv) HV test
(v) Over voltage protection
(vi) Surge protection
(vii) Reverse polarity
(viii) Lux measurement
(ix) Test for IP 65 protection

c) Following Type tests reports shall be provided by the CONTRACTOR for the offered Luminaires along with the BID;

(i) Resistance to humidity
(ii) Insulation resistance test
(iii) HV test
(iv) Over voltage protection
(v) Surge protection
(vi) Reverse polarity
(vii) Temperature rise Test
(viii) Ra (Colour Rendering Index) measurement test
(ix) Lux measurement
(x) Fire retardant Test

(xi) Test for IP 65 protection

(xii) Endurance Test,

(xiii) Life Test

(xiv) Photometric Measurements Test Report (IES LM 79)

(xv) LED Lumen Maintenance Test Report (IES LM 80)

(xvi) Vibration test as per ANSI

4.6.10. Lighting System Equipment:

a) Main Distribution Boards and Lighting Panels:

i. Main Lighting distribution board (MLDB) shall have MCCB as incomer & outgoing feeder with thermal magnetic release for O/L+S/C+E/F protections.

ii. This MLDB shall feed to different Lighting Panels/ Lighting DBs for further distribution.

iii. Where ever MLDB is not applicable, lighting feeder of appropriate rating shall be derived from the local distribution board. This feeder will feed to local LP catering to lighting requirements of that particular area.

b) Constructional Features:

i. Boards and panels shall be sheet steel enclosed and shall be fully dust and vermin proof, providing a degree of protection of IP-54 for indoor. Outdoor panels shall in addition be completely weather-proof with a sloping canopy for protection against rain and providing a degree of protection of IP-55. The sheet steel used for frame, frame enclosures, doors, covers and partitions shall be cold rolled 2.0 mm thick.

ii. The lighting panel for outdoor lighting shall have a programmable timer for automatic control of lighting along-with contactor, MCB, auto/ manual selector switch.

iii. All boards and panels shall be provided with hinged doors for access to equipment. Doors shall be gasketed all round with neoprene gaskets.

iv. A slotted metallic sheet shall be provided inside. Only the MCBs operating knobs shall project out of the metallic sheet slots for safe operation and neat appearance. Incomer to lighting panels shall be provided with Four pole MCB + RCCB

v. All accessible live connections/metals shall be shrouded and it shall be possible to change individual MCBs from the front of the boards/ panels without danger of contact with live metal.

vi. For floor mounting type distribution boards, adequately sized mounting channels shall be supplied and for wall/column/structure mounting type panels suitable mounting straps shall be provided.

vii. Adequate interior cabling space and suitable removable cable entry plates shall be provided for top/ bottom entry of cables through glands and or conduits as required. Necessary number of glands to suit the specified cable sizes shall be provided. Cable glands shall be screwed on type and made of brass.

viii. Two earthing terminals shall be provided to suit the earthing conductor.

ix. All sheet steel parts shall undergo rust-proofing process which should include 7 tank processing. The steel works shall then be painted with two coats of Zinc - chromate primer and two coats of final epoxy based finish paint of colour 63I as per IS 5.

c) Busbars:

i. Busbars shall be of copper conductor of hard drawn (HD) and high conductivity.

ii. Busbars shall be provided with at least the minimum clearances in air as per applicable standards.

iii. Busbars shall be adequately sized for the continuous current rating such that the maximum temperature of the bus bars, bus bar risers/droppers and contacts does not exceed 85° C under site reference temperature.

iv. The bus bars, bus bar connections and bus bar supports shall have sufficient strength to withstand thermal and electro-mechanical stresses of the MCB's let through/cut-off current associated with the specified short-circuit level of the system.

v. Busbar supports shall be VMC type. Separate supports shall be provided for each phase of the bus bars.

vi. The neutral bus of the main 3 phase, 4 wire distribution board shall be 100% of the phase busbars.

d) Panels/ Boards' Component & Lighting Accessories:

i. MCB/ ELCB :

- MCBs shall be C curve type for lighting panels.
- For all the lighting panels RCCBs shall be with 100 mA sensitivity & for all receptacles RCBO sensitivity shall be 30 mA.

ii. MCCB :

- MCCB requirements shall be as per specified in the LV switchgear requirements & as specified above.

iii. Indicating Instruments and Meters:

- Whenever required, instruments and meters shall be of the flush mounting type. They shall be suitably mounted so as to provide for easy access to CTs and small wiring.
- Instruments shall be of minimum 96 mm square size, shall have provision for zero adjustment outside the cover and black numerals on white dial.
- Ammeter/Voltmeter selector switches having 3 positions and off, with stay-put contacts rated 10A shall be provided when specified.

- Potential fuses shall be provided at the tap-off point from the bus bars for the voltmeters.

iv. Instrument Transformers:

- Current and voltage transformers shall be of cast resin type, with insulation class B, & accuracy class 1.0 unless otherwise specified, it shall be the responsibility of the Contractor to ensure that the VA burden of the instrument transformer is adequate for the meters connected to it.

- Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests. Facilities shall be provided for short-circuiting and grounding the CTs at the terminal blocks.

- Voltage transformers shall be provided with suitably rated primary and secondary fuses.

v. Indicating Lamps:

- Indicating lamps shall be of the clustered LED type, low watt consumption.

vi. Internal Wiring

- Panels/ boards shall be supplied completely wired, ready for the external connections at the terminal blocks. Wiring shall be carried out with 1.1 kV grade, FRLS PVC insulated, multistranded Copper conductors. Conductors of adequate sizes shall be used to suit the rated circuit current.

- Cross Ferruling i.e., engraved identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire.

- All wiring shall be terminated on terminal blocks. Terminal blocks shall be one piece moulded rated 500 V, of reputed make of approved list, preferably stud type for higher current ratings such that wires are connected by cable-lugs and complete with nuts and washers. Terminals shall be adequately rated for the circuit current, the minimum rating shall be 20 A.

- Terminals for circuits with voltage exceeding 125 V shall be shrouded.

- Terminals shall be numbered and provided with identification strip for identification of the circuit.

- Terminal blocks for CT secondary lead wires shall be provided with shorting and disconnecting/earthing facilities.

vii. Labels & Diagram Plate:

- All door mounted equipment as well as equipment mounted inside the switchboard/panels shall be provided with individual labels with equipment designation/rating. Also the boards/panels shall be provided on the front with a label engraved with the designation of the board/ panel.

- Labels shall be made of non-rusting metal, 3-ply lamicoid or engraved acrylic

- Inside the door of the 1 phase ways lighting panels a circuit diagram/ description shall be fixed for reference and identification.

viii. Conduits:

- Rigid steel/ non-metallic conduits and their associated fittings as required shall conform to applicable standards. The minimum size of conduit shall be 20 mm for surface installation and 25 mm for concealed installation.

- Steel conduits shall be seamed by welding and hot dip galvanised. They shall be supplied in standard lengths of 5 metre.

- Supply of conduits shall include all associated fittings like couplers, bends and tees as required for lighting system installation work.

ix. Junction Boxes:

- Junction boxes with terminals shall be supplied for branching and terminating lighting cables when required for outdoor areas, three (3) phase receptacles etc.

- The junction boxes shall be dust and vermin proof and shall be fabricated from 14 SWG sheet steel and shall be complete with removable cover plate with gaskets, two earthing terminals each with nut, bolt and washer. Boxes shall be additionally weather proof.

- The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable/ conduit entry knock outs, terminal blocks, and HRC fuses as required.

- The terminal blocks, with specified number of terminals, shall be mounted securely on brackets welded to the back sheet of the box. The terminals shall be 600 V, grade, one piece construction complete with terminals, insulation barriers, galvanised nuts, bolts and washers and provided with identification strips of PVC. The terminals shall be made of Copper alloy and shall be of box clamp type.

- The boxes shall be painted with one shop coat of red oxide zinc chromate primer followed by a finishing coat of paint.

x. Lighting Poles and Flood Light Pole Mounting:

- Lighting poles for street lights and flood lights shall be of stepped tubular steel poles construction as per applicable standard. These poles shall be coated with bituminous preservative paint on the inside as well as embedded outside surface. Exposed outside surface shall be painted with one coat of red lead oxide primer. After completion of installation two coats of aluminium paint shall be applied.

- Poles for mounting flood lights shall be supplied whenever required and as per typical attached drawing. Unless otherwise specified, poles shall be painted with red lead oxide primer and two coats of aluminium paint. One steel ladder shall be provided separately. The length of each step of the ladder shall be at least 300 mm and spacing between two adjacent steps not more than 300 mm.

- The supply of poles shall be complete with fixing bracket/necessary pipe reducer for fixing the fitting and also include the necessary associated pole mounted junction boxes.

- The required sizes of poles and the junction box shall be as indicated in the attached drawings.

- Outdoor JBs shall be minimum IP 55 protected.

- Cable entry for street lighting junction boxes shall be from bottom.

- Rain water canopy shall be provided at the top for the outdoor JBs. Terminal strip shall be provided for looping loop out of cables.

- Street lighting JB shall consist of terminal strip (3 ways) for looping in & loop out of cables. The JB shall be provided with 6A MCB (C- Curve type) for isolation of lighting fixture, as well as sufficient arrangement (earthing studs) for termination of 2 nos. earthing connections.

xi. Ceiling Fans/ Wall Mounted Fans:

- Ceiling/ Wall mounted fans shall be suitable for operation on 240 V, 1 phase, 50 Hz supply and shall be complete with standard mounting accessories such as suspension rods, top and bottom caps etc for ceiling fans and easy accessibility for wall mounted fans. The fans shall be supplied with appropriate speed regulators.

- Exhaust fans, where ever required shall also be provided. The exhaust fan with all parts shall be according to IS: 2312- 1967 & its latest amendment with IP-55 specification. The exhaust fan shall have epoxy powder coating with specially pretreated components for better resistance to corrosion and acid alkali flumes. The exhaust fan shall have totally enclosed highly efficient heavy duty motor with pressure die cast aluminum rotor mounted on two ball bearings.

- The fans shall generally conform to the applicable standards indicated in Tender. Details regarding blade sweep and suspension requirements shall be as per Project layout drawing/price schedule.

4.7. DC SYSTEM :

4.7.1. Scope: DC system (as applicable) shall include the following:

a) One set of 24/ 30 or 110 V DC, maintenance free rechargeable sealed lead acid batteries of adequate AH capacity shall be provided for control of electrical switchgears in the Plant.

b) Batteries shall be provided with battery charger cum DC distribution board. Battery charger shall include a float & float cum boost charger, indicating lamps and annunciations.

4.7.2. Sealed Maintenance Free Lead Acid Battery:

a) Applicable Standards: The sealed maintenance free lead acid battery shall conform to the latest applicable standards specified below. In case of conflict between standards and this specification this specification shall govern.

Sealed lead acid: IS: 1651, 1652 BS: 6290

b) The sealed batteries shall be a starved electrolyte type with electrolyte immobilized in a micro-porous material to allow recombining of generated oxygen internally. The battery shall be completely explosion resistant, shall tolerate freezing and shall not allow gases to escape during normal charging conditions. The battery shall not require any watering and be maintenance free.

c) Positive Plates: Positive plates shall be either of cast solid in pure lead in one piece with plante formation and shall have adequate mechanical strength or of tubular plate which shall consist of a suitable bar with spines cast of suitably alloyed lead to give adequate mechanical strength or of pasted positive plates consisting of either pure lead, low anti-monial lead alloy or lead calcium positive grids; having double separation with a glass wool retainer mat or any other suitable material placed against the surface of the positive plates for good service life.

d) Negative Plates: The negative plates shall normally be of the box type. End negative plates, if of box type may be of the half pasted type. Pasted plates shall have adequate mechanical strength and shall be so designed that the active material is maintained in intimate contact with the grid under normal working conditions.

e) Containers: The containers shall be made of plastics, or fiber reinforced plastics (FRP). The container shall be spill proof, leak proof, explosion resistant and increased safety type enclosure.

f) Vent Plug: The vent plug shall be for safety pressure vent and of self resealing type.

g) Separators: The plate separator shall consist of a micro-porous matrix which shall serve as the mobiliser for the electrolyte. The battery separator shall maintain the electrical insulation between the plates and shall allow the electrolyte to permeate freely.

h) Connectors and Terminal Posts: Inter-cell and inter-tier connectors and terminal posts shall be of Copper. Terminal posts shall be designed to accommodate external bolted connection conveniently and positively. Each terminal post shall have two bolt holes of the same diameter, preferably at right angles to each other. The bottom hole shall be used to terminate the inter-cell connection. The top hole shall be left for terminal connections. All the metal parts of the terminals shall be lead coated. The junction between terminal posts and cover and between cover and container shall be so sealed as to prevent any seepage of electrolyte.

i) Electrolyte: The electrolyte shall be battery grade sulphuric acid conforming to latest editions of relevant standards. The sealed battery shall be transported with the electrolyte immobilized, sealed and fully charged.

j) Accessories: The battery shall be complete with accessories and devices, including but not limited to the following:

i. Battery racks

ii. Set of inter cell, inter-tier and interbank connectors as required for the complete installation.

iii. One Voltmeter with suitable range and leads for measuring cell voltage

iv. Insulated wrencher.

k) One set of terminals and cable boxes with glands for connecting cable as required.

l) Battery Racks: Battery racks shall be constructed from good quality teak wood and painted with two coats of approve alkali resisting paint. The construction of the racks shall be suitable for fixing to a flat concrete floor. The racks shall be rigid, free standing type and free from warp and twist. The completed racks shall be suitable for being bolted end to end to form a continuous row. Insulators shall be provided below the legs of the stands.

m) Capacity: The standard ampere-hour capacity at ten hour rate of discharge of the battery has been based on the requirements of loads as applicable and the minimum ambient temperature specified. Contractor shall guarantee that the capacity of the battery offered by him is adequate for the duty specified (all loads being coincident from the instant of supply failure even at the minimum ambient temperature as specified) assuming that the battery is fully charged to

i. 2.15 V at the start of the cycle

ii. 1.75 V/ cell at the end of the cycle.

n) The Battery sizing basis shall be IEEE 485 & the Contractor to note that the Battery sizing shall be done considering design ambient temperature of 50ºC & following factors.

i. Design Factor- Min. 1.1

ii. Aging Factor- Min. 1.25

iii. Temperature Correction Factor- Min. 1.1

o) Cell Identification: Each cell shall be marked in a permanent manner to indicate the following information:

i. Cell number

ii. Type of positive plate

iii. Ah capacity at 10 hour rate

iv. Type of container

v. Manufacturer’s name

vi. Month and year of manufacture.

p) Drawings/ Document: The complete battery layout drawing shall be furnished as part of the tender and also after award of contract for Purchaser's approval.

4.7.3. Battery Chargers:

a) The battery charger and DC Distribution board shall conform to the latest applicable standards specified below. In case of conflict between the standards and this Specification, this Specification shall govern.

Basic climatic and mechanical durability tests for components for electronic and electrical equipment	IS:9000
Environmental tests for electronic and electrical equipment	IS:9000
Metal clad base material for printed circuits for use in electronic and telecommunication equipment	IS:5921
Transformers and inductors (power, audio, pulse and switching) for electronic equipment	IS:6297
Printed wiring boards	IS:7405
Environmental requirements for semi-conductor devices and integrated circuits	IS 6553
Terminals for electronic equipment	IS:4007
Factory built assemblies of switchgear and control gear for voltages up to and including 1000 V AC and 1200 V DC	IS:8623/BS: 5486 / IEC:439
Air break switches	IS : 13947 (Part –3)BSEN 60947-3
Miniature circuit breakers	IS 8828/BSEN:60898
HRC cartridge fuses	IS:9224/BS:88
Contactors	IS:13947 (Part – 3) /BS:775/ IEC:158-1
Control switches/push buttons	IS:6875
Degree of Protection	IS:13947- (Part 1) /IEC:947-1
Climate-proofing of electrical equipment	BSCP:1014
Code of practice for phosphating iron and Steel	IS:6005/BS:3189
Semi-conductor converters	IEC:146
Semi-conductor rectifier equipment safety code	IS:6619
Specification for copper rods and bars for electrical purposes	IS : 613

b) Requirements: The Battery Charger shall be microprocessor based & shall have two chargers mainly- i) Float Charger ii) Float cum Boost Charger.

c) The float & float-cum-boost type battery charger shall comprise silicon controlled rectifiers (SCRs) connected in a full wave bridge circuit. Each battery charger shall be suitable for float charging the battery under normal conditions and boost charging the battery when it has discharged during service conditions. The changeover from float to boost mode and vice versa shall be automatic. Microprocessor shall be MU 1000C or Equivalent makes from the approved makes.

d) The rectifier transformer shall be dry type and double wound with required number of taps. The DC output voltage during float charging shall be stabilized within ±1% of the

set DC bus voltage for AC input voltage variation of ±10%, frequency variation of ± 5% and DC load variation from 0 - 100%. The voltage regulation shall be achieved by a constant voltage regulator having fast response SCR control. The ripple content shall be within ±1% of DC output nominal voltage with battery disconnected and shall be designed to have voltage regulation of ±1%. Also in any mode of operation, the maximum harmonics in the charger output shall not exceed 5%.The setting of the output DC bus voltage shall be adjustable between ± 10% of nominal rated voltage. There shall be provision for manual control if auto mode fails. Line surge suppressers shall be provided.

e) If the spare float charger supplying DC load fails, the load shall be fed from the point of connection at the tapping of the battery via adequately rated blocking diodes. Two blocking diodes in series shall be provided to take care of short circuit of any one diode

f) For boost charging the discharged battery after a mains failure, the rectifier shall charge the battery at high rate limited to the maximum boost charging voltage. The boost charging shall come on only when selected for boost mode manually. In auto control, the DC output current shall be stabilized within ±2% for AC input voltage and frequency variation of ±10% and ±5% respectively. There shall be provision for manual control if auto-mode fails. The boost charge voltage and current settings shall be adjustable between 70 to 100% of maximum boost charge voltage and between 30 to 100% of maximum boost charging current.

g) Boost charging time for charging the battery to full capacity from fully discharged condition shall not exceed 8 hours.

h) In the float charging mode, the charger shall be designed for supplying:

   i. The DC loads of control, indication and annunciation circuits that remain energized during normal operation and the momentary closing and trip coil loads of circuit breakers, vacuum contactors; and

   ii. The float charging current of the battery.

   iii. 25% margin over the above load.

i) Battery charging equipment complete with all accessories shall be housed in a free standing sheet steel cubicle having degree of protection of IP 42. Sheet steel used for construction shall be 2 mm thick. The units shall be wired using 1100 V grade, FRLS PVC insulated, multi-stranded Copper conductor cables.

j) During boost charging the DC bus load shall be connected via two diodes in series connected to the tap cell of the battery. This is to take care in case of failure of standby charger supplying DC load.

k) All printed circuit cards shall be plug-in type, interlocked to prevent insertion in a wrong slot. Each card shall have LED indication on its front plate to indicate normal condition and readily marked test pins.

l) All components shall be accessible to the maintenance technician for easy disassembly and replacement. Access to parts of equipment shall be with minimum danger from all hazards.

m) All components and modules shall be clearly and unambiguously marked and all wiring colour coded and tagged

n) Each battery charger shall be provided with accessories that include, but not limited to the following:

i. Electronic controller comprising of power supply card, soft start cum current limit card, auto trickle mode card with facility for setting trickle charge current and monitoring battery current, error amplifier cards and pulse generating cards for achieving the DC output voltage stabilization of ±1% and also for achieving current limiting feature. The electronic controller shall have protection features with indications for under-voltage, over-voltage, earth fault, set output voltage and phase failure or voltage unbalance. The controller shall also be suitable for boost charging the battery in case of float-cum-boost charger.

ii. Boost charge current limiter with potentiometer to adjust the setting

iii. Silicon controlled rectifiers connected in full wave bridge circuit with ripple control devices and transient suppression network.

iv. 240 V AC compact fluorescent lamp fixture for internal lighting with MCB

v. Automatic voltage regulator unit with Manual/ Auto control switch

vi. Double wound, dry type, three phase suitably rated mains transformer with fuse protection and with one set of power factor correction capacitors to maintain a power factor of 0.85 (lag).

vii. Electronic controller comprising of power supply card, soft start cum current limit card, auto trickle mode card with facility for setting trickle charge current and monitoring battery current, error amplifier cards and pulse generating cards for achieving the DC output voltage stabilization of ±1% and also for achieving current limiting feature. The electronic controller shall have protection features with indications for under-voltage, over-voltage, earth fault, set output voltage and phase failure or voltage unbalance.

viii. Adequately sized necessary built-in accessories shall be provided such that on failure of the controller in auto mode the voltage can be effectively controlled manually.

ix. Filter circuit comprising of smoothing choke and condensers complete with HRC fuse with trip indication for filter condenser circuit

x. Coarse and fine control potentiometers for manual control

xi. Selector switch for mode of charging i.e. float charging / boost charging

xii. Off-load tap changing switch for changing the taps of the transformer

xiii. DC voltmeter with fuses and a three position selector switch

xiv. DC ammeter with shunt

xv. AC ammeter with selector switch for incoming AC power

xvi. AC voltmeter with selector switch for incoming AC power

xvii. MCB for incoming AC supply along with surge suppressers

xviii. MCB on DC output side with kick fuses and alarm contacts

xix. Voltage dropping diodes in load circuit during boost charging mode

xx. DC under voltage relay and earth fault relay

xxi. AC/ DC switching relays for alarm and indication circuits including buzzer

xxii. Cubicle space heater suitable for 230 V AC, 1 ph, 50 Hz supply, with MCB and thermostat

xxiii. Each battery charger shall be provided with the following alarms / indications:

- AC and DC supply 'ON'
- AC and DC supply fail
- Modes of charging
- Over voltage
- Under voltage on DC side
- Earth fault on DC side
- AC/ DC MCB trip

o) The DC circuit switching shall be through DC MCBs only.

p) Power Electronic Components:

i. Diode and thyristors shall be of mono-crystalline type silicon, capable of providing continuous output at specified voltages. It shall have high power efficiency.

ii. If many diode or thyristor assemblies are connected in parallel, care shall be taken to ensure that each rectifier or thyristor operates within its rating and shares the load uniformly.

iii. Each diode or thyristor built in a multi-built assembly shall be provided with a short circuit protection to avoid complete shut-down of the equipment because of a fault on single unit. Suitable fuses shall be provided for such protection.

iv. Necessary spare capacity shall be built in the equipment to continuously supply full load even with one unit out of circuit.

v. The diodes or thyristors shall be protected against overvoltage due to chopping surges with the aid of snubbers (i.e resistor-capacitor combination and Metal oxide variator

4.7.4. DC Distribution Board:

a) The distribution board shall be of floor mounting design. Entry for incoming and outgoing cables shall be from the bottom. Bus bars shall be of Copper. Incomers, bus coupler and outgoing circuits shall be controlled by suitably rated double pole MCBs suitable for DC application.

b) Constructional features, pre-treatment, painting and other aspects shall comply with the specifications for LV switchboard.

c) An earth busbar of 25x3 mm copper flat shall be provided along the length of the DB at the bottom. Two nos. earthing terminals shall be provided on the external face of the board for connection to the earthing grid.

4.7.5. Tests:

a) The batteries, chargers and distribution boards and their components shall be subjected to routine/ acceptance tests as per the applicable standards. For battery & battery charger, following tests are also to be carried out:

i. Visual checks for dimensions and general arrangement.

ii. Wiring checks.

iii. Functional checks.

iv. IR Test.

v. Capacity test.

vi. Test for voltage charging and discharging.

vii. Ampere-hour and watt-hour efficiency test.

viii. Hipot test, excluding electronic controller, at 2 kV AC for one minute.

b) Certificates of type tests carried out on similar equipment not older than 5 years shall be furnished by Contractor.

4.7.6. Drawings/ Documents Required:

After award of contract Contractor has to submit the below mentioned drawings/ documents for Purchaser's approval :

a) Dimensioned general arrangement drawings

b) Fully dimensioned general arrangement drawings of battery and battery charger with elevation, side view, sectional view and foundation details

c) Complete schematic and wiring diagrams.

d) Detailed BOM for the complete panel, with details of switchgear, controller, components etc.

5. SAFETY EQUIPMENTS/ REQUIREMENTS AND MISCELLANEOUS ITEMS:

5.1. Following safety procedure and practice should be provided by Contractor in switchgear room/ sub-station as per latest edition of I.S. 5216.

5.1.1. 900 mm wide antiskid insulating mat as per IS 15652 and of reputed make to be spread in front of the 11kV, 415V switch gear panels & power DBs, DCDB etc.

5.1.2. First aid box with all the standard contents.

5.1.3. First aid chart made of cloth for electrical shock treatment printed in English, Hindi and Gujarati duly framed with front glasses.

5.1.4. Charts/ drawings duly framed with front glass.

5.1.5. HV and LV power supply single line diagrams in adequate sizes approved by Purchaser/ Purchaser's representative & in line with the local electrical inspector.

5.1.6. Routine maintenance schedule for High Voltage Switchgear, Distribution Transformers, Low voltage Switchgears, APFC panels, Fire Alarm System, UPS system etc.

5.1.7. Provision of portable type Class A, B, C, and D type fire extinguishers at various locations in line with the statutory requirements.

5.2. FIRE SAFETY:

5.2.1. The requirement of hand appliance in switchgear room, electrical equipment room shall be provided as per Clause 4.0 of Fire Protection Manual by Regional Tariff Committee, 10th edition 1988.

5.2.2. Water Sealing & Fire Barriers at appropriate locations as specified in this specifications & good engineering practices.

5.3. DEGREE OF PROTECTION:

5.3.1. The enclosures of the control cabinets, junction boxes and Marshalling boxes, panels etc. to be installed shall provide minimum degree of protection as detailed here under

a) Installed outdoor – IP 55

b) Installed indoor – IP 54

5.3.2. The degree of protection shall be in accordance with IS 13947 (Part I)/ IEC 947 (Part I)/ IS 2063/ IEC 529

5.4. ELECTRICAL EQUIPMENT FOR HAZARDOUS AREAS: The electrical equipments for hazardous areas shall be selected as per IS 5572. Following factors shall be considered for proper selection of electrical equipments for use in Hazardous Area.

5.4.1. Area Classification (Zone):

5.4.2. Gas Classification (Group) – The characteristics of the gas or vapour involved in relation to the ignition or energy and safe gap data

5.4.3. Temperature Classification- The ignition temperature of the gas or vapour involved or lowest value of the ignition temperature, if more than one combustible material is present.

5.4.4. Environmental conditions – In which apparatus is to be installed. The selected electrical apparatus shall be adequately protected against corrosive and solvent agencies water ingress, thermal and mechanical stresses as determined by the environmental condition.

6. INSTALLATION, TESTING & COMMISSIONING – ELECTRICAL EQUIPMENT:

6.1. GENERAL:

6.1.1. In accordance with the specific installation instructions, as shown in Contractor's drawings or as directed by the Engineer In Charge the Contractor shall unload, erect, install, wire, test and place into commercial use of all electrical equipment included in the contract. Equipment shall be installed in a neat manner so that it is level, plumb, and properly aligned and oriented.

6.1.2. The Contractor shall furnish all supervision, labour, tools, equipment, rigging materials and incidental materials such as bolts, wedges, anchors, concrete inserts etc. required to completely install, test and adjust the equipment.

6.1.3. Drawings, instructions and recommendations shall be correctly followed in handling, settling, testing and commissioning of all equipment and care shall be exercised in handling to avoid distortion to stationary structures, the marring of finish, or damaging of delicate instruments or other electrical parts.

6.1.4. The Contractor shall erect and commission the equipment as per the instructions of the Purchaser/ Engineer In Charge and shall extend all co-operations to him.

6.1.5. In case of any doubt/ misunderstanding as to correct interpretation of drawings or instructions, necessary clarification shall be obtained from the Engineer's Representative. The Contractor shall be held responsible for any damage to the equipment consequent to not following instructions correctly.

6.1.6. The Contractor shall move all equipment into the respective buildings through regular doors or floor openings provided specifically for the equipment. The Contractor shall make his own arrangement for lifting of equipment.

6.1.7. Where assemblies are supplied in more than one section, the Contractor shall make all necessary mechanical and electrical connections between sections including the connections between bus bars/ wires. The Contractor shall also carry out the adjustments/ alignments necessary for proper operation of the circuit breakers. All insulators and bushings shall be protected against damage during installation. Insulators or bushings chipped, cracked or damaged due to negligence or carelessness shall be replaced by the Contractor at his own expenses.

6.1.8. The Contractor shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments or relays are supplied separately, they shall be mounted only after the associated control panels have been erected and aligned. The blocking material/ mechanism employed for the safe transit of the instruments and relays shall be removed after ensuring that the panels have been completely installed and no further movement of the same would be necessary. Any damage to relays and instruments shall be immediately reported to the Engineer In charge.

6.1.9. Equipment furnished with finished coats of paint shall be touched up by the Contractor if their surface is spoiled or marred while handling.

6.1.10. Foundation work and grouting of fixing bolts or channels for all transformers, switchgear, motors, and control panels shall be carried out by the Contractor.

6.2. POWER/ DISTRIBUTION TRANSFORMERS:

Inspection, storage, installation, testing and commissioning of transformers shall be in accordance with the latest Indian Standards Code of Practice IS: 10028. All commissioning tests as applicable, vide Appendix B of IS: 10028 (Part II) shall be carried out. Fire Wall of 4 Hr fire rating shall be provided between two transformers.

6.3. HV/ LV SWITCHGEAR CONTROL PANELS:

6.3.1. Switchgear control panels shall be installed in accordance with the latest Indian Standard Code of Practice 10118. The switchgear panels shall be installed on finished surface or concrete or steel sills. The Contractor shall be required to install and align any channel sills which form part of the foundations. Tape or compound shall be applied where called for. The base of outdoor type units shall be sealed in an approved manner to prevent ingress of moisture.

6.3.2. Following minimum clearances shall be observed while finalizing the HV/ LV panel layouts-

a) Minimum clearance of 1.0 meter shall be maintained from the rear of the panel to the nearest wall /structure.

b) Minimum clearance of 2.0 meter between panels facing opposite to each other.

c) Side clearance for LV panels shall be either ≤ 200mm or ≥ 800 mm.

d) For HV metal enclosed, indoor panels, Minimum 1 meter clearance from all sides & 1.5 meter in the front.

6.3.3. Emergency Exit doors shall be provided for electrical room, complying with the requirements of NBC 2005 latest edition.

6.3.4. After installation of all power and control wiring, the Contractor shall perform operating tests on all switchgear and panels to verify the proper operation of switchgear/ panels and the correctness of the interconnections between various items of equipment. This shall be done by applying normal a-c or d-c voltage to the circuits and operating the equipment. Megger tests for insulation, polarity checks on the instrument transformers, operation tests on equipment, and installation tests shall be carried out by the Contractor who shall also make all necessary arrangements for proper functioning of the equipment.

6.4. EARTHING AND LIGHTNING PROTECTION SYSTEM:

6.4.1. The Contractor shall install copper/ steel conductors, braids, etc., required for the system and individual equipment earthing. All work such as cutting, bending, supporting, painting/ coating, drilling, brazing/ soldering/ welding, clamping, bolting and connecting onto structures, equipment frames, terminals, rails or other devices shall be in the Contractor's scope of work. All incidental hardware and consumables such as fixing cleats/clamps, anchor fasteners, lugs, bolts, nuts, washers, bituminous compound, welding rods, anti-corrosive paint as required for the complete work shall be deemed to be included by the Contractor as part of the installation work.

6.4.2. The quantities, sizes, material of earthing conductors and electrodes to be installed as per requirement. Routes of the conductors and locations of electrodes shall be shown in the earthing layout drawings, which are to be prepared by Contractor & approved by Purchaser's representative.

6.4.3. The work of embedment of earthing conductor in RCC floors/ walls along with provision of earth plate inserts/ pads/ earth risers shall be done by the Contractor when the floors are cast

or during construction of walls. Contractor's scope of installation shall also include, laying the conductors in position with 60 mm concrete cover, making welded connections to inserts/pads/risers above the floor near the equipments. The embedded conductors shall be connected to reinforcing rods wherever necessary.

6.4.4. If the tap connections (earthing leads) from the floor embedded main earthing grid to the equipment are more than 500 mm long then the same shall be embedded in floor by the Contractor where required, together with associated civil work such as excavation/chasing, concreting and surfacing. The concrete cover over the conductor shall not be less than 60 mm.

6.4.5. Installation of earth conductors in outdoor areas, buried in ground, shall include excavation of earth up to 600 mm deep 450 mm wide, laying of conductors at 600 mm depth, brazing/ welding as required, of main grid conductor joints as well as risers of length 500 mm above ground at required locations and then backfilling material to be placed over buried conductor shall be free from stones and other harmful mixtures. Backfill shall be placed in layers of 150 mm, uniformly spread along the ditch, and tampered utilizing pneumatic tampers or other approved means. If the excavated soil is found unsuitable for backfilling, the Contractor shall arrange for suitable material from outside.

6.4.6. Installation of earth connection leads to equipment and risers on steel structures/ walls shall include laying the conductors, welding/ cleating at specified intervals, welding/ brazing to the main earth grids risers, bolting at equipment terminals and coating welded/ brazed joints by bituminous paint. Galvanized conductors shall be touched up with zinc rich paint where holes are drilled at site for bolting to equipment/ structure.

6.4.7. Electrodes shall be installed in constructed earth pits, and connected to main buried earth grid, The scope of work shall include excavation, construction of the earth pits including all materials required for construction of earth pits, placing the rod and fixing test links on those pipe/ rod/ plate electrodes in test pits and connecting to main earth conductors.

6.4.8. Installation of lightning conductors on the roofs of buildings shall include laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying fastening/ cleating/ welding of the down comers on the walls/ columns of the building and connection to the test links to be provided above ground level.

6.4.9. Installation of the test links shall include mounting of the same at specified height on wall/column by suitable brackets and connections of the test link to the earth electrode.

6.4.10. Whenever main earthing conductor crosses cable trenches, they shall be buried below the trench floor.

6.4.11. Suitable earth risers shall be provided above finished floor/ ground level. If the equipment is not available at time of laying of the main earth conductors, the minimum length of such riser inside the building shall be 200 mm and outdoors shall be 500 mm above ground level. The risers to be provided shall be marked in project drawings.

6.4.12. Earth leads and risers between equipment earthing terminals and the earthing grid shall follow as direct and short a path as possible.

6.4.13. An earthing mat shall be provided under each operating handle of the isolator and operating mechanism of HV breakers. Operating handle of the isolator and supporting structure shall be bonded together by a flexible connection and connected to the earthing grid.

6.4.14. A separate earth electrode bed shall be provided adjacent to structure supporting lightning arrestors. Each connection shall be as short and as straight as practicable. For arrestors

mounted near transformers, earth conductors shall be located clear off the tank and coolers.

6.4.15. Wherever earthing conductors passes through walls, galvanized iron/PVC sleeves shall be provided for the passage of earthing conductor. The pipe ends shall be sealed by the Contractor by suitable water proof compound.

6.4.16. Earthing Connections:

a) All connections in the main earth conductors buried in earth/ concrete and connection between main earthing conductor and earth leads shall be of welded type.

b) Connection between earth leads and earthing terminal provided on the equipment shall be bolted type.

c) All bimetallic connections shall be treated with suitable compound to prevent moisture ingression.

d) Metallic conduits and pipes shall be connected to the earthing system.

e) Lightning protection system down conductors shall not be connected to other earthing conductors above ground level. Also no intermediate earthing connection shall be made to lightning arrester and transformer earthing leads which shall be directly connected to pipe electrode.

6.4.17. Earth Electrodes:

a) Electrodes shall as far as practicable, be embedded below permanent moisture level.

b) Test pits with concrete covers shall be provided for periodic testing of earth resistance. Installation of pipe electrodes in test pits shall be suitable for watering. The necessary materials required for installation of test pits shall be supplied and installed by Contractor. The installation work shall also include civil work such as excavation and connection to main earth grid.

c) Earth pits shall be treated with salt and charcoal. In case found necessary, then with the approval of Purchaser's representative, Back fill compound of suitable composition may be used. Back fill material shall not be water soluble & shall retain moisture & enhance conduction around electrode. Back fill compound shall be low resistance & non corrosive earth enhancement compound which shall provide safe discharge path to fault current & lightening current.

d) Ohmic value shall be within safe limits & it shall be stable & not fluctuating.

e) Soil, salt and charcoal placed around the electrode shall be finely graded, free from stones and other harmful mixtures. Backfill shall be placed in layers of 250 mm thick uniformly spread and compacted. If excavated soil is found unsuitable for backfilling, the Contractor shall arrange for a suitable soil from outside.

6.5. INSTALLATION OF CABLE RACKS AND CABLE TRAYS:

6.5.1. General

a) Lines and grade for trays may be measured from building steel and finished floor elevations. Change in line or grade, or the addition of offsets by means of cutting

standard tray sections and inserting additional tray fittings to match with the existing arrangement shall be considered as a normal part of the work.

b) Where embedded steel inserts in concrete floors/ walls for welding the supports for cable racks/ trays are not available, Contractor shall provide suitable anchor fasteners at no extra cost.

c) Cable shall be clamped to the cable trays at every 750 mm distance.

d) Flexible metallic conduits shall be used for termination of connection to equipment such as motors, limit switches and other apparatus.

6.5.2. Cable Trays: All the cable tray shall be hot dipped galvanized with minimum galvanization thickness as per mentioned in this specifications.

a) Cable tray shall be of perforated sheet steel with formed flanges and of minimum thickness not less than 1.25 mm for trays up to 100 mm width, not less than 1.5 mm for trays from 100 mm to 150 mm width and not less than 2.0 mm for trays from 150 mm to 300 mm width.

b) All the cable trays above 300 mm width shall be of ladder type with minimum thickness of 2.5 mm.

c) Cable tray for use in areas where chlorine gas may be present shall be constructed from U-PVC or GRP. Cable tray supports shall be of a compatible finish with the associated cable tray.

d) All cable trays tees, intersection units, bends, turns and sets shall be prefabricated (made by the manufacturer) and shall be of a matching design to the main section of cable tray.

e) Tray shall only be joined by couplers supplied by the manufacturers. The joint shall be secured in accordance with the manufacturer's instructions.

f) Cable tray supports supplied by a manufacturer or made up on Site shall have adequate strength to maintain rigid support to the fully laden cable tray along its entire length and shall ensure that the deflection of any one section does not exceed 15 mm at mid span.

g) Wherever possible, cable trays shall be installed in full lengths without cutting. Should it be necessary to cut or drill a length of tray, the bared ends or damaged section of the tray shall immediately be given a coat of zinc rich cold galvanized paint. All site manufactured accessories, supports and metal fittings required to ensure correct installation of the cable trays shall be similarly treated.

h) All cables shall be firmly secured to the tray using purpose made saddles, as approved by the Purchaser's Representative, together with proprietary nylon fasteners and/or cable cleats. Following installation of cables, the tray shall remain rigidly supported and the deflection of any section shall not exceed 15 mm at mid span. All brackets and tray work shall be suitable for withstanding a temporary weigh of 125 kgs.

i) Cable trays shall not be cut to allow the passage of cables through the surfaces of the tray

j) The sizing of the cable tray shall provide a minimum of 20% spare capacity.

k) The tray shall be run at least 300 mm clear of plumbing and mechanical services.

l) Bends in the installation shall take account of the minimum bending radii of cables to be installed.

m) All the cable trays shall be supplied with cable tray supports (of adequate size) at no more than 1.2 meter interval.

n) Other cable tray details & cabling system shall be as per typical drawings attached with the specifications.

6.5.3. Cable Trunking – Metal:

a) Cable trunking shall be manufactured from mild steel of not less than 1.25 mm and shall be hot dipped galvanized. The Contractor shall ensure that the size of the trunking is adequate for the number of cables to be installed together with 50% spare capacity and shall in any case be 50 mm x 50 mm minimum size.

b) Segregation of cables shall be carried out if required using continuous sheet steel barriers with the bottom edge welded to the trunking.

c) The trunking shall have two return flanges for rigidity. Where necessary, additional strengthening straps shall be fitted internally. The cover shall overlap the trunking and be made of the same gauge. Fixing screws for covers shall be recessed and be of the self retaining `quick fix' type. All bends, tees and intersections shall be of the gusset type and shall, wherever possible, be purpose made by the manufacturer and of a matching design to the main trunking.

d) Cables shall be retained in the trunking when the cover is removed by means of straps. Internal connecting sleeves shall be fitted across joints in the trunking and earth continuity ensured by bonding each section of trunking to a continuous earth wire.

e) Non-flammable fire barriers shall be inserted where the trunking passes through walls or floors. Conduit connections to trunking shall be made by flanged couplings and male bushes.

f) Trunking shall be supported at intervals not greater than 2 meter horizontally or 2.5 meter vertically.

g) Crossings over expansion joints shall be made in flexible conduit.

h) Should it be necessary to cut or drill a section of trunking or a trunking fitting the bared ends shall immediately be given a coat of zinc rich cold galvanizing paint.

i) Cable and conduit/ trunking runs shall be determined by the Contractor and agreed by the Purchaser’s Representative before any work is started. The run shall be at least 300 mm clear of plumbing and mechanical services.

j) Conduit/ trunking systems erected outside a building shall be weatherproof.

6.6. CABLE INSTALLATION:

6.6.1. General:

a) Cable installation shall be in accordance with IS 1255: 2001- latest edition.

b) Cables shall be installed in such a way that the minimum bending radii are not reduced when installed or during installation. Cables shall not be installed in ambient temperatures below that recommended by the cable manufacturer.

c) Cables grouped together shall have insulation capable of withstanding the highest voltage present in the group.

d) Cables of different categories shall be installed so as to maintain satisfactory clearances for safety and in order to reduce the possibility of electrical interference. The following Table details the distances in mm that shall be maintained between the different categories of cable.

Table of Separation Distances in mm between different Categories of Cable

Cable Category	**HV Power**	**LV Power**	**C&I/ Protection**	**Tele-communication**
HV Power	N/A	300	600	600
LV Power	300	N/A	300	300
C&I/ Protection	600	300	N/A	200
Tele-communication	600	300	200	N/A

e) These separations are minimum and special circumstances such as the presence of high current flows, or harmonic content may necessitate larger separation distances.

f) A distance of minimum 300mm shall be maintained between the cables to be laid on trays/ conduits carrying low voltage AC and DC signals and a distance of minimum 600 mm shall be maintained between cables carrying HV and LT signals.

g) In order to make economic use of the cable support system, cables shall be arranged in groups of 50 mm maximum overall diameter. These groups shall be securely tied to the cable support system at intervals not exceeding 900 mm for horizontal runs and 300 mm intervals on vertical runs.

h) In order to make the most economic use of cable tray and duct capacity, multicore cabling shall be utilized in order to connect instrumentation groups by using suitably located sub-distribution junction boxes. The junction boxes shall be suitable for the area in which they are to be installed and for the type of circuit. They shall be readily accessible for maintenance and clearly labeled junction boxes shall be constructed of die cast Aluminium and provide degree of protection IP 65.

i) Where practical a separate cable support system shall be provided for power and non-power cables. Where this is not practical a separation as per indicated in above table shall be maintained between power and non-power cables when run on the same support system.

j) Heavy duty galvanized iron cable tray and ladder racking shall be used for cable support systems. FRP/ GRP cable support systems shall be used in areas used for the storage and handling of chlorine. These systems shall be used to route cables around walls and within cable trenches. Cables shall be securely fixed to the support systems. Bundling of cables shall be permitted where allowance for this practice has been made in sizing the cables.

6.6.2. Laying of Cables:

a) Each instrumentation and power supply cable shall be terminated to individual panel/ terminal box.

b) Identification of each cable shall be by proper ferrules at each junction as per cable schedule to be prepared by Contractor.

c) Cables shall be laid in accordance with layout drawings and cable schedule which shall be prepared by Contractor and submitted for approval.

d) All cable 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.

e) Various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables.

f) A loop of 1.0 meter shall be left near each field instrument before terminating the cable.

g) Cables shall be complete uncut lengths from one termination to the other.

h) Separate cables shall be used for digital and analog signals.

i) All cables shall be identified close to their termination point by cable numbers as per cable interconnection schedules.

j) Identification tags shall be securely fastened to the cables at both the ends.

k) Cable shall be rigidly supported on structural steel and masonry, using individually cast or malleable iron galvanized clips, multiple cable supports or cable trays.

l) The Contractor shall take the actual measurement of the cables and the associated accessories such as cable trays, conduits etc required at site, prior to the placement of order on the cables.

6.6.3. Cables Laid Direct in Ground:

a) Buried cable up to 1.1 kV shall have a laid at a minimum depth of 750 mm measured from FGL to the top of the highest cable. On crossing roadways the cable shall be run through a PVC-U duct of minimum diameter 100 mm with a minimum of 1000 mm cover and encased on all sides by 150 mm of concrete.

b) Cables of greater than 1.1kV shall be buried at a minimum depth of 1 meter.

c) The bottom of the cable trench shall be freed of sharp stones and such like and 75 mm of sieved sand laid below the cable. After cable laying 75 mm of sieved sand shall be laid above the cable. For HV cables sand bedding shall be of 150 mm & cables shall be covered with half round Hume pipes of twice the diameter of cable.

d) Interlocking cable protective covers, minimum 1 m long x 300 mm wide, marked ‘Danger-Electric Cable' in English and the vernacular shall be laid on top of the sieved sand. Covers shall extend the whole length of the cable trench and shall overlap cables by a minimum of 50 mm.

e) Warning tape shall be laid a minimum of 200 mm above the protective covers.

f) Cables are to be installed without tees or through joints unless otherwise approved by the Purchaser's Representative. Single core cables shall be run in trefoil formation.

6.6.4. Cables Laid in Underground Ducts:

a) Underground ducts shall be constructed of impact resistant PVC-U and laid at a minimum depth of 750 mm, ducts shall be surrounded by at least 75 mm of sieved sand except at road crossings where it shall be 1.0 meter deep and encased on all sides by 150 mm of concrete.

b) The Contractor shall ensure that sufficient draw-in points have been provided and that adequate room has been allowed for installation of cables. Drawstrings shall be provided in all ducts to enable additional cables to be installed when required.

c) Where cables pass in or out of any duct entries into or within buildings such entries, together with any spare ducts shall be sealed against the ingress of moisture by means of duct stoppers and bituminous compounds or by any other method approved by the Purchaser's Representative. The stopper shall have a fire resistance of at least 30 minutes. Single core cables in trefoil formation shall pass through the same duct and shall not be separated. However, for two different trefoil formations, they shall be laid in separate ducts.

6.6.5. Cables installed in Conduit:

a) Conduits shall be galvanized heavy gauge solid drawn or welded screwed steel type and be in accordance with IS 9537, Part 2 or BS 4568. Accessories shall either be malleable cast iron screwed type or pressed steel and galvanized.

b) A space factor of 40% shall not be exceeded, but in any case conduit of less than 20 mm diameter shall not be permitted. The tubing shall be perfectly smooth inside and out and free from flaws and imperfections of any kind. Both ends of every length of tubing shall be properly reamed with all sharp edges removed before erection.

c) Where a number of conduits converge, malleable cast iron or heavy gauge sheet steel adaptable boxes shall be employed in order to avoid crossings. Conduits shall be connected by means of male brass bushes and couplings.

d) Where conduits are greater than 25 mm, straight through joint boxes shall be of the trough type. Where conduit and/ or fittings are attached to equipment casings, the material or case of the casing shall be tapped for a depth of not less than 10 mm or male bushes and flanged couplings shall be used.

e) Heavy hexagonal lock nuts shall be used at all positions where running joints are required and care shall be taken to ensure that they seat firmly and evenly on to the mating faces of coupling or other adjacent accessories. All junction boxes, draw-in boxes, and inspection fittings, shall be so placed that the cables can be inspected and, if necessary, withdrawn and re-wired throughout the life of the installation.

f) Generally not more than two bends or offsets or one coupling will be permitted without a suitable inspection accessory. Fish wires shall not be left in conduits after erection. The whole of the installation shall be arranged for a loop-in type of system with joints being carried out at switches, isolators, etc. Intermediate joints in the cable will only be allowed by arrangement with the Purchaser/ Purchaser's Representative.

g) Ends of conduits which are liable to be left open for any length of time during building operations shall be plugged to prevent the ingress of dirt, cement, etc. and covers, either temporary or permanent, shall be fitted on all boxes.

h) Generally, conduits shall not cross expansion joints of buildings, but where they cannot be installed in any other manner then a flexible conduit shall be used across the expansion joint. A total 150 mm movement shall be allowed.

6.6.6. Surface Installation:

a) Surface conduits shall be secured and fixed by means of distance spacing saddles or approved purpose made clips at every 500mm, which allow the conduits to be taken directly into accessories without sets or bends. Conduits shall be run in a square and symmetrical manner. An efficient means shall be adopted to provide for the drainage of condensation and the runs shall be properly ventilated. All surface conduit runs shall be marked out for approval by the Purchaser's Representative before the installation is carried out. Where large multiple parallel conduit runs would occur, use may be made of galvanized cable trunking. Conduits installed on structural steelwork shall be secured at spacing not exceeding those for surface conduit by girder clips, otherwise fixing shall be as for surface conduits on walls, drilled and tapped to the metalwork. Power driven fixings shall only be used with the express permission of the Purchaser's Representative. Any drilling or access which is required through any structural member of the building shall be agreed with the Purchaser/ Engineer in Charge before carrying out the work.

b) Exposed threads and places where galvanizing has been damaged shall be cleaned and then painted with two coats of an approved metallic zinc based paint. This treatment shall be applied as the work proceeds.

6.6.7. Concealed Installation:

a) Concealed conduits shall be securely fixed to prevent movement before laying of screeds, floating of plaster, casting of columns or other building operations necessary after the conduit installation. Crumpets or similar fixings shall be used for attaching the conduit to blockwork, etc. Building nails will not be accepted.

b) At least 15 mm cover shall be allowed for finishes over the conduit. Where this cover cannot be maintained then expanded metal shall be fitted with the conduit. Conduit cast into reinforced concrete floors shall be fixed to the steel reinforcing with binding wire and the conduit boxes filled with expanded polystyrene or enclosed in a plastic bag to prevent the ingress of concrete when poured. Where possible, the conduit boxes shall be fixed to shuttering to give a flush finish.

c) Conduit installed in voids, false ceilings, and other concealed routes shall be installed as specified for the surface conduits. Wiring shall be carried out after the false ceiling or permanent ducts have been completed. Conduit installed in floors shall be sealed against ingress of moisture.

d) The conduit installation shall be inspected by the Purchaser's Representative before the building operation conceals the work.

6.6.8. Cable Installed in Flexible Conduit:

a) Flexible conduit shall be of the waterproof galvanized type or PVC wire-wound type with cadmium plated mild steel couplings. Lengths of flexible conduits shall be sufficient to

permit withdrawal, adjustment or movement of the equipment to which it is attached and shall have a minimum length of 300 mm. Flexible conduit shall not be used as a means of providing earth continuity. A single earth conductor of adequate size shall be installed external to the conduit complete with earth terminations.

b) Where conversion from rigid conduit to flexible metallic conduit is to be made, the rigid conduit shall terminate in a through type box and the flexible conduit shall extend from this box to the equipment, the earth continuity cable shall be secured to the box and to the piece of equipment by properly designed earthing screws. The use of lid facing screws, etc., will not be permitted. Adapters shall incorporate a grub screw or a gland to prevent the flexible conduit becoming loose.

6.6.9. Cable Clipped Direct:

a) All cable hangers, clips, cleats and saddles shall be of an approved type and appropriate to the type and size of cable installed. Their spacing shall be such as to ensure a neat appearance and prevent sagging of the cables at all times during their installed life.

6.6.10. Cable Installed in Internal Floor Trench:

a) In shallow trenches (maximum depth 500 mm)

b) In shallow trenches used for electrical services only, cables may be laid in a neat and orderly manner on the floor of the trench. One layer only shall be allowed. Additional cables shall be installed on the walls of the trench in an acceptable manner & such a way that, in no case the distance between two different types of cable shall not be less than the separation distance tabulated above.

c) Where the trench is shared by other services, cables shall be installed on the walls of the trench in an acceptable manner & such a way that, minimum separation distance of 300mm shall be maintained.

d) All other trenches including walk through service ducts

e) Cable trenches & cable installation shall be in accordance with the attached typical cabling system drawings.

f) Where other services are present the cables shall be segregated from them by separation distances as mentioned above and wherever possible kept above `cold' wet services. Cables should not be run if at all possible above or in close proximity to `hot' services.

g) The cabling shall be installed in such a manner as to allow access to the other services for normal maintenance without disturbance of the electrical installation

6.6.11. Cable Terminations and Joints:

a) Power Cable Terminations

i. Power cables shall be terminated in suitable boxes arranged for bolting to switchgear, motor starters and motors.

ii. Cores shall have either crimped lugs or sleeves to match either post terminals or bolted clamp terminals.

iii. Each cable entry into a terminating box shall be made through a suitable gland, which shall have provision for securing the armour where applicable. Where single core glands are required these shall be of the non-magnetic type and the associated box bottom plate, where the core passes through, shall not have a continuous magnetic path.

iv. Adequate provision shall be made to bond the cable armouring to the box and/or switchgear casing of a suitable size to withstand the prospective short circuit fault current of the system, glands shall be fitted with earth bonding tags where intimate screwed contact between gland and cable box is not possible.

v. Where cable glands are exposed to the weather these shall be protected by heat shrink plastic sleeve or purpose moulded sleeves covering the gland continuously from overall sheath to the gland neck.

vi. Where terminations of multicore type have to be made on to items of Plant which have to be dismantled for maintenance, these shall be made off through glands into an adaptable box containing terminals and flexible single cores taken into the equipment via flexible waterproof plastic covered conduit, and a separate earth core linking the box to the equipment.

vii. Where single core cables are glanded to or pass through cabling plates the gland plate or cabling plate shall be constructed of non-magnetic material.

b) Power Cable Joints:

i. Through joints shall only be allowed with the approval of the Purchaser's Representative. Where such joints are necessary in thermoplastic and elastomeric cables, the cables shall be jointed with epoxy or acrylic resin cold setting compound, which has been premeasured and pre-packed ready for use. The boxes shall preferably be of split, moulded plastic type with filling vents for compound. Bonding straps shall be fitted with armour clamps across the joint and inspected by the Purchaser/ Purchaser's Representative prior to filling the box with compound. Wrapped pressure type joints will not be accepted.

c) Multi-core or Control Cable Terminations:

i. A sufficient number of terminals shall be provided to terminate all cable cores. For control and auxiliary wiring an additional 20% of this number shall be provided as spares.

ii. Not more than one core of internal or external wiring shall be connected on any one terminal. Where duplication of terminal blocks is necessary, purpose-made solid links shall be incorporated in the design of the terminal blocks.

iii. Terminals which remain energized when the main equipment is isolated shall be suitably screened and labeled.

iv. Terminal blocks for different voltages or circuit type shall be segregated into groups and distinctively labeled.

6.6.12. Cable Fixings:

a) Ties and strapping shall be suitable for securing cable and cable groups to cable tray or ladder. They shall be resistant to chemical and marine corrosion. Plastic coated metal

ties used in order to obtain corrosion resistance shall not be acceptable. Nylon ties shall be resistant to the effects of ultra-violet light and shall be self-extinguishing.

b) Large single cables shall be secured with cable clamps or cable cleats.

6.6.13. Cable Identification:

At each end of each cable, in a uniform and visible position a label shall be fixed on the cable in accordance with the cable schedule. Labels shall be made of PVC and shall be indelibly marked to the approval of the Purchaser's Representative. The label shall be retained using proprietary nylon strips passing through two fixing holes at either end of the label. If the cable gland is not normally visible, then the label shall be fixed inside the panel by means of screws.

6.6.14. Marking Locations of Underground Cables:

a) The location of all underground cables shall be engraved on brass or other non-corrodible plates to be fixed to the exterior surface of all walls of buildings 300 mm above ground level and directly above the point where cables pass through the wall.

b) Cable route markers as per the attached drawing shall be installed at an interval not more than 30 meter & at bending/ road crossings the interval shall be at every 10 meter.

c) The minimum depth for laying of underground cable route markers shall be as per indicated in the typical drawings attached with this tender.

6.6.15. Additional Requirements for Cable Installations:

a) The Contractor shall install, test and commission the cables specified in the specification. Cables shall be laid directly buried in earth, on cable racks, in built up trenches, on cable trays and supports, in conduits and ducts or bare on walls, ceiling etc. as per drawings, which are to be prepared by Contractor & approved by Purchaser's representative. Contractor's scope of work includes unloading, laying, fixing, jointing, bending, and termination of the cables & all related accessories. The Contractor shall also supply the necessary materials and equipment required for jointing and termination or the cables.

b) All apparatus, connections and cable work shall be designed and arranged to minimize risk of fire and any damage which might be caused in the event of fire. Wherever cables pass through floor or wall openings or other partitions, suitable bushes of an approved type shall be supplied and put into position by the Contractor.

c) Standard cable grips and reels shall be utilized for cable pulling. If unduly difficult pulling occurs, the Contractor shall check the pull required and suspend pulling until further procedure has been approved by the Engineer's Representative. The maximum pull tension shall not exceed the recommended value for the cable measured by the tension dynamometer. In general, any lubricant that does not injure the overall covering and does not set up undesirable conditions of electrostatic stress or electrostatic charge may be used to assist in the pulling of insulated cables in conduits and ducts.

d) After pulling the cable, the Contractor shall record cable identification with date pulled neatly with waterproof ink in linen tags. Identification tags shall be attached securely to each end of each cable with non-corrosive wire. The said wire must be non-ferrous material on single conductor power cable. Tags shall further be attached at 10 meter intervals on long runs of cables on cable trays and in pull boxes. Cable and joint markers and RCC warning covers shall be provided wherever required.

e) Sharp bending and kinking of cables shall be avoided. The bending radius for various types of cables shall not be less than those specified below:

i. 11 kV, XLPE insulated, multicore armoured cables : 15 times the overall dia of the cable

ii. 1.1 kV, XLPE insulated, multicore armoured cables : 12 times the overall dia of the cable

iii. (If shorter radius appears necessary, no bend shall be made until clearance and instructions have been received from the Purchaser/ Engineer in charge)

f) Power, control and instrumentation cables shall be laid in separate cable racks/ trays.

g) Where groups of HV, LV and control cables are to be laid along the same route, suitable barriers to segregate them physically shall be provided.

h) Where cables cross roads and water, oil, gas or sewage pipes, the cables shall be laid in reinforced spun concrete or steel pipes. For road crossings the pipe for the cables shall be buried at no less than one meter depth.

i) Cables laid in ground shall be laid on a 75 mm riddled earth bed. The cables shall then be covered on top and at their sides with riddled earth of depth of about 150 mm. This is then gently filled up to a depth of about 100 mm above the top of uppermost cable to provide bedding for the protective cable covers which are placed centrally over the cables. The protective cable covers for LV cables may be of earthenware and for HV cables of reinforced concrete. The RCC covers shall have one hole at each end, to tie them to each other with GI wires to prevent displacement. The trench is then backfilled with the excavated soil and well rammed in successive layer of not more than 300 mm in depth, with the trenches being watered to improve consolidation wherever necessary. To allow for subsidence, it is advisable to allow a crown of earth not less than 75 mm in the centre and tapering towards the sides of the trench.

j) In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, should the cable develop a fault at a later date.

k) Cables on cable racks, on cable trays and conduits shall be formed to avoid bearing against edges of trays, racks, conduits or their supports upon entering or leaving trays, racks or conduits. Cables shall be racked or laid directory into cantilevered cable trays where practicable, but in some cases it may be necessary that cables are pulled or threaded into trays. To facilitate visual tracing, cables in trays shall be laid only in single layers and unnecessary crossing of cables shall be avoided. Cables on trays shall finally be clamped in an approved manner.

l) Cable splices will not be permitted except where permitted by the Purchaser/ Purchaser's Representative. Splices shall be made by Contractor for each type of wire or cable in accordance with the instructions issued by cable manufacturer's and the Engineer's Representative. Before splicing, insulated cables shall have conductor insulation stepped and bound or penciled for recommended distance back from splices to provide a long leakage path. After splicing, insulation equal to that on the spliced conductors shall be applied at each splice.

m) Jointing of cables shall be in accordance with relevant Indian Standards Codes of Practice. Materials and tools required for cable jointing work, including cold setting bituminous compound shall be supplied by the Contractor. Cables shall be firmly

clamped on either side of a straight through joint at a distance of not more than 300 mm away from the joints. Identification tags shall be provided at each joint at all cable terminations.

n) At cable terminal points where the conductor and cable insulation will be terminated, terminations shall be made in a neat, workmanlike and approved manner by men specialized in this class of work.

o) Control cable termination shall be made in accordance with wiring diagrams, using colour codes established by the Purchaser's Representative for the various control circuit, by code marked wiring diagram.

p) When control cables are to be fanned out and cabled together with cord, the Contractor shall make connections to terminal blocks, and test the equipment for proper operation before cables are corded together. If there is any question as to the proper connection, the Contractor shall make a temporary connection with sufficient length of cable so that the cable can be switched to another terminal without splicing. After correct connections are established through operating the equipment, cables shall be cut to their correct lengths, connected to terminals in the specified manner, and corded together where necessary to hold them in place in a workmanlike manner.

q) Cable seals shall be examined to ascertain if they are intact and that cable ends are not damaged. If the seals are found to be broken the cable ends shall not be jointed until after due examination and testing by the Purchaser/ Purchaser's Representative. Before jointing is commenced, insulation resistance of both sections of cables to be jointed shall be checked by megger.

r) After installation and alignment of motors, the Contractor shall complete the conduit installation, including a section of flexible conduit between motor terminal box and trench/ tray. The Contractor shall install and connect the power, control and heater supply cables as per equipment manufacturer's drawings.

s) Metal sheath and armour of the cable shall be bonded to the earthing system of the station. The size of conductor for bonding shall be appropriate with the system fault current.

6.7. LIGHTING SYSTEM INSTALLATION:

6.7.1. This covers the requirements of installation of the following:

a) Lighting fixtures complete with lamps and accessories

b) Main Lighting distribution board

c) Lighting panels

d) Receptacles and lighting control switches

e) Point wiring

f) Street lighting poles and flood light towers

g) Multi core cables for street and boundary lighting

h) Maintaining equipment/ materials during storage and being responsible for the equipment/ material until they are handed over to Purchaser.

i) Installation, testing and commissioning shall be carried out in accordance with the drawings and as stipulated in this specification.

6.7.2. Applicable Standards for lighting system installation

Electrical wiring installations	:	IS: 732
(System voltage exceeding 650 V)		
Code for practice for interior illumination (Part-1)	:	IS: 3646/ BS: 8206
Code of practice for street lighting installation	:	IS: 1944
Code of practice for industrial lighting	:	IS: 6666
Code of practice for fire safety of building	:	IS: 1646
Boxes for enclosure of electrical accessories	:	IS: 5133(Part-1)
Guide for safety procedures and practices in	:	IS: 5216
electrical work		
Ceiling roses	:	IS: 371

6.7.3. Lighting Fixtures:

a) The installation of lighting fixtures shall be based on the mounting arrangement shown in the drawings. The rates quoted for installation shall include all materials required to mount the fixtures. Hooks in RC slabs for suspension of high bay fixtures shall be provided wherever not already provided. Cost of supply and installation of such hooks shall be included in the cost of installation of lighting fixtures. Rate for installation of lighting fixtures shall include cost of installation of control gear box wherever applicable.

b) Installation of receptacles and switches shall be carried out suitably. Switch shall be mounted in flush with the front cover plate. Cost of supply and installation of necessary hardware shall be included in the lump sum rates quoted for installation of receptacles/ switches.

c) Lighting distribution boards shall be installed at the suitable location. Installation shall include supply and installation of base channels, foundation bolts, etc.

d) Outdoor lighting distribution boards shall be installed on a concrete plinth. The top of plinth shall be 1000 mm (min.) above the grade level. Cost of construction of concrete plinth shall be included in Contractor's scope. No cement and steel will be supplied by Purchaser. Installation cost of lighting distribution board shall include cost of installation of earthing conductor from LDB to the nearest earthing grid.

6.7.4. Point Wiring:

a) Contractor has to prepare the detailed conduit layout drawing showing primary & secondary point wiring points. Point wiring also covers the wiring of the associated control switches of lighting fixtures/control switches of receptacle units.

i. Primary Point Wiring:

Primary point wiring covers the wiring between a circuit of the lighting panel to the junction box of the first lighting fixture/receptacle unit and between junction boxes of the subsequent lighting fixture connected to that circuit of the lighting panel. In some cases where there are junction boxes, the primary point covers the wiring between junction box and the first lighting fixture/receptacle unit in that circuit.

ii. Secondary Point Wiring:

Secondary point wiring covers the wiring of the remaining lighting fixtures/receptacle unit other than that covered under primary point of that circuit in the lighting panel. Secondary point wiring also covers the wiring of the associated control switches of lighting fixtures/control switches and control switches of receptacle units.

b) Supply and Installation of Conduit Point Wiring:

i. The point wiring shall include supply of necessary materials for the conduit wiring such as galvanized rigid steel conduit, galvanized M.S. fixing saddles with spacer plates, nylon/fiber fixing plugs, galvanized M.S. fixing screws, 12 SWG galvanized steel earthing wire, FRLS PVC insulated Copper conductor wires, control switches and pulling, termination of the earthing/ FRLS PVC insulated wires as required, installation of control switches, drilling holes in brick walls/ RCC roof slabs for taking the wiring conduits and refinishing and any other works/material necessary for making point wiring complete in all respects.

ii. Wires used for conduit point wiring of lighting fixtures/ceiling fans, 5A receptacles and receptacles above 15A shall be 1.1 kV grade, FRLS PVC insulated, single core, multi stranded Copper conductor wires of sizes not less than 1.5 sq. mm and 2.5 sq. mm respectively. Wires shall conform to IS: 694 and shall bear the ISI mark.

iii. Contractor shall take into consideration necessary galvanized MS fixing clamps when the wiring conduits are to be supported from steel roof truss/structural members.

c) Supply & Installation of cabling for Street and Flood Lighting:

i. Work includes supply and installation of cables required between LDB and junction box mounted on street lighting pole/flood lighting tower and also between junction box mounted on flood light tower to metal enclosed control gear box located near flood light fixture, supply and installation of all the termination accessories such as crimping type cable lugs and double compression cable glands at each junction box and fixture, termination, testing and commissioning of cables. Contractor's scope of work also includes excavation, preparation of riddled soil bedding, supply and installation of protective covers over the cable, backfilling, ramming, supply and installation of route markers, supply and installation of HDPE / Hume pipes for road crossing, etc, supply and installation of necessary cleating arrangement for cabling on flood light tower, supply of labour, supervision, welding equipment, all tools and tackles and testing equipment as required.

ii. Contractor shall plan and cut the cables in such a way that there is no wastage and no cable jointing is required in any run. However, should any joint become necessary the same shall be provided by the Contractor and a joint marker shall

also be provided at no extra cost. Earthing of street light pole/flood light tower, lighting fixtures, etc. are included under Contractor scope.

d) Point wiring shall also include/ hold good for the following:

i. Supply and installation of lighting control switches and switchboxes complete with fixing accessories.

ii. Drilling holes in brick/ RCC wall and roof for taking cable or conduit, sealing and refinishing with cement plaster.

iii. Testing, commissioning and handing over the lighting system in commercial working condition.

iv. Marginal shifting of any fixture/accessory from the location indicated in the lighting layout drawings.

6.7.5. Outdoor Lighting (Street and Flood Lighting): The following shall be deemed to be included as part of the installation work for outdoor lighting point wiring.

a) Installation of multicore/ single core cables between LDB and junction box mounted on street light pole/flood lighting tower, from junction box to metal enclosed control gear box.

b) Supply and installation of crimping type cable lugs, double compression type cable glands at each junction box and fixture, termination, testing and commissioning of cables.

c) Contractor's scope shall also include excavation and preparation for buried cables. Supply and installation of route markers, supply and installation of HDPE/ Hume pipes for road crossing shall also be included in the scope of installation of point wiring.

d) Supply and installation of necessary cleating arrangement for cabling on flood light poles.

e) Contractor shall provide necessary foundation for erecting street light pole/ flood light tower and install the same. Contractor shall prepare foundation drawings with necessary details & Purchaser Representative's approval shall be obtained.

f) Contractor shall plan and cut the cables in such a way that there is no wastage and no cable jointing is required in any run. However, should any joint become necessary, the same shall be provided by the Contractor and joint marker shall also be provided at no extra cost.

g) Earthing of street light pole/flood light tower, lighting fixtures, control gear boxes, junction boxes, etc. are also included in the scope of installation of point wiring. Contractor shall earth street light pole/flood light poles and junction box with 25x3 mm G.S. flat tap off from the 25x3 mm M.S. flat earthing grid along the street lighting included in scope. The Contractor shall interconnect earthing grid to plant main earthing grid at first and last pole of each feeder circuit and at one intermediate pole.

h) Installation of lighting Poles and Towers for Outdoor Lighting (Street and Flood Lighting)

i. Work includes supply and installation of street light poles and flood light towers including associated junction boxes with fuses, links and terminals for junction

boxes and junction boxes near each flood light fixtures.

ii. All street light poles and towers shall be painted with one shop coat of red oxide oil primer followed by two coats of aluminium alkyd paint.

6.7.6. Installation of Lighting Distribution Board, Lighting Panels (AC & DC), 230 V, AC 1- Ph Distribution Boards.

Installation of above items shall include necessary foundation channels, bolts/ nuts, etc. for grouting lighting distribution boards, iron brackets/ grouting brackets, bolts/nuts for wall/ column mounted panels and associated civil works.

6.7.7. Details of work requirements are covered in lighting installation notes and details and typical drawings which form the part of specification. Any changes, if necessary due to site conditions/requirements shall be carried out after obtaining approval of Purchaser/ Purchaser's Representative. The changes carried out shall be marked clearly in the layout drawings by Contractor and 'AS BUILT DRAWING' shall be prepared by the 'Contractor' and this shall be forwarded to Purchaser's site / design office.

a) Wiring:

i. Wiring shall be carried out strictly as per project drawings and technical specification. All exposed conduit wiring shall have provision for easy inspection. Where cable wiring is specified cable shall be cleated on to the wall as close to the ceiling as possible. In all types of wiring due consideration shall be given for neatness and appearance.

ii. Wherever DC emergency lighting is provided, emergency lighting wires shall run in a separate conduit. Colour of the wires used shall be as follows; white for positive, black for negative.

iii. Wherever lighting system has three phase distribution, separate conduits shall be used for different phases. For easy identification of phases and neutral wires the following colour wires shall be used.

R - Phase	-	Red
Y - Phase	-	Yellow
B - Phase	-	Blue
N – Neutral	-	Black

b) There shall be a circuit breaker on each live conductor of supply mains at the point of entry.

c) Conductors not arranged for connection to the same system or supply different phases of the same supply, shall be kept apart throughout their entire run.

d) Receptacles and lighting fittings in general shall be fed from different Circuits. Five amps receptacles for toilet or small rooms can be fed from the lighting circuit with proper isolating arrangement.

e) Each final sub-circuit from a lighting panel shall be controlled by a single pole switch connected to the live conductor.

f) For long conduit wiring runs, inspection/ pull boxes shall be provided at intervals not exceeding 10 meter. Such facilities shall also be provided at conduit bends.

6.7.8. General Practices for lighting:

a) All receptacles and switches to be installed in offices and control rooms shall be flush mounted within the wall and those in other areas shall be wall or column mounted.

b) Ceiling roses shall not embody fuse terminals as an integral part. For voltages exceeding 250 volts, a ceiling rose or any similar attachment shall not be used.

c) All exposed metal parts of the plug, when the plug is in complete engagement with the socket outlet, shall be in effective electrical connection with the earthing pin.

6.7.9. Earthing for lighting:

Conduits and fittings shall be earthed by 12 SWG GI wires run along the length of the conduit and secured by means of suitable clamps efficiently fastened to conduit tip. To achieve perfect electrical continuity, the conduits shall be bonded effectively on either end of a coupling and other joints.

a) Conduits shall be earthed at the ends adjacent to switch boards at which they originate or otherwise at the earth clip, clamp or gland, in effective electrical contact with the conduit.

b) For outdoor lighting poles & mast 8 SWG GI earth wire shall be run buried in ground at a depth of 600 mm along-with lighting cables and shall be terminated up to the junction box on the pole and 12 SWG wire shall be taken up to the pole fitting. In case of lighting poles where the main earth grid is far away from the pole, local pits shall be provided for pole earthing.

7. PRE COMMISSONING TESTS ON ELECTRICAL EQUIPMENT/ SYSTEMS TO BE CARRIED OUT AFTER INSTALLATION:

7.1. GENERAL:

Pre-commissioning tests in addition to mentioned in the specification requirements for various equipments but not limited to following shall be carried out by Contractor in presence of Purchaser/ Purchaser's representative. Commissioning shall be carried out only after obtaining satisfactory results, acceptable to Purchaser/ Purchaser's representative.

7.2. ELECTRICAL EQUIPMENT:

7.2.1. 11 KV Equipment (Lightning Arrestors, AB Switch/ Isolators & Insulators etc):

a) Visual checks for cracks in insulators.

b) Earth secured continuity check

c) IR Test with 5KV Megger

7.2.2. Power/ Distribution Transformer:

a) Insulation resistance test HV side, LV side and HV - LV.

b) Magnetizing current test.

c) Winding resistance test.

d) Voltage Ratio & Tap continuity test at all tap.

e) Vector group test.

f) Magnetic Balance Test.

g) Buchholz Relay Test (if any)

h) Neutral CT Test (if any)

i) Winding Temperature Indicator/ Oil Temperature Indicator Test

j) Polarization Index Test (For LV windings 3.3 KV and above)

k) Local/ Remote operations of OLTC (if any)

l) Operational tests of RTCC panel (if any) as per schematic drawing.

m) No load test and performance observations

7.2.3. HV Metal Enclosed Switchgear:

a) IR values of power and control circuits

b) Local/ Remote operations in test as well as service position including all electrical interlocks

c) Control circuit and operational tests as per schematic drawing.

d) Tripping through relays and trip circuit health.

e) Anti pumping device operation

f) Protection system operation stability and sensitivity by primary injection testing method including testing of metering circuits

g) HV Test on switchboard

h) Panel indication, annunciation, space heater circuits

i) Spare contact for customer use

j) Termination correctness & proper installation.

7.2.4. LT Metal Enclosed Switchgears:

a) IR Values of power & control circuits.

b) Mechanical charging - closing - tripping of breaker.

c) Electrical charging - closing - tripping of breaker.

d) Trip circuit healthiness and tripping through relays.

e) Remote closing/ Tripping/ Interlocks circuits

f) Indication/ Annunciation/ Panel space heater circuit/ Spare contacts for customer use

g) Secondary injection testing of protective relays/ releases.

h) CT testing for polarity, ratio, IR values and magnetization for class PS characteristics

i) PT testing for ratio, IR values.

j) IR Values of breaker.

k) Testing of modules for DOL/ Star-Delta/ ATS/ Soft Starter starting or any other starting method as per the schematic drawings applicable.

7.2.5. Power and Control Cables:

a) IR Values before Hi-pot

b) Hi-pot Test - Measurement of leakage current

c) IR Values after Hi-pot

7.2.6. Induction Motors:

a) IR Values

b) Polarization Index Test

c) Interlocks and simulation tests local / remote operations

d) No load test

7.2.7. Control Panels for Miscellaneous Equipment:

a) IR Values of all power circuits

b) Operational test and scheme - wiring testing as per control schematics

7.2.8. Lighting System:

a) Visual inspection for operating problems

b) System activation -burning in the lamps for 100 Hrs

c) Measuring light level & reflectance.

7.2.9. Earthing System:

a) Earthing resistance of each electrode.

b) Earthing resistance of grid.

Technical Specification

for

Diesel Generator

4.8. **DIESEL STANDBY GENERATOR:**

4.8.1. Applicable Standards : The Diesel Standby Generator and its components shall conform to the latest applicable standards specified below:

Diesel Engines for General Purposes	:	BS 5514 / ISO 3046
The Electrical Performance of Rotating Electrical Machinery	:	BS 5000
Rotating Electrical Machines	:	IS 4722
Circuit breakers	:	IS-13118, BS-5311, IEC-56 & 694, BSEN-60942 (P-2)
Air break switches air break disconnectors, air break switch disconnectors and fuse combination units for voltage not exceeding 1000 V AC or 1200 V DC	:	IS-13947 (P-3), BS-EN60947, IEC-60947-3
Current transformer	:	IS-2705/BS-7626, IEC-60185
Voltage transformer	:	IS-3156/BS-7625/IEC 60186
Electrical Relays	:	IS-3231, 3842/BS-142/IEC-60255
Contactors for voltage not exceeding 1000 V ac or 1200 VDC	:	IS-13947 Part-IV/ BSEN-60947-4-1/ IEC-60947-4-1
Control Switches	:	IS-6875/BSEN-60947 / IEC-60947-4-1
High Voltage Fuse		IS-9385/BS-2692/ IEC-60282
Low Voltage Fuse	:	IS-13703/BS-1362 IEC-269-1
Electrical direct acting indicating instruments	:	IS-1248/BS-89/IEC-6005
A.C. electricity metres of induction type voltage greater than1000 volts	:	IS722, 8530/BS-5685 / IEC-60145, 60211
Resistance wire, tapes and stripes for heating elements	:	IS-3725

Wrought aluminium and aluminium alloy bars, rods, tubes and sections for electrical purposes	:	IS-5082
Specification for copper rods and bars for electrical purposes	:	IS-613
Toggle switches	:	IS-3452/BS-3676
Control switches/push buttons	:	IS-6875/BSEN 60947
Noise and Emission Limit	:	As per latest notification of ministry of Environment and Forests

4.8.2. General Requirements:

The diesel engine and generator shall be skid mounted and shall be located in a room near Treatment plant substation building. The diesel engine shall draw cooling air directly from outside the room through a weatherproof, acoustically treated duct. The exhaust system shall be insulated to minimize the amount of heat entering the room and to prevent injury to personnel. The silencer shall be of the 'residential' type and be located externally.

The generation voltage shall be 415V for DG capacity less than 2MVA and generation voltage shall be 11kV for D.G capacity more than 2MVA. In case more than one D.G set is required for achieving the required capacity they shall be operated in parallel with necessary synchronizing arrangement. At no point DG sets will be operating parallel with grid.

The diesel engine fuel shall be stored in an above ground bulk storage steel tank to be located adjacent to the generator room at a site accessible for filling to local road tankers. The storage tank shall be sized to store fuel for one (1) day running of the engine at full load. The tank shall be provided with fittings to permit the visual observation of fuel level and filling by local tanker operators. A level meter shall also be mounted in the tank so that remaining fuel volume can be monitored at the generator / substation PLC and the operator stations in the SCADA room.

The fuel storage tank shall be located in a bund capable of holding not less than 125 % of the maximum storage tank contents. Fuel transfer pumps shall be provided to automatically transfer fuel from the bulk storage tank to a high level 990 litres day tank located in the generator room or generator skid mounted day fuel tank. A semi-rotary hand pump shall be provided to permit transfer of fuel in the event of a failure of the transfer pump. Any leakage from the pumps shall be routed to the bund.

A system shall be provided within the generator room to detect fire, to raise a local audible alarm (manually silenced locally) and if a high level day tank is used, to automatically dump the day fuel back to the bulk storage tank.

The system shall be constructed such that leakage of water, fuel or oil within the generator room shall be routed to a local sump where a detector shall be provided to raise an alarm.

The system shall be constructed such that the leakage of fuel or the accumulation of water within the fuel storage bund shall be detected and shall raise an alarm.

All alarms shall be conveyed to the central HMI through the PLC.

4.8.3. Diesel Generating Set Automatic Control

AMF Diesel Generator Set capable of automatic starting and picking the load within 30 seconds shall be provided to cater for emergency loads and lighting during mains power failure. Diesel generating set for use in auto mains failure mode shall have a three position automatic / off / manual selection and shall operate as follows:

(i) Automatic mode :
On occurrence of mains failure the following sequence shall be followed.
Mains to Generator changeover
- mains failure detected
- delay of 10 seconds
- generator is started and run up to speed
- time delay of 50 seconds
- mains supply is switched off
- generator supply is switched on

Generator to Mains changeover
- mains healthy detected
- manual changeover signal received,
- generator supply is switched off
- mains supply is switched on
- generator runs for 2 minutes and stops

All timer settings shall be adjustable.

If mains power is restored during the initial one minute delay then the power shall be monitored for a further one minute and if it is still healthy, mains power shall be restored. The generator shall be stopped after a further 2 minutes of running on no load. If the generator fails to start after an initial period of cranking, two further attempts shall be made with an appropriate interval between each attempt. If the engine fails to start after three attempts the system shall shut down and a local and remote alarm shall be annunciated.

(ii) Manual mode:

The generator shall run to the dictates of manual controls on the generator. No automatic changeover of mains to generator supply or vice versa shall take place. The generator shall be loaded by manual switching if required.

4.8.4. Alternator for Diesel Generating Set:

The generation voltage shall be 415V for capacity less than 2MVA and generation voltage shall be 11kV for capacity more than 2MVA.

Alternator shall be 4 pole, 3 phase ,50 Hz, 0.8 P.F, salient pole, revolving field, brushless type, self-regulating continuously rated and manufactured in accordance with IS 4722, BS 5000 : Part 99 or IEC 60034-1. They shall be totally enclosed, screen protected, fan ventilated and vertical drip-proof conforming to IP 23.The Alternator shall be complete with excitation system, AVR and all necessary auxiliaries. The alternator shall be driven by diesel engine detailed below and shall match the same in all respects. The terminal box shall be dustproof with IP 54 degree of protection. The terminal box shall be suitably sized to terminate the size and number of cables involved. Alternators shall be capable of withstanding a 10% overload for 1 hour in any 12 hour Period under the specified conditions of temperature, humidity and atmospheric pressure.

Alternator windings shall be of Class H insulation with Class F temperature rise and

tropicalised. The alternator shall have pre-packed grease lubricated ball or roller bearings and provided with facilities for regreasing whilst in service.

The alternator shall be foot mounted on a common bed frame with the prime mover close coupled to the engine flywheel housing. The direction of alternator rotation when viewed from the driven end shall be clockwise and phase voltage sequence UVW. The alternator vibration level shall not exceed the values defined in IS 12075.

The alternator shall be capable of maintaining a short circuit current of three times full load current for a period of 10 seconds. The alternator shall be fitted with an anti-condensation heater. No individual harmonic shall exceed 1% and the total harmonic shall not exceed 3%. The alternator, its neutral and control panel shall be earthed as per relevant standards.

The alternator rotor assembly shall comprise exciter rotor, full wave silicon bridge rectifier surge protection device and salient pole rotating field system. The rotor shall be fitted with interconnected pole face damping windings. Voltage regulation shall be maintained to within ±2.5% for a power factor of 0.8 to unity, including hot to cold variations. The steady state frequency droop between no load and full load shall not exceed 5%.Transient voltage deviation following a step load of 60% of rated at a power factor of between 0.4 and zero shall not exceed 15% with a voltage recovery time to 97% rated voltage not exceeding 0.5 second. The set shall be capable of continuous operation with a phase current imbalance of 33% of rated current whilst maintaining the output voltage within ±5% of rated.

4.8.5. Diesel Engine for Generating Set:

Engine shall be four strokes, direct injection, and turbocharged industrial machines. They shall be fitted with renewable wet cylinder liners if water cooled and shall be direct coupled to the alternator and mounted on a common rigid steel bedplate.

Engines shall be rated for continuous duty at site ambient conditions with an inherent O/ L Capacity of 10% for 1 hour in any 12 hours. The engine shall be capable of running at full load for not less than 180 hours without maintenance adjustments and 10000 hours between major overhauls. The maximum operating speed shall be 1 500 rpm. The range of manual adjustment shall not be less than ±5% of rated speed. The performance of engine governors under load conditions shall be to Class A2 in accordance with BS 5514: Part 4.

Engine governors shall be suitable for remote control load sharing between identical engine units. In addition to any electrical over speed trips, there shall be a mechanical device which shall operate at 120% of the rated speed. Re-setting of the over speed trip shall be possible by hand only. The steady state output speed drop between no load and full load shall not exceed 5%. The transient output speed deviation shall not exceed 10% for a step of 60%. Engines shall be designed to run on fuel oil complying with IS 1460 or BS 2869, Class A2.Engines shall be cooled by means of a water jacket, heavy duty air blast radiator with integral radiator header tank, circulating pump and engine driven pusher type fan. The fan shall draw air in from the vicinity of the engine block and discharge it through the radiator core. The radiator shall be mounted on the same bedplate as the engine and alternator on suitable vibration isolators and be arranged so that it is located directly behind automatic louvers set into the external wall of the engine room. A thermostatically operated by-pass valve shall be fitted in the cooling system to maintain an optimum operating temperature during starting and running conditions. Drain cocks shall be provided so that all the water can be drained from the system. A separate oil cooler shall be used for cooling the engine oil. A thermostatic by- pass valve shall be incorporated. Engine lubrication shall be by a closed circuit wet sump, forced feed system supplied by an engine driven pump fitted with pressure regulating and relief valves, sump suction filter and changeover renewable micro-felt full flow line filters. A hand operated semi-rotary oil pump shall be installed to carry out initial priming or to fill or empty the sump as

required. The sump shall be fitted with an easily accessible drain point. The oil shall be of the grade recommended by the engine manufacturer. The starting system shall comprise 12 or 24 V heavy duty lead acid batteries (positioned on a floor mounted stand adjacent to the engine) connected by heavy duty flexible butyl rubber cables. Batteries shall be sized to give six consecutive starts of the engine at 0°C. An engine driven alternator and charging system shall be provided. An automatic mains energised battery charger shall be provided, with sufficient capacity to maintain the battery in a condition to fulfill the starting requirements. Barring (hand turning) equipment shall be provided so that the engine can be manually rotated for maintenance purposes. It shall be arranged so that normal starting of the engine is inhibited whilst the hand turning equipment is connected. Twin heavy duty air intake filters in accordance with IS 3169 or BS 7226 suitable for operating in dust laden atmospheres shall be fitted. The filters shall be of the paper element with pre-cleaner type. Turbocharger filters shall be fitted. Breathers shall be fitted with washable filters which are easily accessible for maintenance.

Instrumentation shall be provided to monitor speed, oil pressure, oil temperature (sets larger than 250 kVA), water temperature and battery charge current. The bedplate shall be of heavy gauge steel construction, stress relieved and free from distortion.

Machined surfaces shall be incorporated for mountings and for leveling. Anti-vibration mountings shall be fitted between the bedplate and the floor to prevent vibrations being transmitted to the building. The mountings shall be adjustable for leveling purposes and shall be designed to resist horizontal movement of the diesel set.

The fuel System shall comprise an engine driven feed pump with duplex filters, 990 litres day tank with supporting structure or generator skid mounted day fuel tank, with all interconnecting pipe work, flexible engine connection pipe etc.

4.8.6. Diesel Generator Control Panel:

The control panel shall be separately mounted on anti vibration mountings and shall Comprise the following:

- Breaker incorporating short circuit and overload trip
- Earth fault protection for the Alternator
- Alternator Over & Under Voltage Protection
- Voltage Controlled Over Current Relay
- voltmeter and seven position selector switch
- ammeter and 4 Position selector switch
- frequency meter
- Power Factor Meter
- kWh Meter
- engine temperature and oil pressure gauge
- service hours run indicator
- key switch start and stop control
- operational status indicator
- anti-condensation heater and thermostat
- alternator anti-condensation heater controls
- mains fed battery charger
- Auto start on mains power supply failure facility
- Fails to Start (Alarm)
- Over / Under Voltage Alarm
- Battery Charger Fault (Alarm)

- Low fuel Oil Level (Alarm)
- Over Load (Alarm)
- Low Lube Oil Pressure (Trip)
- High Water Temperature(Trip)
- High Lube Oil Temperature (Trip)
- Electrical Protection Relays (Trip).

A reset button shall be provided to cancel the alarm /shut-down condition prior to re-starting. Simple operating instructions shall be detailed on the fascia of the control panel.

4.8.7. Synchronizing Panel

Whenever two sets are required to operate together, necessary synchronizing panel complete with circuit breaker, synchroscope, relays, meters etc shall be provided. The Panel shall be floor standing, CRCA Sheet steel enclosed.

4.8.8. Acoustic Enclosure

a) The DG Set shall be provided with acoustic enclosure, fully integrated, weather proof with superior finish for long and durable life.
b) The acoustic enclosure shall be CRCA sheet steel enclosed with necessary panels and doors, inside lining of fire retardant foam /glass wool as acoustic material.
c) The sound level shall be restricted to 75 dB at a distance of 1 meter, under full load, free field conditions as per relevant standards.
d) The acoustic enclosure shall be certified to meet the emission norms.

4.8.9. Bulk Fuel Storage Tanks

Tanks and fittings, etc shall conform to IS 803 or BS 799: Part 5. The tank shall be constructed in mild steel and the fittings in materials other than:

- Yellow brass, including low grade alloys of copper and zinc.
- Lead and zinc.
- Galvanized metals.
- Natural rubber.

An ullage volume above maximum contents level of the tank shall not be less than 5% of the maximum volume of the fuel. The maximum fuel surface level below the point of entry of the vent shall not be less than 100 mm. The internal surface shall be cleaned and treated with temporary preservative, soluble in fuel oil, before shipment. The following fittings shall be included:

(a) 600 mm diameter manhole complete with portable cover situated in the top of the tank complete with ladder to the interior.

(b) Dipstick, calibrated in litres with guide tube and striker plate.

(c) Local indication of fuel level to be given at a position where it can be easily read during fuel delivery.

(d) Filling pipe work and fittings complete with isolation valve and captive end cap. The filling point to be at the top of tank to prevent siphoning.

(e) Outlet pipe situated at the raised end of the tank not less than 150 mm above tank bottom, complete with check valve, isolating valve and end cap.

(f) Drain pipe situated at lowest point in tank complete with isolating valve and captive end cap.

(g) Inlet fittings for overflow pipe from daily service tank or tanks (where specified).

(h) Vent pipe situated at high level in the tank. The pipe shall rise continuously from the tank and terminate with an inverted `U' bend and vermin screen.

(i) External ladder for horizontal tanks more than 2 m diameter.

4.8.10. Drawings / Documents Required:

All Drawings, data, technical particulars, calculations, detailed literature, catalogues Test certificates etc shall be submitted along with the bid/ after award of contract.

Executive Engineer

Vadodara Municipal Corporation

Signature & Seal of the Bidder
Name and Address:

6.20.9
DETAILED TECHNICAL SPECIFICATIONS (DTS) FOR INSTRUMENTATION & CONTROL SYSTEM

GENERAL:

This specification covers the supply, engineering, manufacture, procurement, inspection & testing at vendor's and/or his sub-vendor's works, packing, transportation, delivery, storage & handling at site, erection, start-up, testing & commissioning and performance testing of all the Control, Instrumentation and Automation equipment/system with comprehensive Operation & Maintenance for 10 years, as specified in the scope of work, for the water distribution system along with required accessories and all essential spares, maintenance tools and tackles as specified hereafter. The offer shall comply with the latest applicable codes and standards as prevailing on the date of submission of the bids.

Adequate instrumentation, control & automation facilities shall be envisaged for the proposed water distribution station (WDS), with a view to achieve safe, reliable & trouble free operation of the plant equipment and safety of the operating personnel through user-friendly man–machine communication.

All the field-mounted transmitters shall be 'Smart' type. The instrumentation system shall be based on 4-20 mA DC signals, generally working on two-wire signal system with superimposed digital signal as per HART protocol. In addition to required measurements and controls, adequate sequential and safety interlocks, monitoring and display of all process parameters shall also be provided. All the signals/contacts between field & automation equipment shall be connected by suitable cables. The instrumentation & control equipment to be provided shall be suitable for continuous duty & for round-the-clock operation of the plant throughout the year.

Any equipment/accessories not explicitly indicated in this specification, but considered essential for proper functioning of process shall be included in Bidder's scope of work and supply.

1.1. Scope of Work:

Bidder's scope of work & supply shall include, but not limited to, the following:

1.1.1. Supply, engineering, manufacture/ procurement, supply, delivery, transportation to site, storage, erection, testing and commissioning of all the field & control room mounted instrumentation & automation equipment.

1.1.2. Supply, installation, testing and commissioning of Consumer water meter Ultrasonic type based on AMR/AMI technology and operation and maintenance of 10 yeras. Taking reading from all the water meter connections preparation, printing and distribution of bills to all consumers in different administrative zones of Vadodara city. The item also includes AMR/AMI meter reading software, Handle Unit with latest version of computer for software programme, Data entry etc.

1.1.3. Bidder shall execute complete Instrumentation & Control package on turnkey basis to the satisfaction of Purchaser/ Engineer. Bidder shall comply with all the requirements of scope of work and supply; list of measurements & controls, submission of drawings & documents; supply of instruments from list of approved makes and other related clauses, stipulated in this specification.

1.1.4. All field instruments (gauges/ sensors/transmitters/ switches/ flow meters/motorized valves etc.) as required for monitoring /control / alarm/ interlocking functions involved in the process.

1.1.5. All erection hardware and accessories like branch cable trays from field sensors to Junction boxes & from junction boxes to PLC cabinets, impulse tubes with fittings & accessories, drain/vent valves, root valves, cable glands, structural frames/supports, expander & reducer etc. as required for complete & proper installation of the instrumentation & control equipment, are included in bidder's scope of supply & work.

1.1.6. PLC based control system complete with cabinets, processor modules, I/O modules, power supply modules, communication modules & networks and other associated hardware. PLC based automation system shall be designed using adequate redundancy features. HMIs along with PLC panel & other peripherals shall be installed in the control room.

1.1.7. Supply of UPS of adequate capacity, with battery backup (SMF Ni-Cd batteries) of minimum one (1) hour. AC/DC power distribution from with adequate number of wired spares (minimum 20% after commissioning) breakers and 230V AC/ 24V DC converters (redundant) for I&C Equipment and System.

1.1.8. Supply, laying & termination of Instrumentation, Control, Power & any other special cables as required for entire system under Bidder's scope. Scope shall also include preparation of engineering documentation like cable schedule and Inter- connection schedule.

1.1.9. PC, consoles & other peripherals shall be of industrial grade & of latest available configurations.

1.1.10. Electronic earth pits, as per applicable standard & also meeting automation vendor's requirement and including supply & laying of earthing cables with required accessories shall be under Bidder's scope.

1.1.11. Bidder's scope shall also include supply of spares & consumables for successful commissioning and establishment of performance guarantee of the offered plant equipment & system.

1.1.12. Submission of drawings & documentation as specified in this bid document.

1.1.13. Provision of any other Instrumentation and control equipment, not specifically mentioned in this document, but required for trouble free and safe operation of the system, is also included under bidder's scope.

1.1.14. Bidder shall include & arrange for training of Purchaser's personnel for automation & special instrumentation items at manufacturer's works and also at site in his scope, details & modalities of which will be mutually discussed and finalised later.

1.1.15. Bidder's scope also includes arranging visits by respective instrumentation & automation equipment manufacturer's competent representatives at site, as & when required, during erection & commissioning.

1.1.16. It is not the intent to completely specify all details of design and construction herein. Nevertheless, the Instrumentation & Control system shall conform to high standard of engineering, design and workmanship in all respects and shall be capable of performing satisfactorily in continuous commercial operation under the specified environmental conditions.

1.1.17. Bidder shall include all necessary and supplementary items & equipment in his proposal, required for completeness, safe & efficient operation of the offered system, even though these may not have been mentioned in this specification.

1.1.18. Purchaser reserves the right to issue addendum to the technical specification to indicate modification/ changes in the requirements, if so required at a later date.

1.2. Design basis:

1.2.1. The monitoring and control system for the proposed plant shall be designed & implemented through a Programmable Logic Controller (PLC) based automation system, covering the total functional & operational requirements of the plant involving measurement, control, alarm & interlocking functions. All the process & electrical parameters shall be monitored in HMIs of the PLC system. PLC system selected shall be OPC compatible and shall have GSM/GPRS modem for the wireless communication.

1.2.2. PLC system shall be provided with one no. of Operator cum engineering work stations (ES-cum-OS) along with a printer, peripherals & accessories, as required. PLC based automation system shall be of latest industrially available configuration. Control philosophy shall be provided by the bidder which shall be approved by the engineer in charge from the client side.

1.2.3. The PLC system shall be provided with hot redundant, fault-tolerant features, redundancy in processor

1.2.4. The PLC I/O modules shall be hot swappable, i.e. card changeover, card wiring removal or communication cable change shall be possible on-line (PLC running) without causing any process interruption, bump or nuisance trip or any loss of fidelity during such action. In case of hot swap of I/O card or card wiring removal, the interruption shall be limited to the subject card related I/Os only. On line PLC programme modification shall be possible without stopping the processor.

1.2.5. All analog cards shall be differential type. The cards and processors shall be of same family and series. I/O modules shall have 3 levels of Isolation- a) Channel to Channel Isolation, b) Channel to power Isolation & c) Channel to Ground Isolation.

1.2.6. Channel level diagnostic features shall be available in HMI. The engineering station forms the focal point of the control system design and acts as container of the complete control system application.

1.2.7. The operation & status monitoring of the motorized valves shall be performed from the PLC.

1.2.8. Local instruments like pressure gauges, pressure switches, temperature gauges, level gauges, level switches etc. shall be provided as per the process requirement for proper functioning of the plant.

1.2.9. All the instrumentation & automation equipment and their accessories shall be supplied from approved manufacturers, whose successful performance has been established by record of satisfactory operation in process plants.

1.2.10. Separate electronic earthing system with dedicated earth pit shall be provided by the bidder for ICA equipment. Bidder shall also be responsible for the laying of the network of electronic earthing cables including all the applicable accessories.

1.2.11. Bidder shall be responsible for engineering, selection and connection of all components and sub systems to form a fully complete system whose performance is in accordance with functional, parametric and other requirements of this specification. It is not the intent to specify all individual system components since the bidder has full responsibility for engineering and furnishing of a complete system meeting the monitoring and control requirements of all equipment associated with the system.

1.2.12. Bidder shall support for spares & services for PLC including HMI software and operating System for at least next fifteen (15) years from the date of commissioning.

1.2.13. The tagging, numbering & colour philosophy shall be as per as per ISA standard.

1.2.14. Instrumentation, Control & Automation (ICA) system shall be designed, manufactured, installed and tested to ensure the high standards of operational reliability. Instruments mounted in field and on panels shall be suitable for continuous operation in WDS. All electronic components shall be adequately rated and circuits shall be designed so that change of component characteristics shall not affect plant operation.

1.2.15. All ICA equipment shall be suitable for continuous operation. Unless otherwise specified, all instruments shall be tropicalised. The outdoor equipment shall be designed to withstand tropical rain. Wherever necessary, space heaters, dust and water proof cabinets shall be provided. Instruments offered shall be complete with all the necessary mounting accessories.

1.2.16. Unless otherwise specified, the normal working range of all indicating instruments shall be between 30% and 70% of the full scale range.

1.2.17. Unless otherwise stated, degree of protection for field mounted electrical and electronic instruments shall be IP 65. All instruments of submersible type shall be protected to IP 68.

1.2.18. Unless otherwise stated, overall accuracy of all measurement systems shall be ±1% or better of the measured value.

1.2.19. Dual redundant SMPS shall be used for powering 24 V DC Instrumentation, Control & Automation equipments.

1.2.20. For all the field mounted transmitters, output signal shall be 4-20 mA DC isolated with HART Protocol (version 6 & above) and field transmitters shall be provided with the back lit LCD/LED display.

1.2.21. Lockable & tamperproof enclosure shall be provided for all the field mounted instruments.

1.2.22. FRP Canopy shall be provided for all the field instruments to protect the instruments from rain, sunlight and weather conditions.

1.3. List of Measurements and Control:

The water distribution system shall be provided with required instrumentation equipment for measurement & control functions, indicated below as a minimum, but not limited to the following:

a) Flow measurement at the outlet of ESR (at WDS-1 Sayaji, WDS-2 Vadivadi and WDS-3 Akota (a and b))
b) Flow measurement at common header of pumps (at WDS-1 sayaji, WDS-2 Vadivadi and WDS-3 Akota)
c) Pressure measurement at the individual discharge header and at common discharge header of pumps (at WDS-1 sayaji, WDS-2 Vadivadi and WDS-3 Akota)
d) Level measurement of each sump & ESR (at WDS-1 Sayaji, WDS-2 Vadivadi and WDS-3 Akota (a and b))
e) Control of Pumps based on control philosophy
f) Flow and pressure measurement at the DMA's and pressure measurement at the strategic location for the leakage detection.
g) Monitoring and control of electrical systems such as Energy Meter readings, Breaker control, etc.

Notes-

a) Bidder may propose additional instruments & control equipments for safe, reliable & efficient operation of WDS process proposed by him.
b) Required quantities and application of the above instruments shall be provided as per approved P&ID to meet the requirement of the process.
c) Bidder shall provide the P&ID which shall be approved by the engineer in charge.
d) Necessary alarms, status signals along with the measurements of process parameters etc. shall be displayed in HMI.

1.4. Reference Specifications and Standards

All ICA equipment shall comply with all applicable international and local laws regulations and standards, as mentioned in the bid document.

1.5. General Design Requirements

1.5.1 Instrumentation, control & automation (ICA) system shall be designed, manufactured, installed and tested to ensure the high standards of operational reliability. Instruments mounted in field and on panels shall be suitable for continuous operation in WDS. All electronic components shall be adequately rated and circuits shall be designed so that change of component characteristics shall not affect plant operation.

1.5.2 Electronic instruments shall utilize solid state electronic components, integrated circuits, microprocessors, etc., and shall be of proven design.

1.5.3 All digital outputs from the instruments shall be volt free. The relay/switch contacts shall be rated for the voltage of the circuit in which they are to be wired.

1.5.4 All analogue displays shall be of the digital type with no moving parts.

1.5.5 Zero and span adjustments shall be provided for all instruments.

1.5.6 After a power failure, when power supply resumes, the instruments and associated equipment shall start working automatically.

1.5.7 The instruments shall be designed to permit maximum inter-changeability of parts and ease of access during inspection and maintenance.

1.5.8 The field instruments i.e. the instruments mounted outside the control panel shall be mounted at a convenient height of approximately 1.2 meters above grade platform.

1.5.9 All the field mounted transmitters shall be provided with back lit display.

1.5.10 The instruments shall be designed to work at the ambient conditions of temperature, humidity, and chlorine contamination that may prevail. The instruments shall be given enough protection against corrosion and all the wetted parts of the instruments shall be non-corrosive.

1.5.11 All field instruments and cabinets/panel mounted instruments shall have tag plates/name plates permanently attached to them.

1.5.12 The performance of all instruments shall be unaffected for the ±10% variation in supply voltage and ±5% variation in frequency simultaneously.

1.5.13 Unless otherwise specified, SS 304 double compression glands with PVC shroud shall be used for glanding the cable in field instruments and instrument control panel.

The Contractor shall obtain all instruments from the approved vendor's list. The design and quality of all instruments shall be fully suited to the conditions which will be met in service. The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC-801. The instrumentation and control system shall be designed, manufactured and installed to ensure highest standard of operational reliability. Major instrumentation shall be electronic type. Panel mounted receiving instruments shall be electrically operated miniature flush mounting type unless otherwise specified. All instruments shall be installed in accordance with the recommendations or instructions of the instrument manufacturer for particular application. All instruments shall be capable of carrying their full load currents without undue heating. They shall not be damaged by the passage of fault currents within the rating of the associated MCB or through the primaries of their corresponding instrument transformers. All instruments shall be back connected and the cases shall be earthed. Approved means shall be provided for zero adjustment of instruments without dismantling. All voltage circuits to instruments shall be protected by MCB's in each unearthed phase of the circuit placed as close as practicable to the main connection. Analogue signals shall be 4-20 mA according to BS 5862: Part I 1986 or its latest edition.

They shall operate over two wires and be isolated from earth. 1-5V DC signals shall only be permitted within the main instrument enclosure.

Analogue signals shall be so connected that the failure of a remotely transmitted signal to another panel can not affect other readings on instruments operated by the same signal.

The contractor shall furnish technical details / catalogues / drawings for the instruments and panels offered for monitoring and control of the plant, as per the operation philosophy specified, to client/consultant for their approval prior to procurement of the same.

Contractor shall offer inspection for the instruments/panel offered by him and in case of waiver of inspection by the client / consultant, necessary test certificates shall be submitted for approval of client / consultant before clearing the material for despatch. Contractor shall submit their inspection plan to client/consultant for their approval for this purpose.

All instruments procured by the contractor as per the Engineer's approval, and those which perform similar duties shall be of uniform type and manufacture throughout the scheme in order to facilitate maintenance and the stocking of spare parts. Moving parts and contacts shall be adequately protected from the ingress of dust, and all instruments shall be protected by moisture and dust-proof cases including those mounted in panels. All equipment shall be suitable for its environment. Panel mounted receiving instruments shall be of the electrically operated miniature flush mounting type unless other wise stated. Scales shall be clearly marked with black lettering and graduations on a white background. Instruments of the same type and range shall have identical scales. Unless otherwise specified, the normal working range of all indicating instruments shall be between 30% to 70% of the full scale range. After a power failure, when power supply resumes, the instruments and associated equipment shall start working automatically. The instruments shall be designed to permit maximum interchangeability of parts and ease of access during inspection and maintenance. The field instruments i.e. the instruments mounted outside the control panel shall be mounted at a convenient height of approximately 1.2 m above platform. Lockable enclosure shall be provided for the field mounted instruments wherever required. All field instruments, and cabinets / panel-mounted instruments shall have tag plates/name plates permanently attached to them.

In general, Instrumentation System shall be designed as per good engineering practice.

POWER SUPPLY TO PACKAGE:

Power Supply shall be made available by the bidder at the following voltage levels, unless otherwise specified.

- For Instruments, Control Systems, Analysers: 230V AC + 10%, 50 Hz + 3 Hz
- Solenoid Valves, Relays, Lamps: 24V DC
- Input Interrogation Voltage: 24V DC
- Panel/Cabinets Lighting: 230V AC + 10%

Contractor shall make provision for a separate feeder in the Plant MCC of suitable current rating to

provide 230V AC + 10%, 50 Hz + 3Hz supply to Instrument Panel(s). 24V DC required for Input Interrogation, SOVs, relays and lamps etc., same shall be generated by the bidder using dual redundant power supply. Power shall be suitably Conditioned by providing UPS / Isolation Transformer-Voltage Stabilizer-CVT to Prevent damage to instruments against power fluctuation / disturbances.

Instrument power circuits shall be individually protected from fault with the help of fuses. Power supply to the individual instrument shall be disconnected with the help of fuses. Miniature circuit breakers (MCB's) may be selected in place of switch fuse unit in case protection is provided for overload protection.

EARTHING :

Vendor shall provide separate earth bus bar connections for shield and panel electrical earthing. Any special earthing requirements, if required, shall be provided by vendor during detailed engineering.

Necessary earth pits for instrument earth and signal earth (minimum 2 nos. of each type) shall be provided by the vendor.

ENCLOSURE :

All instruments enclosure mounted in the field shall be weatherproof to IP-65 / NEMA4 as a minimum.

INTERLOCKS / LOOPS :

All plant interlocks shall be carried out using PLC / electromagnetic relays to be supplied by vendor for fail safe and reliable operation. Vendor to indicate all process interlock requirements on the P&IDs.

Loop integrity must be maintained for each loop. No component of any loop shall be shared by other loop. The system shall be designed fail safe and shall meet the following requirements, as a minimum:-

All initiating contacts shall be close under normal conditions and shall open under abnormal conditions.

All relays and solenoid valves shall be energised under normal conditions and shall deenergise under abnormal conditions. The system shall be designed using PLC / electromagnetic relays unless specified otherwise and shall be located locally or remotely as per the operational requirements. The system shall meet the following requirements as a minimum :

The electromagnetic relays shall be low power continuously rated type and shall have LED for status indication.

The relays shall be plug-in type and their plug-in bases shall have screwed terminals for interconnection. Lug type soldered connection shall not be acceptable.

Each relay shall have three numbers of 'NO' and three numbers of 'NC' contacts as a minimum each suitable to drive the connected. Out of these, one 'NO' and one 'NC' contacts shall not be used.

Each shutdown/interlock logic shall be individually protected using separate switch fuse unit and shall have a lamp for indicating power healthy status. Each shutdown circuit and solenoid valve shall be provided with a switch-fuse unit separately.

PUSHBUTTONS AND SWITCHES

Pushbuttons, where applicable, for operational circuits shall be provided with a shroud, guard or other suitable means to prevent inadvertent operation. They shall be in accordance with the high standard generally required by the specification as a whole and by the equipment with which they are associated. Illuminated pushbuttons where applicable / used shall be of a design that allows easy replacement of the lamps from the front of the panel. If legends are engraved on the pushbuttons they shall be clear and concise and shall be approved by the Engineer – In charge before manufacture. Control switches shall be in accordance with the high standard generally required by the specification as a whole and by the equipment with which they are associated.

INSTRUMENT CONNECTIONS:

Electrical cable entry shall be ½" NPT(F). Suitable cable gland shall be used.

End connections shall meet the following unless, otherwise specified:

Threaded end connection shall be NPT as per ANSI / ASME B.1.20.1

Flanged end connection shall be as per ANSI / ASME B16.5

ANALOGUE SIGNAL MULTIPLIERS:

The flow, level and Pressure signals shall be provided with back of panel mounted signal multipliers. They'll provide loop power with option to select measurement with power and without. The multiplier will provide 2 outputs of 4-20mA one for the panel mounted indicator and other for PLC i/p. There will be total galvanic isolation between field I/O's and also between the 2 outputs.

DETAILED SPECIFICATIONS FOR INSTRUMENTS

Instruments as per following details and specifications shall be provided by vendor as a minimum. Quantities mentioned, if any, are indicative and minimum only and contractor shall provide all necessary instruments described in this section or as required for proper operation of the plant as described else where in this tender or found necessary during detailed engineering in addition to below mentioned instruments and their locations.

All instruments, gauges and control equipment shall be strictly procured as per the list of approved vendors enclosed herewith as part of the tender documents.

a) ULTRASONIC LEVEL TRANSMITTER

Ultrasonic level measurement shall be accomplished by the use of non-contact, echo-time measuring equipment operating at ultra-sonic frequency.

The sensor shall be suitable for mounting in the open, or within an enclosed tank, and shall be with environmental protection to IP-68 as minimum. The sensor / transducer range shall be as required to cover Liquid Depth + Free Board + Blanking Distance as a minimum.

The control units shall incorporate:

Facilities for calibration and shall have an output of 4-20mA proportional to selected Measurement parameter of level as per user selection / program. 4 digits or other suitable as per mfr std. LCD read out of selected measurement parameter in suitable engineering units. The contractor shall provide a

canopy for the sensor and the control unit exposed to sunlight to provide protection from direct sunlight.

Ultrasonic Transmitter for Level Measurement:

Ultrasonic transmitter shall be provided to measure liquid level for WDS Sump and ESR. The purpose is to monitor Sump and ESR levels and for start/stop of pumps/valves in auto mode through suitable logic to be decided during detailed engineering, low/high level alarm annunciation on PLC/SCADA at control room, etc. The brief specifications in addition to above specifications shall be as under:

a)	**General**		
i.	Service	:	Level measurement of ESR and Clear water sump
ii.	Overall accuracy of measurement loop	:	± 0.5% of full scale
iii.	Range	:	0-5 mtr for clear water sump and ESR
b)	**Level sensor**		
i.	Type	:	Ultrasonic
ii.	Weather protection class	:	IP 68
iii.	Process connection	:	As per process requirement
iv.	Temperature compensation	:	Required, built in temperature sensor in transducer
v.	Swirling arm arrangement for mounting of sensor	:	Required for access during maintenance
vi.	Sensor MOC		PVDF or equi. suitable
c)	**Level transmitter**		
i.	Type	:	Microprocessor based SMART type with backlit LCD / LED display
ii.	Programming facility with programmer	:	Required

iii.	Output	:	4-20 mA DC isolated with HART protocol (version 6 or above) proportional to level • Relay output for loss of echo alarm (only for level application) and high and low alarms(Configurable)
iv.	On line diagnostic facility	:	Required
v.	Facility to suppress the echo from interfering structures	:	Required
vi.	Facility for averaging / dampening the readings due to water turbulence	:	Required
vii.	Enclosure material	:	Die cast aluminium with epoxy coating
viii.	Enclosure protection class	:	IP 65
ix.	Mounting	:	Integral for Sump and remote wall/2" pipe mounting in case of ESR
x.	Power		2/4 wire (24 V DC or 230 V AC, 50 Hz)
xi.	Programming device		Inbuilt in controller or hand held
xii.	Operating temperature		Ambient temperature
d)	**Digital Level indicator**		
i.	Type	:	Microprocessor based
ii.	Display	:	Digital LED display
iii.	Digit Height	:	14 mm or higher
iv.	No. of Digits	:	3 ½
v.	Input	:	4-20 mA DC with HART protocol (version 6 or above) -2 nos.
vi.	Zero & Span Adjustment	:	Required

vii.	Engineering Units for display	:	Meters and %.
viii.	Accuracy	:	±0.1 % of span
ix.	Enclosure Material	:	Non corrosive
x.	Retransmission output	:	Isolated 4-20 mA DC-2nos.
xi.	Power supply to Transmitter	:	24 V DC
xii.	Alarm outputs	:	1NO+1NC for high, low and Low-Low alarms (adjustable)

Level readings shall be continuously displayed locally as well as in remote at Panel mounted Process Indicator and at PLC/SCADA at control room. Low-Low & High-High level alarms shall be annunciated at HMI/SCADA. Pump operation shall be interlocked with the status of motorized valve at inlet of ESR in on/off mode /ESR water level subject adequate level of water in clear water sump. The pump shall operate in level i.e. start at set high level and stop/close at set low level or at set times as finalized during detailed engineering. The working and standby pump shall be selected by operator at HMI or shall be determined by operating hours of pump such that pump with minimum operating hours shall start first & so on and in case of pump trip, pump with maximum operating hours shall stop first and so on. Operating hours of pump shall be logged in PLC.

Ultrasonic Level Transmitter provided at ESR for monitoring ESR level and control the Electric Actuator operated valve provided at inlet pipe of ESR in case of ESR level reaching programmed high level (to prevent overflow and to open valve in case of ESR level reaching programmed low level. ESR low level alarm shall be provided at WDS. WDS Pump operation shall be interlocked with the status of motorized valves at inlet of ESR / ESR water levels in on & off mode subject adequate level of water in clear water sump.

b) ELECTRO MAGNETIC FLOW MEASURING SYSTEM (MAINS SUPPLY)

Generally, the flow meter shall be as follows:

Flow metering System

1) Full bore type Electromagnetic flow meter shall be provided at the common discharge header of pumps and at the outlet of ESR. The flow meter shall consist of flow sensor (i.e. flow tube), flow transmitter/ flow computing unit and remote flow indicator cum integrator. The electromagnetic flow meter shall be manufactured as per BS EN ISO 6817 standard (Measurement of conductive liquid flow in closed conduits, method using electromagnetic flow meters).
2) The flow tube flanges and transmitter housing shall be properly earthed.
3) Flow tube shall have waterproof construction (IP 68) and shall be suitable for installation on underground pipe lines buried directly in the soil and also suitable for above ground pipelines.

4) The transmitter of the flow meter shall be SMART type microprocessor based using digital technology having facilities for configuration of engineering units, flow range and features of memory and self diagnosis. The transmitter shall be mounted separate from the flow tube, connected by a cable. The flow transmitter and flow computation/ evaluation unit shall be mounted in a field mounted metallic field enclosure / cabinet.
5) The electromagnetic flow meter shall have bi-directional measurement feature and with accuracy better or equal to + 0.5% of measured value inclusive of linearity, repeatability, pressure effect etc.
6) Flow transmitter/ flow computing unit should be microprocessor based having digital display with flow-rate indications and integrated flow values with the configuration facility from the front facia.
7) Material of construction of the wetted parts of flow meters shall be suitable for functioning on treated / raw and chlorinated water applications. Flow tube shall be rugged in construction and shall be suitable for continuous operation. Flowmeters shall be suitable for the water turbidity at site during various seasons.
8) The flow meter shall be installed in such a way that it always remains filled with water. To avoid the effects of disturbances in the velocity profile, a straight and uninterrupted run, upstream as well as downstream from the location of the flow meter shall be provided, as required by the flowmeter manufacturer. The flow tube shall be installed at a location free from flow turbulence. In order to achieve the same, the flow tubes shall be installed in the pipe section such that straight lengths of pipe without bends or tee connection shall be minimum 5 diameters on upstream and 3 diameters on downstream side. The Contractor shall finalize the exact location of flow transducers in consultation with Employer.
9) The flow meter output signals shall contain the data for flow-rate and integrated flow readings. The output signal of the flowmeter will be connected to panel mounted Flow Indicator & integrator and PLC.

a)	**General**		
i.	Service	:	Treated water application at the outlet of ESR and at the common discharge header of pumps
ii.	Function		To measure and indicate instantaneous flow and totalized flow
iii.	Conductivity		>5 micro Siemens/cm
iv.	Overall accuracy of measurement loop	:	±0.5 % of reading
v.	Suitable concrete chamber for enclosing flow meter.	:	Required
b)	**Flow tube**		

i.	Type	:	In line full bore electromagnetic
ii.	Size of flow tube	:	Same as pipe size
iii.	Weather Protection Class	:	IP 68 for flow meters installed outdoor below ground level and IP 67 for flow meters installed above ground level.
iv.	Range	:	Bidder to state
v.	Surge protection devices (SPD) between flow tube and flow transmitter	:	Required for protection from lightning surges
vi.	Electrode material	:	Ss 316L, Hastelloy C
vii.	Flow tube Lining	:	Polyuethane / PTFE/Hard Rubber
viii.	Power supply		From transmitter
ix.	Coil Housing		SS 304
x.	Flow tube material		SS 304/316
xi.	Flange Material		CS or better
xii.	Grounding		Earthing electrode/set or earth rings SS 316
xiii.	Cable entry (for remote version) and glnads		Shall be as per manufacturing standard and suitable to maintain the specified protection class at site and SS glands shall be there
xiv.	Cable length		Min 25meter, dual shielded cable from sensor to transmitter
xv.	Upstream/downstream length		5D/3D
c)	**Flow Transmitter Unit**		
i.	Type	:	SMART type Microprocessor based with facility to configure the ranges.
ii.	Type of display	:	4 digit, LCD for flow rate in m^3/hr. 8 digit LCD for totalised flow in ML Remote type display
iii.	Input	:	From flow tube
iv.	Output	:	4-20 mA DC (isolated) with HART protocol (version 6 or above) proportional to flow rate -2 nos.
v.	Power Supply	:	230V AC / 24V DC
vi.	Zero and Span Adjustment	:	Required
vii.	Weather Protection Class	:	IP 67

viii.	Battery backup for totalised flow	:	Required
ix.	Facility for on line diagnosis	:	Required
x.	Cable entry		½" NPT 2 nos.
xi.	Mounting		Wall mounting/ 2" pipe mounting
xii.	MOC		Dia. Cast Al. With epoxy coating
xiii.	Vibration condition		Conformity to IEC 60068-2-6 or equi., shall be able to endure vibrations, when in service, without any degradation in performance.
xiv.	Pipe not full detection/ empty pipe detection		Required
xv.	Canopy for transmitter		MOC: FRP-min. 4mm thick/ GI-min. 2 mm thick to prevent from direct sun and rain
d)	**Flow Indicator and Integrator**		
i.	Type	:	Electronic, Microprocessor based, single unit for flow indicator and integrator.
ii.	Display	:	Digital, LED display
iii.	Digit Height	:	14 mm or Higher
iv.	No. of Digits - Flow indicator - Flow integrator	: :	 4 Digits 8 Digits
v.	Input	:	4-20 mA DC (Isolated) with HART protocol (version 6 or above) from flow transmitter for flow rate
vi.	Zero and span adjustment	:	Required
vii.	Manual Reset Facility for flow integrator	:	Required (shall be protected)
viii.	Engineering Units for - Flow rate indicator	 :	 CUM / Hr
ix.	Battery backup for flow integrator	:	Required
x.	Retransmitted output	:	Required

Flow (Instantaneous and Totalised) readings shall be continuously displayed at PLC HMI.Real time and histroical trend shall be available for last 180 days. Flow meter shall be mounted above ground level as far as possible. In case of flowmeter mounted below ground level shall be provided with suitable water proof covered chamber constructed in RCC (with access through manhole of sufficient size & CI rungs) & elevated 300mm above FGL of sufficient size for ease of operation and maintenance as decided during detailed engineering to avoid submergence in water.

Flow meter shall be mounted as per manufacturer's recommendation and good engineering practices with required upstream and downstream straight length and other precautions as recommended by vendor to ensure proper flow measurement and each flow meter shall be provided with a bellows at suitable location to enable ease of removal / insertion of flowmeter for maintenance. For flowmeter mounted below ground level, chamber shall be sized suitably to accommodate flowmeter in the same chamber.

The Flow meters shall be calibrated according to the ISO-8316. Standard. Performance Type Testing Certification (ISO 9104) strictly not acceptable. The suppliers shall also have a testing facility in India or abroad so that methodology and procedures can be verified. The testing facility shall be duly accredited in accordance with ISO 17025 standards in India. Test bed shall be accredited by national /international certifying authority (FCRI & NABL) as per ISO 8316 (Calibration by Volumetric Method) or ISO 4185 (Measurement of fluid flow in closed conduits - weighing method). Minimum 10% or one no. (Whichever is higher) of flow meters of each size shall be wet calibrated at accredited facility / test bed as mentioned above either at manufacturer works or any other such facility in India. Flow meters shall be tested for accuracy, calibration & sealed in presence of the Client Engineers / TPI / PMC at manufacturer's works / Calibration Facility. All electro-magnetic flow meters shall be provided with manufacturer's calibration certificates.

c) ELECTRO MAGNETIC FLOW MEASURING SYSTEM- (BATTERY OPERATED)

The general specifications for battery operated electromagnetic flow meter shall be as under:

a)	**General**		
i.	Service	:	Treated water application at the DMA
ii.	Function		To measure and indicate instantaneous flow and totalized flow
iii.	Conductivity		>5 micro Siemens/cm
iv.	Overall accuracy of measurement loop	:	±0.5 % of reading
v.	Suitable concrete chamber for enclosing flow meter.	:	Required

b)	**Flow tube**		
i.	Type	:	In line full bore electromagnetic
ii.	Size of flow tube	:	Same as pipe size
iii.	Weather Protection Class	:	IP 68 for flow meters installed outdoor below ground level and IP 67 for flow meters installed above ground level.
iv.	Range	:	Bidder to state
v.	Surge protection devices (SPD) between flow tube and flow transmitter	:	Required for protection from lightning surges
vi.	Electrode material	:	Ss 316L, Hastelloy C
vii.	Flow tube Lining	:	Polyuethane / PTFE/Hard Rubber
viii.	Power supply		From transmitter
ix.	Coil Housing		SS 304
x.	Flow tube material		SS 304/316
xi.	Flange Material		CS or better
xii.	Grounding		Earthing electrode/set or earth rings SS 316
xiii.	Upstream/downstream length		5D/3D
c)	**Flow Transmitter Unit**		
i.	Type		SMART type microprocessor based
ii.	Mounting		Wall/pipe mounting
iii.	Enclosure protection class		IP68
iv.	Enclosure material		Die cast Aluminium with epoxy coated
v.	Length of the sensor cable		20 meter. Min.
vi.	Power supply		Powered by battery, shall be able to operate also on the mains power if available
vii.	Battery type		Lithium battery, internal battery
viii.	battery replacement		Must be without data loss
ix.	Data logger		Required with adequate data logging and selectable as daily, weekly, monthly
x.	Forward, reverse and bidirectional		required

	net flow totalize flow data		
xi.	Low flow cutoff		required
xii.	Display		Flow rate, totalized flow, velocity, remaining battery life with alarm, empty pipe detection, etc.
xiii.	Output		RS 485 with modbus/ As per manufacturer standard.(with suitable/ matching connectivity for modem/ PLC/ RTU as required)
xiv.	GSM/GPRS modem		Required with required cable/ built in with flow meter
xv.	Antenna		Required with suitable cable length if applicable
xvi.	Alarm output		For abnormality in flow measurement or battery indication
xvii.	calibration certificate		5 point calibration certificate is required
xviii.	Necessary software at receiving end		Required shall integrate with the SCADA to provide and display flow and other relevant flowmeter data on SCADA
xix.	Password protection		Multilevel password protection is required
xx.	Diagnostic capability		Required

Flow readings & other relevant data shall be transmitted to control room through GSM sytem once or twice in a day as decided by client and shall be displayed at SCADA at control room. The battery life shall be at least 5 years considering remote data transmission (GSM/GPRS) twice in a day. Vendor to quote for battery replacement & any other recommended spares cost as part of offer. Vendor to specify clearly the life of battery for one and two time data transmission per day (GSM/GPRS) and considering average ambient temperature of 35 deg C and peak ambient of 45 deg C.

Flow meter shall be mounted as per manufacturer's recommendation and good engineering practices. The Flow meters shall be calibrated according to the ISO-8316. Standard. Performance Type Testing Certification (ISO 9104) strictly not acceptable. The suppliers shall also have a testing facility in India or abroad so that methodology and procedures can be verified. The testing facility shall be duly accredited in accordance with ISO 17025 standards in India. Test bed shall be accredited by national /international certifying authority (FCRI & NABL) as per ISO 8316 (Calibration by Volumetric Method) or ISO 4185 (Measurement of fluid flow in closed conduits - weighing method). Minimum 10% or one no. (Whichever is higher) of flow meters of each size shall be wet calibrated at accredited facility / test bed as

mentioned above either at manufacturer works or any other such facility in India. Flow meters shall be tested for accuracy, calibration & sealed in presence of the Client Engineers / TPI / PMC at manufacturer's works / Calibration Facility. All electro-magnetic flow meters shall be provided with manufacturer's calibration certificates.

d) PRESSURE GAUGES:

1. All pumps shall have PG at their discharge lines. PG dial face shall be marked with pressure element material. Ranges shall be so specified that the gauge normally operates in the middle third of the scale and shall confirm to IS- 3624 standard dials, wherever possible. Pressure gauges shall comply with IS 3624. Where the gauge is subject to pressure pulsations and/or vibration, it shall be mounted on gauge board / stanchion.
2. The minimum diameter for round pressure gauges shall be 150 mm unless specified otherwise or as per the equipment manufacturer's standard practice when the gauge forms part of the equipment.

Technical Particulars:

Sr. No.	Description	Particulars
1	**General**	
1.1	Item	Pressure Gauge
1.2	Service	Pump Discharge and at the discharge common header
1.4	Fluid	Treated water
1.5	Area Classification	Non Hazardous / Hazardous
2	**Pressure Gauge**	
2.1	Type	Bourdon
2.2	Sensor and other wetted parts M.O.C	SS 316
2.3	Process connection	Threaded connection ½" NPT (M)
2.4	Dial size	150 mm
2.5	Material of dial	Aluminium with white back ground and black numerals
2.6	Glass	Shatterproof
2.7	Housing material	Die cast aluminium with epoxy coating
2.8	Accuracy	±1% of full scale or better
2.9	Over range protection	130% of full range
2.10	Gauge Protection	IP65
2.11	Temperature	50 °C Ambient
2.12	Range	0-10kg/cm2

Sr. No.	Description	Particulars
2.13	Accessories	• Snubber • 3 way isolation valve • Glycerine filled as applicable • Impulse tubing, fittings (if needed) • All other installation hardware including SS tag plate
2.15	3 Way Isolation Valve M.O.C	SS316
2.17	Blow out disc	Required
2.18	Calibration test	3 point calibration

e) PRESSURE TRANSMITTER:

Pressure Transmitters shall be manufactured from material suitable for use with the process medium and for the site ambient conditions. Only Smart transmitters of approved make shall be used. Indication shall be provided at PLC HMI / SCADA.

The transmitter housing shall be IP-68, yoke mounting, provided with mounting arrangements suitable for 2" pipe mounting. Body material shall be of Cast aluminium. The materials of construction shall be suitable for the climatic conditions described in the specification and where necessary suitable, heavy duty GRP weather proof enclosure with viewing windows shall be provided.

Transmitters shall provide 4mA to 20 mA DC HART output signals proportional to the measured conditions. They shall operate on a 2 wire system receiving their power form the residual 4 mA in the transmission signal. Transmitter power supply will be 24V DC. They shall be fitted with output meters to give an approximate indication of transmitter output scaled 0–100%. Output meter shall be Digital LCD type. Accuracy shall be +0.1% of span. Pressure which shall have capacitance or indicative type sensing element of SS 316L, shall be fitted with direct mounted, stainless steel, 2 valve manifolds.

Transmitter equipment should be supplied and installed complete in all details including tube / pipe work, stop cocks, drain clocks and any similar ancillary item of equipment. Process data, calibrated shall, rang, output, protection, accuracy and connecting details shall be as necessary to satisfy the particular specification requirements. The transmitter shall have non-induction external zero and span adjustment and shall have facility for an optional external damping adjustment.

Each transmitter shall be equipped with a stainless steel nameplate, permanently attached, indicating the following specified data as a minimum :-

Transmitter tag no.

Purchase order no.

Name and address of Manufacturer

Type/Model No.

Serial No.

Calibrated range

Range and maximum working pressure, temperature, sped, vibrating level etc

Materials of construction.

Electrical protection classification.

Pressure readings shall be continuously displayed locally as well as in remote at Panel mounted Process Indicator and at PLC / SCADA at main control room. Low & High alarms shall be annunciated at HMI/SCADA. Pressure transmitters are proposed to be provided at common header line of pumps of water distribution station to monitor the discharge pressure with local and remote indication at panel mounted process indicator & at HMI with low & high alarms. Pressure transmitters are also proposed to be provided at critical nodes / locations & DMA's on pipe lines in distribution network to monitor pressure at the location and transmit the data to SCADA room for alarms and corrective action and for data storage and monitoring at SCADA system as required.

Sr. No.	Description	Particulars
1	**General**	
1.1	Item	Pressure Transmitter
1.2	Service	Pump Discharge Common Header., at the strategic location for the leakage detection, at the outlet of ESR and at the DMA's
1.3	Fluid	Sewage Water
1.4	Area Classification	Non Hazardous / Hazardous
2	**Pressure Sensor**	
2.1	Type	Diaphragm / piezoelectric
2.2	Sensor and other wetted parts M.O.C	SS 316
2.3	Process connection	½" NPT (F)
2.4	Sensor Fill Fluid	Silicon Oil
2.5	Temperature	50 °C Ambient
2.6	Range	0-10kg/cm2
3	**Pressure Transmitter**	
3.1	Type	SMART Type / Microprocessor Based, Head Mounted
3.2	Power Supply	230 VAC Line Power / 24 VDC
3.3	Accuracy	± 0.1 % of span
3.4	Response Time	100 ms
3.5	Transmitter Protection	IP68
3.6	Transmitter MOC	SS316 /Diacast Aluminium with PU finish
3.7	Output	One Current – 4 to 20 mA (isolated) proposanal to pressure

Sr. No.	Description	Particulars
		Hart (version 6 or above)
3.8	Display	Alphanumeric backlit LCD Type, Programmable
3.9	Over range protection	130% of full range
3.10	Zero and span adjustment	Required
3.11	Cable Entry	½" NPT(F) 2 nos. With SS double compression type cable gland. Spare entry shall be plugged with SS plug
3.12	Accessories	• Snubber • 3 way isolation valve • Impulse tubing, fittings(if required) • Mounting Bracket • SS Tag Plate • All other installation hardware
3.13	3 Way Isolation Valve M.O.C	SS316
3.14	Impulse Tube Fitting M.O.C	SS316
4	**Digital Pressure Indicator (Panel Mounted)**	
4.1	Type	Electronic, Microprocessor based
4.2	Display	Digital, LED display
4.3	Digit Height	14 mm or Higher
4.4	No. of Digits - Pressure indicator	8 Digits
4.5	Input	4-20 mA DC (Isolated)
4.6	Zero and span adjustment	Required
4.7	Engineering Units for - Pressure indicator	Kg / Cm2
4.8	Battery backup for flow integrator	Required
4.9	Retransmitted output	Required

f) LEVEL SWITCH:

Clear water sump and ESR sump shall be provided with level switches for dry run protection of pump (in addition to ultrasonic type level transmitter) for auto trip to prevent dry running of all pumps in auto as well as manual mode. The necessary contacts shall be multiplied by relay in ICP and shall be interlocked with each starter as applicable. Low level alarm shall be provided at PLC HMI / SCADA. Switching element shall be a micro switch, Contact shall be 2NO + 2NC and contact rating shall be minimum 2A rated at 230V AC resistive load.

1. The conductivity type level switch shall consist of level probes mounted on the reservoir, connected by suitable cable to the conductivity controller unit for generating control actions and high / low level alarms.
2. The controller output shall be connected to the instrument control panel for generating an alarm when the water level becomes Low or High and pump tripping signal when the level becomes very low.
3. The conductivity type level switch shall work on the principle of detecting presence or absence of liquid between two electrodes based on conductivity. The voltage at electrodes shall be A.C. The controller unit shall be electronic using ICs or microprocessors. Both the electrode assembly and the controller unit shall be suitable for field installation.
4. The Contractor shall provide extra lengths of electrodes and adjust the length by cutting the excess lengths at site, as necessary.
5. The level probes shall be installed on a flanged connection on the reservoir. The Contractor shall provide the required nozzle and the matching flanges.
6. Stilling pipe shall be provided for level electrodes in order to obviate the effect of water turbulence in the reservoir.
7. The conductivity type level switch shall function for normal conductivity of water.

Technical Particulars

a) General			
i.	Service	:	Treated water at the ESR and at the clear water sump
b) Level probe			
i.	Type	:	Rod / Rope type
ii.	Weather protection class	:	IP 65
iii.	Probe material	:	SS 316
iv.	Probe head material	:	Non corrosive
v.	Insulation on the probe	:	Teflon
vi.	Counter weight for rope type probe to keep it straight		Required
vii.	Spacers between the probes to avoid entangling with each other	:	Required
viii.	No. of electrodes	:	4 nos. (high, Low, Very low and reference)
ix.	Length of the electrodes	:	Suitable for reservoir dimensions
x.	Stilling pipe	:	Perforated HDPE pipe Internal diameter to suit the level probe

			assembly
c) Level Controller Unit			
i.	Mounting	:	Inside local cabinet fabricated from sheet metal.
ii.	Weather protection class	:	IP 68
iii.	Alarm contacts	:	For high, Low and Lo-Lo.
iv.	Contact rating	:	24 VDC 2 A / 230VAC 1 A.
v.	Power supply	:	230 VAC
vi.	Material of enclosure	:	Non corrosive
vii.	Sensitivity adjustment for conductivity	:	Required

g) RECEIVING INDICATORS MOUNTED AT ICP/LCP:

All indicators/controllers shall be electronic (microprocessor based) type programmable indicator and shall be mounted on the control panel. Multiplying factors, shall be specified on manufacturer's nameplate, if applicable. Specifications, as applicable are as follows:

Process Indicator:

Type : Microprocessor based, programmable

Input : 4-20 mA

Display : 4 ½ Digit, 7 Segment LED display

Display Units : % or Engg. Units, user programmable at site

Alarm Setpoint : Two nos., pot. free relay contact rated at 5A @230V AC resistive load, adj. over entire range

Transmitter Supply: Required, 24V DC @30mA

Retransmission Output: Required, 4-20 mA in 600 ohm load

Accuracy: + 0.25% of FSD

Terminals: suitable for up to 2.5 sq.mm. wires

Mounting: panel flush mounting

Power: 230 V AC, 50 Hz

Comm. Port: RS-485 Serial Port (Modbus)

Flow Indicator cum totaliser shall also have following in addition to above:

Totalising Counts/Hr: User Programmable at site

Totaliser Display: 8 Digit Digital Display with Battery Backup to retain totalized data in the event of power failure for a minimum period of 24 hours.

h) **PROGRAMMABLE LOGIC CONTROLLERS SYSTEM FOR Water distribution station, ESR (PROPOSED & EXISTING)**

Bidder to note the location specific requirements specified as under to be provided/included in scope of work irrespective of whether mentioned in following general specifications or not:

1. 3 nos. Water Distribution Station Location (WDS-1 at Sayaji head works, WDS-2 at Vadivadi ,WDS-3 at Akota):

Micro PLC Based Instrument control Panel with Local SCADA for acquiring the ESR location data (level, flow and inlet, outlet and bypass valve status), clear water sump data (Level) and pump data, system comprising of min. 21" PC with A4 size laser jet printer for report / alarm printing, Min. 3 kVA online UPS along with CVT, Open protocol connectivity along with required Ethernet switch, GSM/GPRS modem (4G), SIM card for remote data transmission. The DMA's data can be communicated based on GSM/GPRS with required communication port and modem suitable for GPRS data communication on 4G network of selected service provider.

2. At District Metering Area (DMA):

Micro PLC based control system is proposed at each pressure, Flow and actuator location for acquiring the field instrument data (pressure / inst. & tot. flow), Min. 1 kVA online UPS along with CVT, Open protocol connectivity along with required Ethernet switch, GSM/GPRS modem (4G) , SIM card for remote data transmitting Zonal SCADA as well as Master Control SCADA and concerned WDS. The data communication shall be based on GSM/GPRS with required communication port and modem suitable for GPRS data communication on 4G network of selected service provider along with SIM card. The Panel proposed at Field locations shall be with IP-66 enclosure, with padlocking facility and necessary arrangement for applying seal shall be provided to prevent panel tempering. An MS section Pillar shall be provided with lockable door to enclose the PLC Panel suitable for installation in outdoor area. Additionally a door lock limit switch shall be provided interlocked with PLC to provide local & remote alarm with SMS to programmed users in case of an attempt to open the panel door by any person. The panel / enclosure shall be wall/floor mounting type. The data of WDS as well as field instruments at ESR and distribution network shall be transmitted to SCADA system to be provided at WDS/VMC office location as directed by VMC for acquiring data, storage and monitoring.

3. Following is proposed for WDS-1, WDS-2 and WDS-3 SCADA at Control room

Water Distribution at Sayaji, Vadivadi and Akota:

The provision of SCADA System shall be keeping in mind the data acquisition/transfer to & from various WDS, ESR & field locations of concerned area or additional area and with provision to display various process data of WDS, ESR & Field Locations within Distribution Network as per design for required monitoring, alarm and initiating control/corrective steps at concerned WDS & Field by O&M agency.

The proposed SCADA system shall also meet the following requirements:

FUNCTIONAL REQUIREMENTS:

The system is provided with Supervisory Control and Data Acquisition (SCADA) with Graphical Users Interface (GUI) based Man-Machine Interface capable of acquisition of operational and monitoring data from the field stations, validate and consolidate the same, present the same in graphical form, extract trending information, analyze data in real time and apply analytic tools to recommend logical decision for implementation.

The SCADA shall be capable of displaying following information dynamically.

1. Overall view of the water grid with dynamic mimic display of status of measured values of the Pumping Station Data on daily and monthly basis and event logging.
2. Generate Control Command Signal based on sequential and discrete control operation.
3. Sequence of control operation is on the basis of select acknowledge and execution logic.
4. Man-Machine Interface shall be provided to generate clear graphical representation of the whole of the pipe line water transmission system, alarm management system, storage of data base for trending, daily / monthly / yearly reporting etc.
5. Software program shall be such that any person without any prior knowledge of software shall be capable to operate the system. Program shall be window based menu driven for ease of operation. The user interface shall be through GUI. Printers loggers shall be provided for periodical print out of the parameters alarms events etc. Also to provide print out of data of thirty (30) minutes pre & post occurrence of events.
6. The SCADA shall be provided with an adequate storage system for data. The data and all operational parameters shall make available online at least one (1) month data, which can be recalled and processed on demand. Provision shall be made to download the data on appropriate storage devices for permanent storage for archiving.
7. Computer based SCADA is aimed at achieving efficiency, equitable distribution and uninterrupted water supply management. Automation will also lead to manpower utilization, saving of power, timely service offered to consumers.

This shall be server class computer of latest specifications available in the market at the time of execution. Vendor shall submit the indicative specification with the bid for approval.

- Selected SCADA shall be with Unlimited Tags/Screens for future up-gradation
- SCADA Software shall have Web Access facility for monitoring
- Daily and weekly Reporting shall be available in Downloadable Format
- A minimum of 3 months historical data should be Downloadable
- Administrator should have access to control over users right to access the system.

-System shall be pass word protected.

The SCADA system shall comprise of:

• 1 Nos. Desktop PC (EWS cum OWS) with 21” LCD Display

• Required Licensed OS (Operating System) windows 7 min., Anti-Virus & other software

• Required communication ports / Multi-channel receiving modems

• 4TB Data NAS System -high performance RAID network storage and backup device for data storage

• A4 Laser jet Printer – 1 No.

• PLC + SCADA (Runtime + Full development) Software License

• Reporting Software license

• SMS transmission facility, additional Micro PLC shall be provided as
required

• VPN Router with suitable number of ports

• SIM CARD as required (at all locations viz. SCADA, WDS & DMA)

• Industrial grade Ethernet switch min. 8 port

• 3KVA (Min.) UPS along with CVT with CVT with 1 Hour Back up – 1 No.

• Copper plate earth pit - min. 4 nos. or higher as required / recommended by SCADA vendor

• Copper wire / copper strips for earthing as required

Note: Bidder to note that the control logic shall be finalized during detailed engniering and shall required be changing / fine tuning during operation phase as per operational experience and requirement to provide adequate supply with minimum manual intervention. This is applicable for all entire instrumentation work including PLC/SCADA logic and screen development.

CABLES AND CABLING

Instrumentation Signal Cables:

1100V grade, Multi pair 7 stranded x 0.53mm dia, Stranded tinned Electrolytic copper conductor of insulation HRPVC Type-C, Pairs shall be twisted with a lay of 50 mm and twisted to each other, Lapped to form bunch with Mylar tape. Individual as well as overall Shielded with Polyethylene coated Aluminum Mylar tape (min shield thickness .05 mm for single pair & 0.075mm for multi pair) with tinned Copper drain wire. Internal & External sheath of Extruded FRLS PVC, Thickness as per International Standard, Suitable for temperature up to 70 deg. Celsius. G.I. wire/strip armouring of international standard thickness. Max. DC resistance shall not exceed 12.3 ohms/km at 20 deg. Celsius. Applicable standard shall be IS 1554 / BS 5308 / IEC 189.

RTD cables:

1100V grade, triad cables 7 stranded x 0.53mm dia, stranded tinned Electrolytic copper conductor. Three insulated conductor shall be uniformly twisted with a min. 20 twist per meter. Individual as well as overall Shielded with Polyethylene coated Aluminum Mylar tape (min shield thickness .05 mm for single pair & .075mm for multipair) with tinned Copper drain wire. Internal & External sheath of Extruded FRLS PVC, Thickness as per International Standard, and Suitable for temperature up to 70 deg. Celsius. G.I. wire/strip armouring of international standard thickness. Max. DC resistance shall not exceed 12.3 ohms/km at 20 deg. Celsius.

Ethernet Cables:

EIA/ TIA 568A category 6, multi pair 0.5 sq. mm solid conductor with plastic foil wrapping. Overall screen to consist of aluminium bonded polyester tape and tinned copper wire. Overall sheath shall be light grey PVC.

Power Cables for Instrumentation, Control & Automation equipment:

Power cables for ICA equipment shall be 2.5 sq.mm, 1100V multicore cables using high conductivity annealed tinned stranded copper conductor having extruded PVC insulation. The cables shall be inner sheathed with extruded PVC. Armouring shall be with galvanised steel wire and overall sheath shall be extruded PVC. Applicable standard shall be IS 1554 / BS 5308 / IEC 189.

Control cables:

Refer electrical specification for Control cables.

Laying of Cables

a) A distance of minimum 300mm shall be maintained between the cables to be laid on trays/conduits carrying low voltage AC and DC signals and a distance of minimum 600mm shall be maintained between cables carrying HT and LT signals. Each instrumentation and power supply cable shall be terminated to individual panel/ terminal box. Identification of each cable shall be by proper ferrules at each junction as per cable schedule to be prepared by Contractor.

b) Cables shall be laid in accordance with layout drawings and cable schedule which shall be prepared by Contractor and submitted for approval.

c) All cable 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. Various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. A loop of 1 metre shall be left near each field instrument before terminating the cable.

d) Cables shall be complete uncut lengths from one termination to the other. Separate cables shall be used for digital and analog signals.

e) All cables shall be identified close to their termination point by cable numbers as per cable interconnection schedules. Identification tags shall be securely fastened to the cables at both the ends.

f) Cable shall be rigidly supported on structural steel and masonry, using individually cast or malleable iron galvanized clips, multiple cable supports or cable trays.

g) The Contractor shall take the actual measurement of the cables and the associated accessories such as cable trays, conduits etc required at site, prior to the placement of order on the cables.

Junction Boxes

a) In order to make the most economic use of cable tray and trench capacity, multicore / multipair cabling shall be utilised in order to connect instrumentation groups by using suitably located junction boxes.

b) The junction boxes shall have weather protection suitable for the area in which they are to be installed and for the type of circuit. They shall be readily accessible for maintenance and clearly labelled. Junction boxes shall be constructed of die cast aluminium and provide degree of protection IP 65.

c) Wires and terminals for the digital and analog signals shall be segregated within junction boxes.

MICRO PROGRAMMABLE LOGIC CONTROLLERS (PLC) SYSTEM SPECIFICATIONS

A Micro PLC shall be provided for monitoring, control, recording, and logging etc. for Water distribution system. This shall consists of PLC based SCADA system.

Water Distribution system shall be designed for manual & automatic operation through PLC and SCADA based system with PC based systems and peripheries. All the essential Drives shall be provided with standby arrangements.

The control system shall be selectable to either “Local(Manual)” or “Automatic” or “Remote Manual” modes. Annunciation shall be provided on the HMI. All electrically actuated Valves shall be operated from HMI through PLC/SCADA.

Operation & control philosophy of entire WDS shall be suggested by bidder/technology provider and same shall be submitted to Engineer In-charge for their approval. For fully/semi automatic operation, Instrument Panel shall be provided for control and monitoring of WDS.

The Instrument Panel shall be pre-fabricated and floor mounted type.

The Panel shall consist of minimum following devices in addition to clause

a) PLC with integral alarm annunciator & all required hardware and software
b) PC based SCADA system with all required hardware, software and peripheries.
c) Power supply modules.
d) Surge protection units.
e) Indicator for level, pressure and flow.
f) Selector switches for selection of Normal mode, flush mode, score mode and drives and various other modes as per process design requirements.
g) Push buttons.
h) MCBs.
i) Any other item required for functioning of the system.

a) Micro Programmable Logic Controller (PLC)

Codes and Standards

PLC shall comply with the following codes and standards:

- International Society of Automation (ISA)
- National Electricity Manufacturers Association (NEMA)

- International Electro-technical Committee (IEC)
- American National Standards Institute (ANSI)
- The Institution of Electrical and Electronic Engineers (IEEE)

b) Design and Construction Requirements:

1) PLC shall be provided as a standalone controller to perform combinational and sequential logic functions, status monitoring and reporting functions with counter and timer facilities.
2) PLC shall comprise of necessary processors, input/output (I/O) modules, communication interface modules, power supply modules, prefab cables etc.
3) PLC shall have the following attributes as a standalone controller:
   i. It shall carry out sequential operation of WDS based on process requirements.
   ii. It shall carry out sequential start/stop logic implementation for operation of the pumps and motorised valves.
   iii. It shall accept downloaded program from a programmer.
   iv. It shall have different functional modules to perform the desired functions
   v. It shall scan the inputs in time cycles and update the status of inputs/outputs
   vi. It shall have relays, counter/timer functions, internal registers/ flags, watch dog timer, set/reset facilities, up-down counter etc.
   vii. It shall have a provision for spare input and output modules.
4) The PLC system shall be expandable and shall be modular in construction so as to carry out the future expansion. PLC shall be microprocessor based with state of the art technology. System components shall be carefully chosen so that the reliability of the PLC shall be high. PLC shall use standard bus protocols and structures for communication within and outside the system. In case of system failure or power supply failure all the outputs shall attain pre-determined fail safe condition. Spurious signals shall not cause equipment operation.

c) Central Processing Units

1) The Central Processing Unit (CPU) shall be high performance processors with modular configuration suitable for real time process application. High inherent reliability, self checking, error-recovery and trouble-shooting features shall be source of the features of CPU.
2) Automatic restart of the system on resumption of power shall be provided.

d) Memory Unit

1) Memory unit shall comprise of highly reliable memory chips which are industry standard, proven design with fast random access and suitable for operation in process environments. Main memory shall be modular and facility shall be provided for up-gradation and expansion of memory to meet future demands.
2) Sufficient program memory and data memory space shall be provided. System initialization and application software shall be stored in EEPROM with necessary hardware. Running data shall be stored in a RAM with internal battery back-up. The battery back-up provided shall last for at least one month with life of battery a minimum of 3 years. Appropriate

programs for application software modification shall be provided.

3) At least 20% extra memory space shall be provided over the actual requirements.

e) Input/ Output Modules

1) Standard rack mounted I/O modules with plug-in cards shall be provided. Field wiring shall be terminated in screwed terminal and interconnected to the processor I/O system with pre-fabricated cables with plug-in type connectors.

2) 20% extra points of installed capacity for each type of input shall be provided as spares and shall be wired to the terminal block of the control panel. Provision shall be made for future expansion of extra I/O modules.

3) Some of the common features of the I/O modules shall be as follows :

i. All inputs shall be terminated with input protective network and necessary isolating barriers.
ii. Filters for noise rejection.
iii. Provision for isolation of faulty channels.
iv. Test points and fault indication LEDs shall be provided to carry out module testing.
v. Surge withstands facility as per IEEE standards.
vi. All the modules shall be of addressable type.
vii. Protection for continuous overload up to 200% of all input ranges.
viii. Fuse protection and fuse failure detection.
ix. Internal battery backup.

f) Software

a) The online real time operating system supplied shall be proven for similar application and shall be able to support all the equipment/peripherals.

b) Software shall support various mode of operation of the WDS automatic / manual & various modes as per process requirements & shall be upgradable at any time during O&M period. Software (HMI, SCADA & other required software's) licenses shall have lifetime validity.

c) All graphics for WDS operation and controls.

g) PLC Programming

a) The PLC programming software shall be Windows based user friendly package. The software shall be supplied along with its documentation (hard copy as well as soft copy). The software shall have facilities for:

i. carrying out program revision and management of these revisions
ii. insertion of comprehensive program subroutine and rung comments
iii. search and find and search and replace ‘contacts’ and ‘coils’
iv. simulation functions and testing of the program by changing the status of

contacts and monitoring the outputs

v. preparation of coil and contact list and their locations and memory maps

vi. make system backup copies while the system is online

vii. upload and down load programs to the PLC online

viii. carry out line maintenance and fault finding on the PLC

b) The PLC programming shall be prepared using the PLC manufacturer's programming software package only. The PLC code shall be structured in the manner of the best industry standard and have comprehensive subroutine and rung annotation.

c) The PLC shall be commissioned using RAM memory storage modules which shall be replaced with an EEPROM when testing is complete.

Technical Particulars

Sr. No	DESCRIPTION	REQUIREMENT
1	Type of Control system	Programmable Logic Controller (PLC)
2	Offered PLC System configuration and PLC system hardware	Latest system available / being supplied in the international market by the manufacturer with proven performance record for the similar type of application
3	Operating System windows based	Windows –7 or latest.
4	Hierarchical protection for operator & engineer functions	Multi-level security required
5	UPS – Input-415V, 3P / 240V 1P AC (to be decided during detailed engineering) Output- 230 V AC, 1Ø, 50 Hz	UPS of adequate capacity with battery back-up of min. 1hour (SMF Nickel-Cadmium batteries). 415V, 3P / 240V 1P AC (to be decided during detailed engineering)
6	No of UPS feeders (outgoing)	Bidder to indicate
7	UPS sizing	Bidder to indicate. Adequate capacity UPS considering 30 % spare load.
8	UPS Battery back-up time	Min. One (1) hour
9	Response time (Maximum) for Analog input RTD	250 m sec
	Digital Input / output	1 sec
	Loop cycle time inclusive of controller processing time	25 - 50 m sec
		250 m sec (Analog); 100 m sec (Digital)
10	Card changeover, card wiring removal or communication cable change shall be possible on-line (PLC running) without causing any process interruption	PLC Card removal shall be hot swappable.
11	Display Call up time in HMI monitor	1 sec or better
12	Dynamic update time of parameters in the HMI monitor for	1 sec. or better

Sr. No	DESCRIPTION	REQUIREMENT
	measurement and control	
13	Spare capacity required in the control processor considering spare I/O channels and future I/O modules to be located in the spare I/o slots	Minimum 20 %
14	Output status on controller failure	Configurable in engineering station
15	Output status on power supply failure	Configurable for switching to fail safe mode
16	Status indication for each channel in DI / DO card	LED indication required
17	Power supply healthiness status in all modules	LED indication required
18	Optical Isolation with IPR for DI / DO	Required
19	Galvanic isolation for AI / AO	Required
20	Fuse Protection for AI / DI modules	Required
21	Fused terminals with LED indications for each DO and also for Power supply to PLC	Required
22	All I/O module status monitoring (Channel & Module level) in PLC system HMI & shall be from same processor family.	Required
23	Self-diagnostics for all PLC modules	Required
24	Control processor with floating point arithmetic capability	64 bit processor
	Capacity of RAM	2 MB minimum
	Spare capacity in RAM	Minimum 50 % including spare I/Os
	Processor Redundancy	Required. Dual redundant hot stand-by, Physical cable connectivity between primary and secondary controllers, loading of programs in primary controller alone.
	Power supply source redundancy with Auto changeover scheme.	Not Required.
	Power supply module redundancy in the PLC panel	Not Required
	Communication module redundancy	Not Required
26	Failure of communication module/ data bus/ communication bus/Power supply module shall not lead to change over of Processor/CPU	Required
	Network & Network module redundancy	Required

Sr. No	DESCRIPTION	REQUIREMENT
	Hot redundant connectivity between processor to I/O rack	Required
27	Primary and secondary indication on controllers	LED indication & also in MMI required
28	Memory expandability	150% of offered capacity
29	RAM with Battery back up	Minimum 72 hr without power.
	Supply of Flash RAM for memory /Program retention	Required
30	Closed loop control	Redundant I/O system
31	Open loop control (Logic , protection & interlock)	Non-redundant I/O modules
32	Maximum number of channels in I/O modules - Analog I/O modules RTD, Thermocouple Digital I/O modules	 8 Channels (Differential type) 16 Channels 32 Channels
	Input – Output Philosophy	
	Motor	**Digital Input:** Local / Remote Selector-1 No Run Feedback- 1 No Stop Feedback- 1 No Over Load Feedback- 1 No **Digital Output:** Start Command- 1 No Stop Command-1 No **Analog Input:** Speed Feedback (Applicable for VFD driven Pump)-1 No Vibration Sensor Feedback(Applicable for MV Motor)- 6 Nos **Analog Output:** Speed Reference (Applicable for VFD driven Pump)-1 No **RTD Input:** Windings & DE / NDE Bearings Temperature (Applicable for motor having winding and bearing RTDs)- 8 Nos
	Pump	**Analog Input:** Pressure Transmitter- 1 No (wherever continuous Pressure monitoring is required) Flow Transmitter- 1 No (wherever continuous Flow monitoring is required)
	Motorized Valve	**Digital Input:** Local / Remote Selector-1 No Open Feedback- 1 No Close Feedback- 1 No Over Load Feedback- 1 No Torque Switch Feedback-1 no **Digital Output:**

Sr. No	DESCRIPTION	REQUIREMENT
		Open Command- 1 No Close Command-1 No **Analog Input:** Position Feedback (Applicable for Modulated Control Valve)-1 No **Analog Output:** position Reference (Applicable for Modulated Control Valve)-1 No
	Breaker	**Digital Input:** Local / Remote Selector -1 No ON Feedback- 1 No OFF Feedback- 1 No Master Trip Relay Operated- 1 No **Digital Output:** ON Command- 1 No OFF Command-1 No
	Transformer	**Digital Input:** Oil Level Low Alarm-1 No Oil Temperature High-1 No Oil Temperature Very High-1 No Winding Temperature High- 1 No Winding Temperature Very high-1 No Buchholz Alarm-1 No Buchholz Trip-1 No Pressure Relief Device Trip -1 No OLTC Fault-1 No
	Sump / Tank	**Digital Input:** Level Very High-1 No Level High -1 No Level Low-1 No Level Very Low-1 No **Analog Input:** Level Transmitter- 1 No (wherever continuous Level monitoring is required)
33	Power supply to the field transmitters	Analog input module shall drive the connected field transmitter on 2 wire loop
34	Interrogation voltage for Digital signals	24 V DC
35	Concept of I/O grouping	a) No two identical / similar equipment shall be grouped in the same I/O module b) I/Os related to an equipment and I/Os related to its associated auxiliaries shall be connected to different modules. Inputs and outputs shall not be combined in a single module.
36	USB ports on Operator station	4 nos.
37	DVD R/W drives on Operator Station	One(1)
38	Displays on HMI monitor	Process mimic displays, trend displays, system status, alarm displays, logs /

Sr. No	DESCRIPTION	REQUIREMENT
		reports etc. HMI software shall have minimum 100 pages with unlimited tags.
39	Minimum no of plant mimics configurable	100
40	Time activated logs	Periodic logs, shift report, daily report, status change log, Control system fault log
41	Engineering Work Station cum OWS	One no. industrial grade EWS cum OWS shall be considered. - Intel I5 / I7, Minimum 3.6 GHz processor or latest - 21" LCD Monitor - 8 GB RAM min or better - 4TB HDD - DVD R/W Drive - QWERTY Keyboard - Workstation model - Original OS & antivirus
43	Annunciation System	Integral to the PLC
44	Printers	One A4 size colour laser jet printer (600 DPI resolution) shall be provided
45	Hot Spare I/O modules	20 % (wired up & mounted) hot spare modules for each type of I/O module shall be provided in the panel
46	Spare Channels in each I/O Module used	20 % (wired up) spare channels over the entire population of each type of module.
47	Spare slots in the I/O rack (wired with connector)	20% additional slots/base in each rack shall be provided which shall be wired with connectors for future provision. This is in addition to the required 20 % (wired & mounted) hot spare modules.
48	Fuse with led indication for I/O channels	- Individual for analog signals - Group of max 8 for digital channels
49	SER	SER in PLC is envisaged for electrical signal only.
51	Interposing Relays	24 V DC with freewheeling diode across the coil – Relay contact rating A at 230 V AC
52	Panels / Cabinets	Wall mounting type having maximum height of 800mm
54	Mechanical features	a) 2 mm thick CRCA steel sheet for panel walls. 3mm thick removable gland plate b) 2.5 mm thickness for double doors c) Panel - door switch d) Fans and louvers e) Paint as per RAL 7035 f) Automated panel Illumination by

Sr. No	DESCRIPTION	REQUIREMENT
		push buttons g) Suitable enclosure protection
55	Panel Earthing	Safety earth for enclosure and Electronic earth for PLC system.
57	Quality Assurance	As per quality plan to be approved by the Purchaser / Engineer
58	Inspection Requirements	Factory Acceptance Test & Site Acceptance Test as per procedure approved by the Purchaser / Engineer.
59	Communication	The communication shall be redundant between the control processors and HMI as well as across processors and transmission rate shall be minimum 100 MBPS/1GBPS through multi- port switch having FO ports, ensuring adequate number of spare ports. Also communication between control processors and I/O shall be redundant. PLC shall be provided with required number of MODBUS ports. PLC shall have time synchronisation facility with master clock directly connected to PLC cards. It shall also have GSM/GPRS model for communicating with the DMA
60	Undertaking for Spares & support	OEM's undertaking shall be furnished for Spares & service support for minimum 10 years.
61	Make of PLC	As per Approved List.
62	**Control Cabinets/ Consoles:**	
	Type & Constructional Features	• Indoor, wall mounting type with maximum height of 800 mm • Sheet Steel Thickness - 2.0 mm thick CRCA sheet for panel walls. 3mm thick removable gland plate. • Paint Finish as per RAL- 7032. • Enclosure Protection – IP54
	Accessories	• Panel - door switch • Fans and louvers • Panel Illumination Lamps
63	**Software:**	
	PLC Development License Software	Required

Sr. No	DESCRIPTION	REQUIREMENT
	SCADA Development License Software	Required
	SCADA Run Time License Software	Required
	Work Station Operating System License Software	Required

Uninterruptible Power Supply (UPS)

a) A UPS with 60 minutes backup time shall be provided for the power supply of Instrumentation, Control & Automation system. The UPS shall have sealed maintenance free batteries and AC distribution board.

b) The batteries shall be sized such that the maximum recharge time does not exceed 8 hours. Contractor shall furnish UPS sizing calculations for review and approval.

Sr. No	DESCRIPTION	REQUIREMENT
1	Input	415V, 3P / 240V 1P AC (to be decided during detailed engineering)
2	Output	230V AC, 50 Hz
3	UPS Capacity	*KVA (* KVA rating shall be finalized during detailed engineering)
4	UPS Battery back-up time	Minimum 60 min.(SMF NI-CD)
5	No of UPS feeders (outgoing)	As per system requirement.
6	UPS Type	Online, Double Conversion, Industrial
7	Rectifier Charger Type	SCR / IGBT Based
8	Static Inverter Type	SCR / IGBT Based
9	Static Transfer Switch Type	SCR-SCR Based
10	Bypass	Solid State Static Bypass with Isolation in matching cubical
11	Manual Bypass Switch Type	Change over
12	Battery Type	SMF NI-CD
13	Isolation Transformer	Required, Built in within UPS- Input Side & Output Side
14	Degree of Protection	IP41 or better
15	Cable Entry	Back Side Bottom
16	Communication - SNMP Card & MODBUS	Required
17	Potential Free Contacts	- Rectifier Trip - Inverter Trip - Load on Battery - Battery low Pre-alarm - Load on Static Bypass - One Relay contact for each, Rating – 1A/230 Vac OR 2A / 12 Vdc
18	Drawings / Documents	SLD, GA, Power & Control Wiring Diagram & Foundation Details, Type

Sr. No	DESCRIPTION	REQUIREMENT
		Test Certificate, FAT/SAT Procedure
19	Reference standard	IEC 62040-3 or equivalent

GSM/GPRS MODEM

- 1 Modem shall support SIM900 Quad Band GSM/GPRS engine suitable to transfer data over GPRS for any 4G network
- Modem shall have Built In RS232 Serial Interface Port/ Ethernet /Suitable port
- Modem shall have Built In Network Status LED
- Modem shall have Built In Sim Card Holder
- Modem shall have configurable Baud Rate
- Modem shall operate with Input Voltage of 24VDC

Surge Protection Devices:

a) Surge Protection Devices (SPDs) shall be provided for each signal and power loop for field instruments located outdoor. One SPD shall be provided in the field near transmitter and the other SPD of the loop shall be mounted in the control panel. SPDs shall be suitable for withstanding the surge arising out of high energy static discharge / lightning discharges and protect the instrument to which it is connected against damage. SPDs shall provide protection through the use of quick acting semiconductors like Tranzorb, zener diodes, varistors and an automatic disconnect and reset circuit. SPDs shall be passive and shall require negligible power for operation. During the occurrence of a surge it shall clamp on the allowable voltage and pass the excess voltage to the ground. The SPDs shall be self resetting to minimise the down time of the measurement loop. SPDs shall have minimum surge rating of 10 KA.

b) SPDs shall have a weather proof casing and shall be suitable for field / back of panel mounting as applicable. There should be total isolation between input, output and ground terminals.

Surge protection devices (SPDs) shall be provided at the control panel end of all instrumentation cables for the instruments located outside the building, in addition to the SPD at the instrument end. The SPD s shall be grouped in a specific area within instrument panel.

QUALITY ASSURANCE, INSPECTION AND TESTING:

Contractor shall submit test and calibration certificates for various instruments for review and approval prior to despatch. Factory inspection for instruments is not required. Contractor shall offer FAT for PLC system at the manufacturer's / system integrator's works. The system shall be inspected for the workmanship, correctness of wiring and operation with necessary simulation.

The automation system shall be designed, selected & supplied ensuring proper quality & performance. Vendor's procedures for Factory Acceptance Tests (FAT) and Site Acceptance Tests (SAT) shall be

submitted at least 60 days prior to the scheduled conduction of these tests for review/acceptance.

The proposed FAT & SAT procedures of Vendor shall be reviewed and modified as required to generate mutually agreed & finalized procedures, based on which these acceptance tests will be performed and supervised by authorized agency of purchaser.

All system hardware & software used for testing shall be complete as specified and shall use actual equipment to be shipped to the site as per scope.

The test equipment, meters, instruments etc. used for testing shall be calibrated at recognized test laboratory at regular intervals and valid certificates shall be made available to the purchaser at the time of testing. The calibrating instruments used as standards shall be traceable to international standards. Calibration certificates for test instruments shall be produced from a recognized laboratory for the purchasers consent in advance of testing and if necessary the instruments shall be recalibrated or substituted before the commencement of the test.

Factory Acceptance Tests (FAT):

The factory acceptance test shall be held at manufacturer's works. Prior to the FAT, all the equipment shall be fully assembled, wired and properly connected & tested to establish all the specified features & functional requirements of the systems.

During FAT, functional integrity of the system hardware and software shall be tested & demonstrated. All the necessary simulation kits as may be required for testing of software shall be arranged.

Bidder shall perform functionality tests of complete system and satisfy himself of the results before giving notice regarding readiness of the system and its availability for FAT. Such notice shall be given minimum 15 days before the scheduled start of the FAT.

The factory acceptance tests shall include visual and mechanical testing to establish correctness, completeness, good workmanship and functional testing.

The tests shall systematically, fully & functionally establish performance of all the hardware & software in presence of authorized representatives. All the sub-systems shall be interconnected to simulate, as close as possible, the total integrated system. Each test carried out shall be documented. Simulators shall be used for simulating field inputs. Any deficiency or problem faced shall be clearly brought-out and corrected.

Before start of the FAT, the complete integrated system shall be kept powered on for 72 Hrs.

All assemblies shall be aligned & adjusted and all test results shall be documented. The automation system shall be shipped to site only after successful completion of FAT and receipt of dispatch clearance from purchaser.

Site Acceptance Test (SAT)

At site, the system shall be properly installed taking care of manufacturer's recommendation, after which Site Acceptance Tests (SAT) shall be carried out taking into the actual field instruments/ equipment in the loops.

The Site Acceptance Test shall be held at site after the system has been installed as per the finalized SAT procedures. The tests shall be witnessed by purchaser.

The minimum tests to be carried out shall be as indicated in table below. A log of all failed/ mal-operating components /modules in a sub-system shall be maintained by Vendor, with description of the affected components /modules, cause of failure, effect of failure on the sub-system and number of hours of operation before it failed. This will start from the date of powering on of the system for cold commissioning.

Test & Acceptance Criteria:

Test Criteria:

Following tests shall be performed as a minimum for automation system, during both FAT & SAT, in presence of authorized representatives and documented test results shall be compiled:

Sl. No	Test Description	FAT	SAT
1.	Check of supply completeness	√	√
2.	Visual & dimensional check	√	√
3.	Check of complete system configuration loading	√	-
4.	Check of system diagnostic features. These shall include failure of any sub-system, module, power supply, interface unit, failure of transfer to redundant module on main module failure etc.	√	√
5.	Power-off and power-on of any single unit	√	√
6.	Test of alarm system	√	√
7.	Check of correct functionality of keyboards	√	√
8.	Testing of proper working of the printers	√	√
9.	Simulation of power failure and restart. Self-booting up of system configuration & program after power restoration.	√	√
10.	Analog / digital input / output check	√	√
11.	Check of scan time for PLC	√	√
12.	Check of scan time, screen update time and loop cycle time.	√	√
13.	Check of loop configuration for correct entry of ranges, limits etc.	√	S
14.	Check of HMI displays (all kind of displays)	√	S
15.	Checking of HMI screen refresh rate, data base update and display call-up time.	√	S
16.	Check of system internal loading (processor, communication system etc.)	√	-
17.	Check of various log formats, shutdown reports etc.	√	S
18.	Demonstration of all PLC system builder functions including addition/deletion of an input/output, addition/deletion of a rung or an element in a rung generation of dynamic graphics and other views, report generation etc.	√	√
19.	100% checking of logic configured in the PLC by connecting switch/lamp at input/output.	√	-
20.	Redundancy check for PLC including correct changeover of the back-up unit in case of failure of main unit. These shall be applicable for following: CPU Redundancy CPU Power supply redundancy Each CPU to host system communication interface & communication link redundancy I/O subsystem to processor system communication redundancy I/O rack power supply redundancy	√	√
21.	Checking of output status on processor failure for PLC & checking of first-out alarm generation.	√	√

FAT=Factory Acceptance Test; to be performed at Vendor's workshop. SAT= Site Acceptance Test; to be performed at site. √= Complete test; 100% of devices/ functionality will be tested. S = Sample test

All the necessary simulation kits as may be required for testing of software shall be arranged. Acceptance of any equipment or the exemption of inspection shall in no way absolve the Vendor of the responsibility for delivering the equipment meeting the entire requirement specified in this specification and also as may be required for satisfactory operation of the process.

Acceptance Criteria:

Automation system shall be suitable to meet the below minimum acceptance criteria, which are to be demonstrated by the successful bidder during testing of the system.

Sr. No.	Description	Criteria
1	Availability of Automation System	99.8% [calculated over a period of seven (7) working days]
2	HMI screen refresh time	1 sec
3	I/O scan time/data up gradation time	250 milisec for analog signals 100 milisec for digital signals Priority processing shall be provided for the data requiring faster scan rate
4	Network bandwidth utilization (Average of 5 minutes) (To be measured over continuous period of 8 hours)	< 10%
5	Spare (free) memory capacity available (for system, server & PCs, PLC controller)	50% (after commissioning)
6	Spare I/O capacity of each type at each location, spare ports of networking switches	20% (after commissioning)
7	CPU loading (5 minutes average)	50% (after commissioning)

SPARES AND CONSUMABLES:

Commissioning spares:

Bidder shall submit a list of spares & consumables required for start-up and commissioning of the plant, equipment, systems etc. which will be supplied as part of scope. The list shall broadly include spares & consumables for the field instrumentation items, as per manufacturer's recommendation and one no. of each type of I/O module of the PLC based automation system, with respective description & quantities. In addition, any other spare & consumable, required during these activities, shall also be supplied by bidder under his scope.

O&M Spares:

As specified in the Scope of Work, Bidder shall keep with himself necessary spares during entire period of Operation & Maintenance for repair, replacement, maintenance etc. of ICA equipment.

The list of recommended spare parts shall be provided by the bidder but shall not considered in price bid. Mandatory spare parts shall be inclusive of quoted price.

TOOLS AND TACKLES:

Bidder shall include in his offer and provide all the special tools and tackles for erection, testing & maintenance of the instrumentation & automation system, as required for proper functioning and maintenance system

APPLICABLE NATIONAL/INTERNATIONAL STANDARDS

a) AGA American Gas Association, Gas Measurement Committee

b) ANSI/ASME American National Standards Institute/American Society of Mech. Engineers

B 1.20.1 Pipe Threads

B 16.5 Steel Pipe Flanges and Flanged Fittings

B 16.20 Ring Joint Gaskets and Grooves for Steel Pipe Flanges

c) ANSI/FCI American National Standar ds Institute/Fluid Controls Institute

70.2 Control Valve Seat Leakage Classification

d) API American Petroleum Institute

RP 520 Sizing, selection and installation of pressure relieving systems in refineries.

Part-I - Sizing and selection

Part-II - Installation

RP 521 Guide for pressure relieving and depressurising systems

RP 526 Flanged steel safety relief valves

RP 527 Seat tightness of pressure relief valves

MPMS Manual of Petroleum measurement standards

RP 551 Process measurement instrumentation

Part - I Process Control and Instrumentation

RP 552 Transmission Systems

S 2000 Venting atmospheric and low pressure storage tanks

S 670 Vibration, Axial-Position and Bearing Temperature Monitoring Systems

e) ASTM American Society for Tests and Materials

f) BS British Standards

BS-1042 Measurement of Fluid Flow in Closed Conduits

BS-5308 Part-II Specification for PVC insulated cables

BS-7244 Breather Valves

g) DIN-43760 Temperature Vs. Resistance curves for RTDs

h) DIN-19234 Electrical Distance Sensors; DC interface for distance sensors and signal converter

i) DIN-50049 Document on Material Testing

IEC International Electrotechnical Commission

IEC 79 Electrical apparatus for Explosive Gas atmosphere

IEC 85 Thermal evaluation and classification for electrical insulation

IEC 332 Test on bunched wires or cables

Part III Cat. A

IEC 529 Classification of degree of protection provided by enclosures

IEC 534-2 Industrial Process Control Valves - Flow capacity

IEC 584-2 Thermocouples - Tolerances

IEC 751 Industrial Platinum Resistance Thermometer Sensor

IEC 801 Electromagnetic compatibility for industrial process measurement and control equipment

j) IS Indian Standard

IS-5 Colours for ready mixed paints

IS-319 Specification for free cutting brass bars, rods and sections

IS-1239 Mild Steel tubes, tubulars and other wrought steel fittings

IS-1271 Specification of Thermal Evaluation and Classification of Electrical Insulation

IS-1554 Part-IPVC insulated (heavy duty) electrical cables – working Voltage upto and including 1100V

IS-2074 Ready mixed paints, air drying, red oxide - zinc chrome

IS-2147 Degree of protection provided by enclosures for low voltage switch gear and control gear

IS-2148 Flame proof enclosures for electrical apparatus

IS-3624 Specification for Pressure and Vacuum gauges

IS-5831 PVC insulation and sheath of electric cables

IS-7358 Specification for Thermocouples

IS-8784 Thermocouple compensating cables

ISA Instrument Society of America

S-5.2 Binary logic diagrams for process operations

S-7.3 Quality standard for instrument air

S-75.01 Flow equations for sizing control valves

k) ISO 5167 Measurement of fluid flow by means of orifice plates, nozzles and venture tubes inserted in circular cross-section conduits

l) NACE National Association of Corrosion Engineers - MR-01-75

m) NEC National Electric Code

n) NEMA National Electrical Manufacturer's Association

ICS-6 Enclosures for industrial control and systems

o) NFPA National Fire Protection Association

p) NFPA-496 Purged and pressurised enclosures for electrical equipment

q) OSHA Occupational Safety and Health Authority

Any other national and international codes as applicable subject to approval of Client

DETAILED TECHNICAL SPECIFICATIONS FOR CONSUMER AMR/AMI WATER METER CONNECTION

SUPPLY OF AMR/AMI WATER METER

Supply of ultrasonic type Domestic AMR/AMI Water Meter of Class-B type, AMR/AMI meter of domestic type for 15mm, 20 mm and 25mm size shall be equipped with in built AMR/AMI technology & wireless, and above 20mm size shall be inbuilt/ directly fitted on water meter RF based AMR/AMI technology & wireless, Dry dial, MID approved conforming to ISO: 4064-2005/OIML R 49 with IP-68 protection class inclusive of all taxes, testing, loading, unloading, insurance etc. complete.

19.1. GENERAL SPECIFICATION FOR DOMESTIC WATER METERS & STRAINERS

Scope of Application :-

Supply of ultrasonic type Domestic AMR/AMI Water Meter of Class-B type, AMR/AMI meter of domestic type for 15mm, 20 mm and 25mm size shall be equipped with in built AMR/AMI technology & wireless, RF/Cellular/Low powered wide area network based AMR/AMI technology & wireless, Dry dial, MID approved conforming to ISO: 4064-2005/OIML R 49 with IP-68 protection class inclusive of all taxes, testing, loading, unloading, insurance etc. complete.

The meter will be used for the measurement of cold, chlorinated potable water. The meter manufactured after year 2016 will only be accepted.

Technical Specification for Domestic AMR/AMI Water Meters ultrasonic type:-

a) A battery operated inline Ultrasonic water meter with no moving parts and based on transit time technology using sensors for high stability and accurate measurements.

b) Battery operated meter with a battery life of minimum 15 years. The life of battery of AMR/AMI water meter shall not be less than 15 years from successful installation of said AMR/AMI water meter along with its AMR/AMI system

c) Meter must comply to IP68 for indoor and outdoor operation, including fully submerged installations

d) The meter should be type approved and verified according to international water meter Standard OIML R 49 and or ISO 4064. The meter should be MID approved.

e) Accuracy Class 2 – +/-2% or better over operating range and temperatures. The ultrasonic water meter should maintain its accuracy over its lifetime.

f) 3-Point calibration with calibration certificate available for each unit.

g) Dynamic Range of Minimum 500:1 (Q3/Q1).

h) The water meter composite body shall be made of corrosion resistant material like brass, bronze or engineering plastic. Other material shall not be accepted

i) Working pressure is 16 bar.

j) Temperature of 0.1 degree C to 50 degree C.

k) The meter should be tamper proof with suitable data protection of calibration and revenue parameters.

l) The smart meter should have advanced diagnostics with active alarm(s) indicated on display

m) Display with ≥5 digits for main information. Index, menu and status symbols for dedicated information

n) The measuring units should be m^3 for volume

o) The ultrasonic water meter should have inbuilt remote reading capability using point-to-point RF/cellular/Low powered wide area network

p) Minimum starting flow shall be 1 litr/hr for 15mm and 2l/hr for 20/25mm.

q) The meter should not measure air flow.

r) The water meters shall have the anti – magnetic properties / immunity, as specified in ISO-4064:2005, when tested with 4000 gauss magnet. The AMR/AMI system shall remain unaffected with application of 4000 gauss magnet, as specified in ISO-4064:2005.

Applicable Standards:

The meter shall conforming to OIML R49, ISO-4064-2005 and MID Approved Certificate and protection as per IP-68 for required size standards for ultrasonic water meters. The pattern approval document should be sent with the tender documents as well as any other technical document, which may help VSCDL in assessing the meters technical merits and its suitability for the prevailing operating conditions.

Material:

- The meter upper and lower cases in addition to the material should be in accordance to OIML R49, ISO-4064-2005 and other exposed parts shall be made of brass or bronze alloy or engineering plastic; other materials will not be accepted.

- Material that come in contact with the water supply shall withstand 2 ppm (parts per million) of chlorine residual in the water supply and shall be resistant to corrosion.

- The AMR/AMI Water Meter and accessories shall be manufactured from materials of adequate strength and durability.

- The materials, which come in contact with the potable water, shall not create a toxic hazard, shall not support microbial growth, and shall not give rise to unpleasant taste or discoloration in the water supply. The meter should be approved for use in potable water application, necessary document and evidence shall be submitted by the bidder.

- The body of the meter shall be of either Brass or Bronze or engineering plastic. The firm shall

specially mention in the offer, the metal used in manufacturing.

- The meter must offer the facility to compatible with latest technology of wireless AMR/AMI RF/Cellular/low powered WAN unit should be acceptable.

The Totalizer and Totalizer Shield:

The totalizer protective cover shall be made of sturdy glass/engineering plastic and shall have thickness in accordance to ISO-4064-2005. Study glass is defined as the ability of the counter protection glass to withstand, without damage, a free fall of a metal ball weighing 27.2 grams from a vertical distance of not less than 70 cm.

- Totalizer shall be of straight reading type.
- The totalizer shall register in cubic meter units.
- The totalizer shall be show reading of less than 10 kl at the time of supply.
- The totalizer shall consist of a row of minimum five on-line consecutive digits to read at least 99,999 m3.
- Another three digits or pointers shall register flows in liters and be of a different color.
- The totalizer should be of closed type.

Internal Strainer

- The meter shall be supplied with a strainer in the inlet of the Water Meter

Accuracy Class:

The accuracy of the meter shall be in accordance with ISO-4064-2005, class- B.

Pressure and Temperature:

The working pressure shall not be less than 16 bar and shall conform to the testing in accordance with ISO 4064. The meter shall be capable to operate in an ambient temperature of up to 50°C.

Meter Markings:

The AMR/AMI Water Meter shall be marked with the following identifications:

(a) A Direction of water flow with an arrow indicating the direction.
(b) Trade mark and/or name of the Manufacturer.
(c) The metrological class and Q3 rate in m3 / hour and R.
(d) The Manufacturer's serial number of the meter permanently affixed to the meter's upper or lower case or on the electronic register or it can be programmed in the electronic register.
(e) Stamped with the initial "VSCDL" on meter body/dial.
(f) Working pressure.
(g) Approval marking and No. of approval certificate.
(h) Year of manufacturing printed on the counter or engraved on the head ring.
(i) MID /CE marking and code.

Accessories :

The meter shall include the following accessories:

1) Two threaded tailpieces, which shall conform to IS: 8521 for threaded end.

Spare Parts:

The cost of spares required maintaining the meter for contract period and during defect liability period shall be inclusive in the cost of meter.

Packaging:

The AMR/AMI Water Meters shall be packed in containers or boxes containing not more than fifty (50) meters each.

Meter Testing:

1) The meter shall be tested for test according to IS0-4064 in FCRI laboratory as below in presence of owner's representative. However, head of the Hydraulic Department is authorized to permit testing at NABL accredited laboratory in special cases.

> Pressure tests

> Determination of error curves as a function of flow rate.

> Pressure loss test

FOLLOWING AMR/AMI TESTING MUST BE DONE BY BIDDERS AT FCRI, PALAKKAD, KERALA.

- IP 68 Testing of AMR/AMI system.
- Remote reading of AMR/AMI Water Meter in dry i.e. Open air condition.
- Remote reading of AMR/AMI Water Meter in submerged condition i.e. under water, with under variable water depth condition.
- Remote reading with different temper alarms for back flow, magnet and physical damage etc.
- Response time of AMR/AMI reading on HHU.
- Real index
- Visual inspection of AMR/AMI Water Meter and its AMR/AMI system along with its software.
- Demonstration of uploading of readings from hand held unit to PC and vice versa.

2) The testing shall be carried out for the flow rate as mentioned ISO-4064 and the error permitted shall not exceed that mention in ISO-4064.
3) For the accelerated wear test, manufacturer's test certificate for the life cycle of supplied model of meter shall be furnished. and certificate of approval from FCRI under model approval programme.
4) The tenderer shall have to make all necessary arrangements for testing/ inspection. All the charges towards testing/ inspection including travelling, accommodations and other expenses of owner's representatives (Max 2 persons) shall be borne by the tenderer.
5) Satisfactory certificate from end user.

Material and Workmanship:

The meter shall be guaranteed against defects in material and workmanship for a minimum period of ten years from date of delivery.

Working Pressure:

The meters working pressure shall be 16 Bar with test pressure of 25 Bar as per ISO 4064.

AMR/AMI SYSTEM:

1) If the AMR/AMI communication frequency is using/ operating on paid frequency band then the AMR/AMI Water Meter manufacturer has to produce the valid copy of license issued by Govt.of India/Deptt of Telecom (DOT) for using the said operating frequency band. The cost of the same will presumed as included in the quoted rate.
2) If the meter is transmitting in unlicensed frequency band, then manufacture has to provide equipment type approval certificate issued by WPC, DOT, and Government of India.
3) The AMR/AMI meter shall have the facility to transmit reading in maximum submerged condition (as specified for IP-68 compliance) & the remote readings should be obtained outside the meter chamber, with AMR/AMI Water Meter in submerged condition & lid of the chamber closed.
4) Battery life of AMR/AMI Water Meter shall not be less than 15 years from successful installation of said AMR/AMI Water Meter along with its AMR/AMI system.
5) The AMR/AMI trans- receivers shall be wireless and have IP-68 protection class i.e. no ingress of water after submerging AMR/AMI meter for 48 hours under 3 meters of water column.
6) The AMR/AMI System shall have facility to record the reverse flow in AMR/AMI Water Meters reading and it shall show the quantum & period of reverse flow.
7) AUTOMATIC METER READING Shall be obtained even under submerged condition.
8) Meter interface unit shall not get affected for its AMR/AMI functioning due to High tension high voltage line concentration.
9) The AMR/AMI system shall have the facility to record the abnormalities like application of external magnetic effect, very high consumption, water leakages etc. along with necessary alarms in HHU and soft ware.
10) All AMR/AMI reading shall show the date and time of the reading recorded.

HAND HELD DEVICE /HAND HELD UNIT (FOR WALK BY/DRIVE BY SOLUTION)

1) Hand Held Unit or Reading device shall have the sufficient memory (minimum 4000 reading data) for storage of Maximum data/ reading along with sufficient power back up. It shall be rugged, HHU/tablet/ Android/IoS device suitable for the purpose of remote meter reading.
2) Hand Held Unit device shall have capacity to store 4000 nos. AMR/AMI Water Meter reading at a time. Min 2 GB RAM and minimum storage of 64 GB solide state hard drive and have minimum 7" LCD/LED display and Qwerty keyboard
3) Hand Held Unit Should be adjustable back light, sunlight readable, colour and touch screen.
4) Hand Held Unit must be designed to be comfortable for hand held meter reading.
5) The Battery of Hand Held Unit or Reading device shall give power back up for at least 8 hours continuously.
6) The unit must have able to withstand three foot drop on concrete.
7) There must be audible beep when indicating key has been pressed, there must also be an auto repeat function on keys and rapid response between keying and seeing results on the screen.

8) Hand Held Unit should have the facility to create route, modify route on site and arrange in desired sequence as per site condition.
9) The HHU shall have the onsite search facility, to locate the exact physical location of AMR/AMI Water Meter in particular area and to obtain the corresponding details of it.
10) The handheld must come with an integrated intelligent fast charge capability that allows full charge within 8 hours.
11) The hand-held must have a 3G/GPRS connectivity for real-time data communication with central server and integrated Global Positioning System (GPS) for route monitoring and configuration. Additionally, at least one USB port and min. One RS 232 port shall also be provided for data transmission to the server.
12) Remote reading of individual AMR/AMI Water Meter, maximum distance of 200 meters with clear line of sight under submergence condition with lid of chamber enclose position, with Walk by and Drive by during field demo as well as after installation main work.
13) Hand Held Unit / Reading Device should have the facility to send/ receive data to cloud/ web server.

AMI

1) Suitable gateways/cellular modems as necessary to guarantee min. 95% data transfer from meter to server shall be provided
2) Cellular Modems-

Sim card shall be provided by the bidder and should ne active for the entire contract period.

GSM/GPRS MODEM

1) 1 Modem shall support SIM900 Quad Band GSM/GPRS engine suitable to transfer data over GPRS for any 4G network
2) Modem shall have Built In RS232 Serial Interface Port/ Ethernet /Suitable port
3) Modem shall have Built In Network Status LED
4) Modem shall have Built In Sim Card Holder
5) Modem shall have configurable Baud Rate
6) Modem shall operate with inbuilt battery

3) Gateways –
   a) Either the bidder himself or the bidder having an arrangement with or assured access from a basic service operator (BSO) shall provide the AMI/fixed network for remote metering system.
   b) The bidder or the BSO shall be registered with or have the requisite license to provide M2M connectivity for commercial purpose using Low powered wide area network.
   c) The bidder or BSO shall provide necessary infrastructure such as gateways and server for the transfer of meter data to the cloud server/physical server.

d) The gateways should have deep indoor penetration upto 2m min. Inside the premises to ensure over 99% of meters are able to transmit data to the server on daily basis.

e) The coverage range of should be min 1km to 5 km.

f) The bidder or BSO should ensure that end to end encryption of data is achieved.

Note: All charges for the SIM cards and their activation or data transfer from meter to server using gateways and any related expenses shall have to be borne by the bidder during the entire contract period.

SOFTWARE (HHU software and Meter data management system)

1) Operating System: Windows 7 or latest version of windows operating system.
2) The software shall give output, at least in XML/CSV/XLS format and the data should be in standard format .
3) The software shall allow the PC operator to review and edit any account in Route Manager database. Also, the PC operator shall be able to generate route and activity reports. The 90 days historical data should be available in the route as well as the data along with historical data in the output in the XML/CSV/XLS format. Alternatively, the software should allow receipt of data from any AMR/AMI meter within the range of the HHU device and this data should be visible on the HHU irrespective of the fact that the meter was included in the route file or not.
4) The software shall allow the PC operator toe review and edit any account in Route Manager database. Also, The PC operator shall be able to generate route and activity reports.
5) The software shall upload routes from the reading device.
6) Password Protected, individually defined authorization level for each user.
7) The software shall enable the user to specify the data to be exported from the database from transferring to billing system.
8) Automatic data exchange between PC and hand held unit.(Consumer data, readout routes, read out data & manipulation user access data)
9) The software shall select the routes to be read, and assignment of routs to reading device and dynamic updating of routes and sub-routes to be enabled.
10) Software shall alert the meter reader for unread account in that route.
11) Software shall takes routs from an existing data base for loading in to reading device.
12) Data should be available in hand held unit and Base computer software both.
13) Software shall be able to set meter status on fly like, meter not okay, reading not reliable, meter maintenance required etc.
14) Software should have a radio configuration tool which can enable/ disable meter, set/read meter status.
15) Data collection and management and Analysis software/ application should be on cloud based/ web based technology.

16) Software should be capable to handle the reading by manual reading mode, wireless AMR/AMI walk by mode, wireless AMR/AMI walk by mode or wireless AMR/AMI drive by reading mode. Once reading taken it should send the data(reading, historical data) to web server.
17) Software should indicate meter reader statistics to monitor meter reader performance, meter reading speed of meter reader.
18) Integration with AMR/AMI Water Meter Billing Software
19) Software should also allow viewing/generation/printing/export of various reports in tabular, charts, pdf and Csv formats.

BILLING SOFTWARE

Software specs

Billing and Customer Care Software

General features of billing software:

Sr.	Features	Description
1.	Modular Architecture	System shall be built on modular architecture facilitating the implementation of the specific modules/sub-modules or the entire product in total.
2.	Industry Standard Software	System should meet the existing standards in software development. System should be built using latest industry technologies for faster and enhanced performance of the system.
3	User Friendly Browser User Interface (BUI)	System should have Browser User Interfaces enabling easy operation and administration. The application shall have easy navigational and sorting features for faster retrieval and viewing of data.
4	Database	The system should support standard RDBMS like Oracle, MS SQL, PostGress, MysQL, DB2 etc.,
5	Operating System	Latest
6	Service Levels	The system should facilitate user defined service level for each action under each service like request processing, New connection application processing etc.
7	Consumer Profiling	The system should have a facility of profiling the customers based on various parameters. The parameters for profiling the customers should be user defined.
8	Dash Board Intelligence	System should have intelligent components, such as decision driven alerts, which should display instantaneous

		real-time information
9	Integration with third party software's	The software should be able to integrate with third party ODBC compliant systems such as SCADA, GIS, Works Management, Material Management, and Outage Management, Payment Gateways, Email Gateway, SMS Gateway etc. for the future requirements.
10	Executive Information	The Executive Components should consist of Login Information, Office and designation Information and Security Access rights Information. The application should facilitate execution of all the database related operations such as Add, Edit, Delete, View and Search easily from the BUI.
11	Help and Support System	The System should have in-built process help and context specific application help for faster and easy operations. The system shall have well laid out do's and don'ts pertaining to the end users using the system. The system should have contingency-crisis management information such as the contact details of the people to whom the problem shall be reported in case of an emergency. The System should provide easy and quick searching of information pertaining to the department policies, guidelines and know-how's, through a information system
12	Role Based Permissions (RBP)	System should provide access rights to the different modules of the System based on the Login Information. The System should provide access control to the last level of application access, such as whether the users can access/view/modify a particular information or field of a screen depending upon privilege. The System should have login and office based configurable reporting interface enabling the users to view the data corresponding to their own domain of functional control and privileges.
13	Configuration Management and Customization	System should provide configuration module in order to configure the database information based on the user login information, Enabling and Disabling Application Logging, Audit trails and Database Logging, and

		changing the Logging Level (INFO, WARNINGS, ERRORS, CRITICAL). The configuration module shall provide for adding/creating new users, accounts, complaint types, complaint masters and various master tables. System should facilitate for dynamic database reconfiguration.
14	Audit trail	The audit trail information which will help in bringing accountability of the users of the system shall provide well-defined administrator level audit trail system for monitoring and ascertaining application and database level operations performed by end-users.
15	Redefining process rules	The system should have a facility for changing the process rules such as redefining the escalation, service levels, payment details, inspection details & durations, registration numbers conventions etc, by the administrator. Application Remote Monitoring and Logging System shall support remote logging and monitoring of the system to carry out activities related to database reconfiguration and hot deployment of application updates.
16	Data Replication for Centralized Control & Supervision	The System should have seamless data pooling system using industry tested and accepted technologies, Advanced Replication, Push pull technology etc for pooling the data from different centers to a centralized server through Internet / LAN / PSTN Dial Up Network for centralized control and supervision. The centralized database should be available for web publishing for generating online MIS reports.
17	Extensive Analytical and Decision Support Reporting	System should generate various types of analytical reports for MIS. The reports shall be available in various formats such as Word, Excel, HTML etc with printing facility. The reports should contain header and footer information, paging information for viewing particular number of records at a time. The reports shall provide graphical representation of MIS data, wherever necessary.

18	Backup procedures. (Database and Application)	The System should provide for in-built automated database backup procedures at predefined schedules, without the necessity of end-user intervention. The System should provide for manual entry of day-to-day operations, which will act as a back-up facility in case of system /application down.
19	Report Builder	The system shall have the facility to provide the end-user to define and generate ad-hoc reports as per his chosen report criteria, through an easily operable report-builder interface.
20	Efficient Error Handling	System should display error code, brief description of error, possible cause of an error and suggested rectification for the error. Errors should be categorized for easy problem identification and rectification.
21	Security	The system should provide appropriate security/licensing features at application and database levels.
22	Collections anywhere	The system should facilitate online and offline collections at the collection centers and also through payment gateways etc.
23	Query Engine/ Builder	Report builder: the system must have a feature of query builder that allows users to create reports on their own with both tabular & graphical representations The system shall also have inbuilt query system for which a set of buttons shall be provided on tool bar for each pre defined query to be mentioned in SRS. Besides the query engine shall be capable to handle all queries may be generated on the inputs.
24	Biometric finger print authentication for all transactions	All the users who are authorized for transaction approvals are required to register and enroll with the system. All the transactions, which are having financial implications and modification of important information of the customers, have to go through the transaction approval.
25	Customer Care System	• The system should facilitate recording of consumer complaints and grievances by the

		customer care operators. • Unique ID should be generated for each complaint and the docket number shall be the single point of reference and communication. • The System shall facilitate category wise registration of the complaints and shall facilitate the updating of the status. • The System should be able to print Job Cards as per the Operating and Maintenance division wise, which should be configurable. • The system should be able to escalate the complaints to the higher authorities as configured and should be configurable for escalation. • Interface on web portal for consumers to register complaints should be provided. • System should be capable to integrate various other methods and means of consumer grievances. • The system should be capable of generating various MIS reports for all the CRM activities. • There is an existing centralized Consumer Redressal System implemented in the Board (Control Room and Response Centre) at Bangalore. The services of CRRC can also be availed.

Major Modules of the Solution:

S.No	Functionality	Description
1.	Unique Bill No	All bills generated by the system have given a unique number
2.	Format of bill number	The logic for defining the bill number would be flexible and provided by the board. For example the system shall be capable of generating bill numbers that are reflective of the DMA, Zone etc.
3.	Bill Calculation -Billing	Board will provide the billing logic for generation of

	Logic flexibility	bills. This tariff configuration module shall provide the flexibility to revise the billing logic from time to time depending upon the modifications in regulations, tariffs, etc. All changes shall be made in web based software. It shall be possible to manually modify the billing logic on a case basis, with alerts and within specified limits. The periodicity of bill generation is configurable and may vary from generating continuous monthly bills for spot billing to bills once a year for particular type of customers.
4.	Meter Status and Billing	The system shall be capable of identifying meter reading and bill generation as per board defined criteria and generate flags for operator intimation and further investigation. The billing system shall be capable of generating bills in case of; 1. Faulty meters 2. Premises Found Locked 3. Low Pressure 4. No Meter 5. Meter Struck 6. Any other status as defined by board from time to time.
5.	Bar code generation	System is capable of automatic generation of bar code and printing on the consumer's bill
11.	Tariff revision cases	The Spot Billing Device will be able to calculate the tariff rates accordingly with the previous and present rates during the assessment period, so as to issue the on date calculated demand to consumers under tariff revision period including number of days, slab rates etc.
12.	Skipping of meter reading entry	The Spot Billing Device will prompt for entry of present meter reading. If meter reading is skipped, average/units consumed for previous month from the master shall be calculated /retrieved and units for billing shall be displayed.
13.	Billing with charges / adjustments	The Spot Billing Device will prompt for any other adjustments/charges depending on the category of the consumer. Net bill is to be calculated after adjustment of

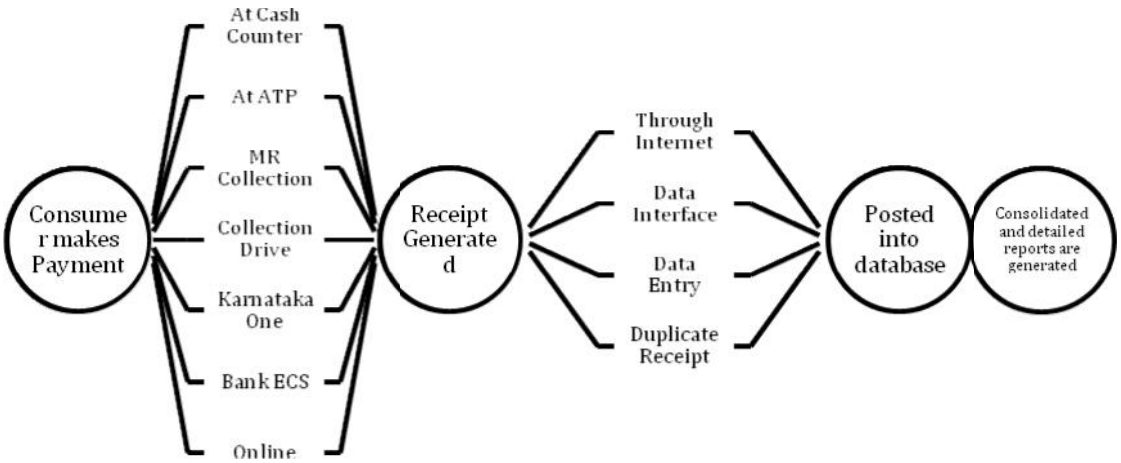
		above charges and should be displayed and prompt for printout shall be given.
14.	Error checking	Extensive error checking is provided to assure data integrity during communications between the Spot Billing Device and Server.
15.	Validation of reading data	Field validation for meter reading is ensured if the readings are beyond a predefined range and software shall have provisions to enter remarks in such cases of abnormality.
16.	Printing of summary report	Spot Billing system have provision to print the summary report with Spot Billing Device serial number, which contains the consumer file downloaded to the unit, total number of services, services billed / unbilled, total amount etc.
17.	Password protection	Spot Billing Device has two levels of Password Protection -Supervisory level for functions for configuration, time setting etc., and other supervisory functions and Meter Reader level for starting and closing the meter reading.
18.	Event logging	All events will be recorded in the event file in Spot Billing Device. The event details should be downloadable for analysis.
19	Menu driven Modular format	The spot billing software is user friendly, menu driven, structured and modular format for flexibility (Easy changes / Up gradation etc.)
20	Time stamping of logged data	Data Logging in the spot billing device will be date and time stamped.
21	Provision For enhancing the functionality	There is provision for enhancing the functionality of the software by adding additional features.
22	Device Registration	The System shall facilitate device registration, deregistration, allotment to meter readers etc based on device serial no.
23	Meter Reading Route	The system shall have facility to create route plans modify as per the requirements.
24	Barcode Reading	If the Meter's have Barcode then the Spot Billing Device should have capability to attach the barcode reader and

		read the barcode for consumer identifiction.

Cash Collection

The cash collection module facilitates payment collection against bills and other miscellanious heads and has head wise reconcillation and collation facilities. Various modes of payment entry are facilitated by software like:

1. Entry of Manual Payment Stubs and Reconcillation with Cash book and bank
2. Online payment through payment gateways and reconcillation
3. Facilitate automated updates for payments collected through Online and Offline Automated Payment Collection Kiosks.
4. Computerised payment collection centers
5. Payments collected by thrid party collection agencies like 1) Citizen Centers 2) E-Mitra 3) Post Office 4) Authorised collectors etc.



New Consumer Processing and New Consumer Entry

New Consumer Entry module facilitates the creation of one time master data of any consumer who has been serviced by the board. The module also facilitates the data updating upon any change of parameters like Name, Tariff etc. The Data Entry screen is built as per the Input format to enable error free record creation.

New Consumer Processing with Document Management System module facilitates all the processes right from issuing of application to the first bill generation for the consumer. The various documents submitted by the applicant during the process are also scanned and stored against the consumer record.

All the parameter changes are subject to the transaction approval by the respective competent authority. All the transaction history is logged in the system for audit and in future consumer data analysis requirements.

The module also facilitates bulk importing of master data from third party systems where bulk conections are released and data is provided in soft digital form.

The module also has functionalities for inter DMA transfer of consumer master data and merging of accounting units etc.

The Module facilitates grouping of consumers based on various requirements for group bill generation etc.

Meter Data Management

The module facilitates recording of meter data like manufacturer details, meter specification, meter type etc. Search based on meter number or grouping of consumers on type of meters etc.

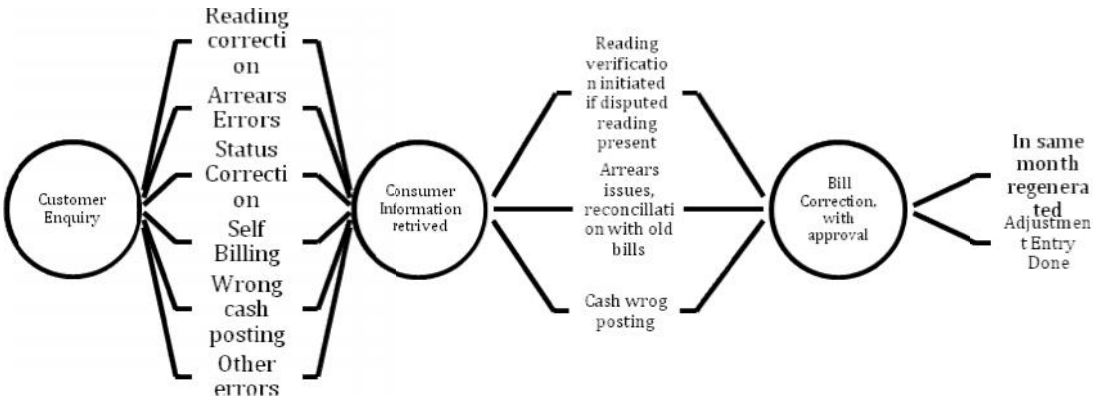
Recording the transaction parameters with the complete log of old meter data and the details of the new meter along with billing parameters.

Batch bulk meter change details can be uploaded from XLS sheets or text files when large number of meters are replaced under various development schemes.

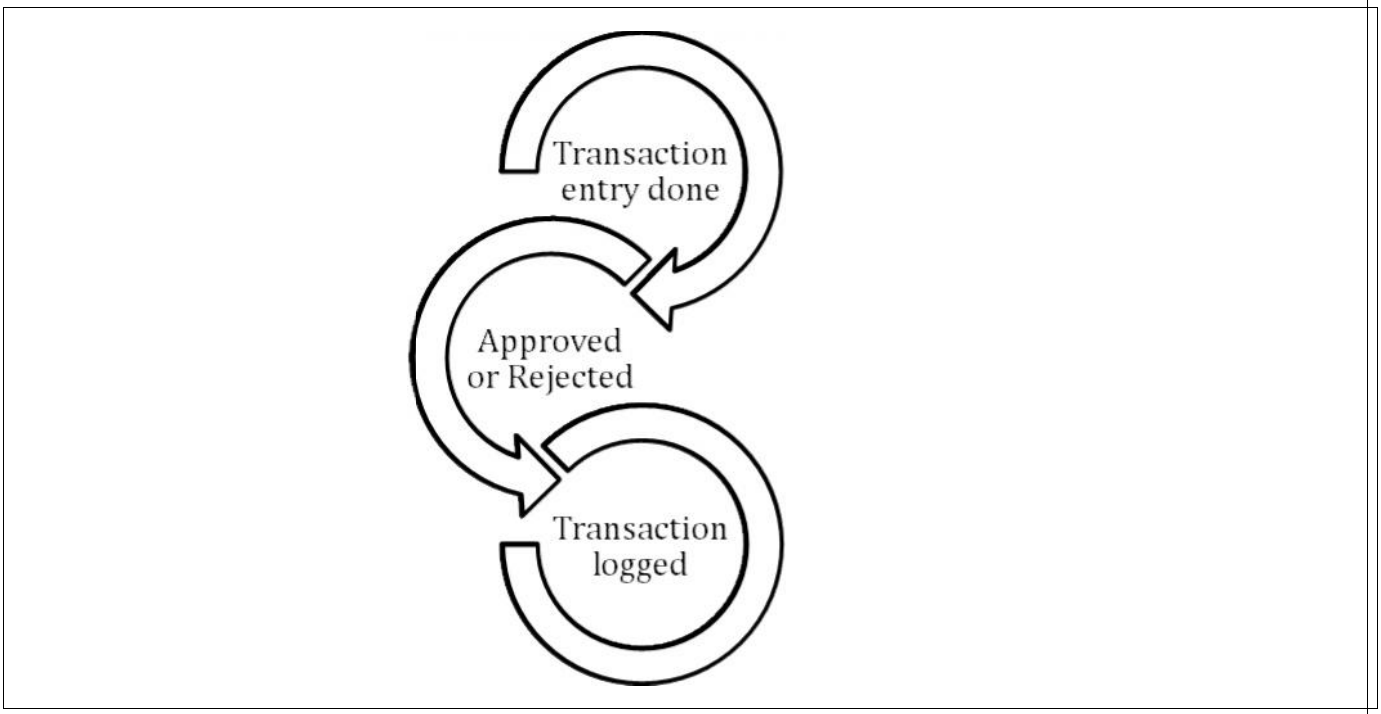
Recording of additional parameters in cases of special meters etc.

Bill correction and rectification

Consumer will walk in into the sub division or accounting section at a designated location and will present the bill issued to them along with the request for clarification or correction. Retrieve the details and verify the same and will initiate the process of rectification. If the correction is for the same month and the issue is with the reading, then the bill is regenerated after due verification. If it’s on the account of accounting, an adjustment is generated and posted.



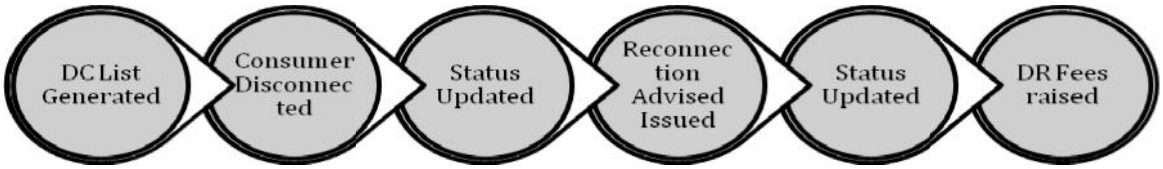
Transaction Processing:



Any transaction involving financial implication are first entered by designated operators personnel and are available to the officers for verification, which can be approved or rejected for rectification or wholly. All the transactions are logged for audit.

Disconnection and Reconnection

Disconnection lists are generated on daily basis for the default consumers. Field personnel carry the list and perform the disconnection and the same is provided back to the sub division staff for entry into the system. Once the consumer pays the amount the status is updated and the D&R fee are debited to the consumer account.



Tariff Management & Rule Editor

A fully configurable tariff and rule editor for modification and addition of rules and billing logics eliminating requirement of frequent changes in the program code.

Input of Advices

Different screens/forms for input of advices for various activities like, meter change, due date extension, sundry advice, name change, vigilance charges etc. with appropriate approval steps from competent authority.

Audit trail

The audit trail information which will help in bringing accountability of the users of the system is provide with well defined administrator level audit trail system for monitoring and ascertaining application and database level operations performed by end-users.

Redefining process rules

The system should has facility for changing the process rules such as redefining the escalation, service levels, payment details, inspection details & durations, registration numbers conventions etc., by the administrator. Application Remote Monitoring and Logging System has support for remote logging and monitoring of the system to carry out activities related to database reconfiguration and hot deployment of application updates.

Extensive Analytical and Decision Support Reporting

System has facility to generate various types of analytical reports for MIS. The reports are available in various formats such as PDF, Word, Excel, HTML etc with printing facility. The reports contain header and footer information, paging information for viewing particular number of records at a time. The reports also provide graphical representation of MIS data, wherever necessary.

SMS Alerts

The software has provision to send SMS alerts to the registered consumers.

Email Alerts

The software has provision to send E-mail alerts to the registered consumers.

Customer Web Self Service

Any customer can view his details online, will be able to see/perform the following:

- Dashboard that will display his last 6 months bill details and payment details.
- The Master Data with respect to the consumer
- He can view any of his old bills, download and print the same.
- His ledger extract for any period
- Estimate the bill by entering the current consumption
- Make payments through Credit Card, Debit Card, Net Banking Etc.
- Register a complaint or seek information form the officer.
- Update his contact details like Mobile No, Email Id etc.

Ticketing for Issues

This module facilities user in raising tickets for achieving issue resolution either related to application or for achieving the desired functionalities. The user has the option of escalation and provides the summary dashboards to the administrators on the status of the tickets raised and resolved.

VENDOR DATA REQUIREMENT

S R. NO	Description	With Bid	Info./Review	As-built
1.	Piping and instrumentation diagram		*	*
2.	Instrument index		*	*
3.	Vendor's list for instrument and accessories		*	
4.	Sizing calculations		*	
5.	Utility requirements		*	
6.	Instrument specification and datasheets		*	*
7.	Detailed loop diagrams		*	*
8.	System architecture drawing		*	*
9.	Panel front arrangement		*	*
10.	Wiring diagrams for panels		*	*

11.	Cable schedule		*	*
12.	Instrument installation drawings		*	*
13.	Bill of materials for installations items		*	*
14.	Inspection and test procedures		*	
15.	Test certificate and certificate from statutory bodies		*	*
16.	Complete catalogues with part list for all ven supplied instruments, controls etc.	*	*	
17.	Installation, operation and maintenance manuals			*

Note: This list indicates the minimum drawing and document list. However vendor shall also furnish any other drawing or document required to be furnished during the course of job execution.

APPROVED VENDOR'S LIST

S R No.	Item Description	Approved Vendor
1.	Programmable Logic controller	ABB/Schneider/Rockwell/Siemens/reputed
2.	Auxiliary Control relays	OEN/PLA/OMRON/PHOENIX/ABB
3.	Signal cables	Associated Cables, Assocaited Flexibles & Wires, Brooks Cables, Delton, Havells, Uday Pyro, Finolex, RR Kabel
4.	Ultrasonic Type Level / Diff. Level / LOH & ROF / Open Channel Flow Transmitter	ABB, E+H, Krohne, Siemens,Honeywell,
5.	Ultrasonic/Electro Magnetic Flow Meter	Siemens, ABB, Krohne Marshall, E+H, Honeywell
6.	Differential Pressure / Pressure / Temperature Transmitter	ABB, Emerson, Honeywell, Siemens, Yokogawa
7.	Electric Actuators	Auma, Marsh, Rotork, Reputed
8.	pH Analyzer	Reputed
9.	Turbidity analyser	Reputed
10.	Chlorine analyser	Reputed
11.	Pressure Transmitter	ABB, Emerson, Honeywell, Siemens, Yokogawa/reputed
12.	HMI(Human Machine interface)/SCADA	Honeywell, Rockwell (Allen Bradeley), Schneider, Siemens

S R No.	Item Description	Approved Vendor
13.	GSM/GPRS modem	Reputed
14.	LT / Instrument Power & Control Cables	RR, Polycab,CCI, UNIVERSAL, FINOLEX, INCAB, TORRENT, GLOSTER,BHARATCAB
15.	UPS	Hi-Rel/Emerson/APC by Schneider/Reputed
16.	Communication switches and cable	Reputed
17.	Panel Enclosures	Rittal/Eldon/FCG/Reputed
18.	Instrument Valves and Manifolds, Tube Fittings, Pneum. Brass Fittings	Excel Hydropneumatic, Industrial Enterprise, Festo, Multimetal Industries, Placka, VMC, Technomatic, Reputed
19.	MCB/MCCB/ACB/Soft Starter	SIEMENS / L& T / SCHNEIDER
20.	Selector Switch, Fuse, LED indication	SIEMENS / L& T / SCHNEIDER
21.	Terminals	Elmex, Phoenix, Wago, Connectwell
22.	Panel Wires	Finolex, Havell's, R R Kabel, Lapp Cable
23.	Push Button/ Selector Switch	Teknic, Schneider, Siemens, equi. Reputed
24.	Indication Pilot Lamps	Teknic, Schneider, Siemens, equi. Reputed
25.	Cable Tray	Globe, Jacinth, M.M. Engineering, equi. Reputed
26.	Receiver Indicators (Panel Mounted)	Masibus/Pantech/Radix/Reputed
27.	Conductivity type level switch	Reputed
28.	Pressure Gauge	Danfoss/Baumer/H-guru/reputed
29.	Panel Mounted Digital Level Indicator	Masibus/Pantech/Radix/Reputed
30.	Panel Mounted Digital Pressure Indicator	Masibus/Pantech/Radix/Reputed
31.	Panel Mounted Digital Flow Indicator Totalizer	Masibus/Pantech/Radix/Reputed
32.	Domestic water meter	Itron/Arad/ zenner/baylan/reputed

Abbreviations Used

AMF	Automatic Mains Failure	LAN	Local Area Network
API	Application Program Interface	MIS	Management Information System
CCTV	Closed Circuit Television	MLD	Million Litres per Day-

COM/DCOM	Computer Object Model/ Distributed Computer Object Model	MUX	Multiplexer
CPU	Central Processor Unit	OPC	OLE for Process Control
SCADA	Supervisory Control and Data Acquisition System	ORP	Oxidation Reduction Potential
DDE	Dynamic Data Exchange	OSI	Open Systems Interconnect
DLP	Data Loss Prevention	PLC	Programmable Logic Controller
DO	Dissolved Oxygen	PS	Pumping Station
EMCS	Electromagnetic Compatibility Society	RAS	Returned Activated Sludge
FBD	Functional Block Diagram	RTU	Remote Terminal Unit
FOC	Fibre Optic Cable	SCADA	Supervisory Control and Data Acquisition
GPRS	General Packet Radio Service	WDS	Water Distribution Station
GRP	Glass Reinforced Plastic	TCP/IP	Transmission Control Protocol/Internet Protocol
GSM	Global System for Mobile	TE	Treated Effluent
HMI	Human Machine Interface	VBA	Visual Basic for Applications
I&C	Instrumentation & Control	VFD/VSD	Variable Frequency Drive/ Variable Speed Drive
IEC	International Electro technical Commission	SAS	Surplus Activated Sludge
I/O	Input / Output	Windows™	Microsoft Windows
ISO	International Standards Organization	WTP	Water Treatment plant
IT	Information Technology	XML	Extensible Mark-up Language
AMR	Automatic Meter reading	AMI	Advance Metering Infrastructure
HHU	Hand Held unit	GSM	Global System for Mobile communication
GPRS	General Packet radio Service		

Executive Engineer

Vadodara Municipal Corporation

Signature & Seal of the Bidder
Name and Address:

6.20.10
DETAILED TECHNICAL SPECIFICATIONS FOR AUTOMATED CHLORINATION UNIT

Detail Technical Specification for Chlorinators and Chlorination System

1. SCOPE :-

The chlorinators are required for the disinfection and treatment of municipal and industrial water and wastewater.

This scope of work covers the design & engineering, manufacturing, performance testing, delivery, installation and commissioning of Chlorination system. Unless otherwise specified in the Particular specification, the complete chlorination system & plant shall comprise the union connecting to the cylinder / drum valve up to and including the final dosing point.

STANDARDS APPLICABLE:

Chlorination system including all main parts, sub parts, bought out items shall be designed to conform to all applicable:

- IS, NEC and NEMA specifications (IS 10553 PART B-1983 DIN-19606 AN2 STD.)
- Chlorine Institute specifications/recommendations.
- Compressed Gas Association recommendations.

2. OPERATION AND CONTROL:

The chlorinator operates under a vacuum that is produced at the ejector and transmitted through the control unit to the remote vacuum regulating valve located at the gas supply.

Gas enters the vacuum regulating valve and moves toward the flow control components under a vacuum. Gas next passes through the Rota-meter, where its flow rate is measured and the V-Notch orifice, where feed rate is controlled manually or by an automatic positioner. At the injector, the metered gas is dissolved in the water stream. The resultant Hypochlorus solution is discharged to the point of application.

CONTROL METHODS:

Feed rate of Chlorinator shall be controlled by either one or both of these methods: interrupting the injector water supply to shut off the chlorinator's operating vacuum; changing v-notch-orifice area (by positioning the v-grooved plug in its ring) while holding vacuum differential across the orifice constant.

3. DESIGN AND CONSTRUCTIONAL FEATURES :-

A. General:

a. The contractor shall provide pressure feed, vacuum operated, solution feed, cabinet mounted, floor/wall mounted chlorinators for dispensing chlorine gas from a pressurized manifold for chlorination purpose with chlorine booster pump as per data sheet.

b. The chlorinator equipment shall be designed to ensure maximum safety of operating personnel and equipment. The chlorine gas control system shall operate under vacuum to prevent gas leakage.

c. The chlorinator shall consist of floor/wall mounted cabinet containing a flow rate indicator, an ejector with vacuum gauge, a control valve with or without electric motor actuator, a vacuum

regulator and a flow meter. The vacuum regulator shall incorporate a positive chlorine gas shut-off valve, a pressure relief valve, and an excess vacuum shut-off valve. The Chlorination system shall have a chlorine gas feed capacity as per data sheet.

d. The system shall convey the gas under remote vacuum from the vacuum regulator through a remote flow meter to the ejector assembly. The remote flow meter will provide a feed rate indication and a means of manual feed rate control.

e. The system shall be constructed of materials suitable for wet or dry chlorine gas service. All vacuum connections & Raw water/Solution line shall be of schedule 80 UPVC with required specials.

f. Contractor shall also consider appropriate RCC structure to accommodate chlorination system.

B. Chlorine gas manifold:

1. **Auxiliary Isolation valves** shall be designed for use on chlorine liquid/gas service and shall conform to the recommendations of the Chlorine Institute. The auxiliary valve shall be installed on the chlorine tonner valve to minimize operation of the chlorine toner valve. The valves shall be of forged phosphorus bronze body with monel spindles and stem, glandless design. The valve shall be provided with screwed end connections and shall be full bore sized. The valve should also comprise of a yoke to avoid use of threads of chlorine tonner valves. The body of which shall be silver platted and than painted to golden yellow color. The container end and the header end shall have an auxiliary valve and two line valves for isolation respectively.

2. The **flexible connector** shall be provided between an auxiliary isolating valve and a header valve, constructed of brass. The flexible container connector shall be of 3/8" Dia. cadmium plated, arsenic free annealed copper tubing duly PVC sleeve. The high silver brazed tensile brass flexible connector shall terminate with a valve and union connector set at the drum end. Connecting nut shall be gun metal and complete assembly shall be silver plated. The 3 mm thick washer of lead with antimony, two nos., shall be provided. The arrangement will be such as to release the very minimum of chlorine gas into the atmosphere when changing drums or cylinder and the pipe is not twisted near the end connectors due to tightening.

3. The **chlorine gas manifold** shall be constructed of suitably sized, not less than 3/4" Dia. high grade seamless carbon steel, SA 106 Gr B SCH 80 pipe and shall be suitable for use with dry chlorine gas with screwed or tongue and groove type flanged connections. Screwed joints shall be made with an approved jointing compound only. Gaskets for flanged joints shall be of inert material compatible with chlorine gas or liquid. Pipe sizes and lengths shall be designed by the contractor and submitted for approval. All fittings shall be forged steel rating. The manifolds shall be located at a higher level than the drums to allow liquid chlorine to drain back to the drums.

4. A **Chlorine pressure gauge-** bourden type, complete Stainless Steel construction, IP 65 enclosure, dual scale calibration shall be provided on each manifold. The chlorine pressure gauge shall be diaphragm protected and diaphragm protection assembly housing shall be of monel wetted part. The diaphragm protection seal shall be filled with Silicon Oil - suitable to chlorine applications.

5. **Liquid trap/ Catch pot:**
Carbon steel/C.I construction, vertical mounting type Liquid traps/Catch pots shall be connected in the manifold lines immediately before the vacuum regulators. These shall serve to intercept any

liquid chlorine which passes with the gas and allow it to vaporize back into the gas stream. It shall also act as gas filter and spray catcher. Filter element shall be removal cartridge type woven glass fiber and activated alumina. Filter element holder shall be of finer material like monel.

6. **Chlorinator isolating valve** having one piece design, external stem and gland type, made of forged carbon steel shall be provided. It shall have flanged end connections, balls and stem of monel, seat of virgin PTFE, MS handle, PVC sleeve. The body shall be silver platted and painted to golden yellow color.

C. Vacuum Regulator

1. It shall be differential pressure vacuum regulator having spring loaded diaphragm operated valve mechanism.
2. Vacuum regulating valves, mounted on the gas supply containers, immediately reduce the pressurized gas to a vacuum. It shall include a Union Flange for connection to the chlorine gas manifold.
3. The body of the vacuum regulator shall be solid machined PVC material for maximum durability and cracking resistance. It shall be molded / machined construction.
4. The regulator shall have a spring-opposed diaphragm, which controls vacuum and closes tight upon loss of vacuum.
5. It shall have a lever mechanism and front panel knob that provide the operator a quick indication of 3 or 4 operation modes (operating, low gas supply, off, and standby for automatic switchover arrangements). An additional built- in indicator becomes visible in the low/out- of-gas situation and an optional contact is available for remote indication.
6. The regulator shall incorporate a pressure relief (vent) valve (required to vent off chlorine in case of vacuum failure) and vacuum relief valve (required to relive vacuum in case of chlorine gas failure) for with separate ports for chlorine feed and chlorine vent.
7. The regulator shall be equipped with an inlet filter to remove particulate matter from the gas before it enters the inlet safety valve.
8. MOC of various parts of vacuum regulator shall be as below:

Sr No	Part	Material of construction
1	Body	Solid machined PVC/ABS
2	Springs	Tantalum alloy or Hastelloy C
3	Seat	PTFE
4	Inlet Valve	Silver/Teflon
5	Diaphragm	Fluoro Ethylene Polymer / Teflon

D. Gas Flow Meter and flow control valve

1. The variable area type **gas flow meter** shall be provided to indicate the gas flow rate. The flow meter shall be manufactured from borosilicate glass and float shall be made from inert material, PVC or Teflon.

   The glass shall be very clear and of high quality having calibrated scale printed directly on glass tube. The meter shall be calibrated directly to the mass flow of chlorine gas.

2. Flow meter tubes shall indicate flow rates suitable to rated capacity of chlorinator and down to a minimum of 1/20 of the maximum value and shall be dual scale calibrated.
3. This gas flow meter shall be equipped with a **flow control valve**, easy to operate, precisely machined quality for manual feed rate adjustment (also suitable to automatic operation). The flow control valve shall be calibrated to the flow meter and both shall be manufactured in combination. PVC body valve having Teflon seat shall be offered. The MOC of plug and the seat shall be PTFE and PVC respectively. It shall have readable indication for operation.
4. The chlorinator shall have dual check non return valve to avoid flooding of water in chlorinator. The valve shall be diaphragm type and ball/plunger type. Both NRV shall be installed din series and shall work independently.
5. MOC of various parts of Gas flow meter shall be as below:

Sr No	Part	Material of construction
1	Flow meter tube	Borosilicate glass
2	Float	PVC/Teflon
3	Inlet and outlet adopter	PVC
4	Spring	Hestalloy-C /Monel
5	Gaskets and O rings	Viton

E. Ejector and drain valve

1. The **ejector** shall be water operated Venturi nozzle type having both convergent and divergent nozzles. Ejectors shall provide the operating vacuum of minimum 660 mm of Hg for the chlorination system.
2. The ejector shall incorporate a spring loaded, normally closed check valve to prevent the backflow of water into the chlorine gas equipment. The check valve shall be suitable for backpressures up to a minimum of 100 psi.
3. The ejector shall be made of completely molded / machined construction with detachable nozzle. The ejector shall have suitable Flange Connections.
4. The ejector check valve shall automatically close upon the loss of vacuum in the ejector.
5. The solution is to be feed in the pressurized line. The operating pressure can be derived based on the pump head mentioned in the data sheet. Bidders are requested to visit the plant side or similar plant side for evaluating operating pressure and back pressure conditions. Detail Engineering and calculation for Ejector should be submitted.
6. The draining facility shall be provided in an event of water ingress pass the ejector. The **drain valve** shall be manufactured from the chlorine resistant material.
7. MOC of various parts of ejector shall be as below:

Sr No	Part	Material of construction
1	Stud for housing of ejector nozzle	Monal
2	Ejector through/nozzle housing/ Ejector Jet	PVC
3	Throat housing/Jet Housing	UPVC
4	Spring	Hestalloy-C /Monel / Tantalum
5	Gaskets	Rubber

8. MOC of various parts of Drain valve and check valve shall be as below:

Sr No	Part	Material of construction
1	Body/Backing plate/ Backing plate button	PVC/ Acrolyte Butanel Stroid
2	Spring	Hestalloy- C
3	Valve /Spring guide connector/Valve cap connector/ End connector	PVC/Acrolyte Butanel Stroid
4	Diaphragm	ECTFE/PTFE

F. Differential Pressure Regulator ;-

1. Differential Pressure Regulator should maintain steady flow of gas and should indicate steady reading on flow meter. It should maintain constant vacuum between rate Valve & Flow meter and differentiate excess vacuum during control of rate valve, in event of development of excess vacuum. It should be in position to lock the Unit and there by facility to activated vacuum relief valve and High / Low Vacuum Switch.
2. MOC of various parts of DPR shall be as below:

Sr No	Part	Material of construction
1	Body/Backing plate/ Backing plate button	PVC/ Acrolyte Butanel Stroid
2	Spring	HEASTOLLY - C
3	Spring guide connector/ End connector/ PVDF Pipe connector	PVC/ Acrolyte Butanel Stroid
4	Diaphragm	ECTFE/PTFE

G. Diffusing system

1. Where chlorine solution is to be diffused into a UGT, an underground piping arrangement has to be done according to the individual site UGT under guidance from Engineer Incharge, pipe material should not be affected by chlorine solution.
2. Injectors feature required:
    i. Built-in Double Check Valves for protection against back flooding. A spring-loaded diaphragm with a spherical seat for positive sealing and a spring-loaded poppet check to maintain system integrity.
    ii. Flexible Mounting Orientation for convenient installation. The gas inlet connection shall be rotatable to provide pipe entry at selected angles. It shall be possible to mount injectors in horizontal or vertical planes. It shall have an integral mounting bracket and should be possible to disassemble for service without removal from the wall or disconnecting the inlet/outlet piping.
    iii. Optional Anti-siphon Arrangement negative backpressure applications.

H. Booster Pump

1. Chlorine booster pumps shall be supplied with each chlorinator. The booster pumps shall supply suitable water pressure to the ejector.

2. Booster water pumps shall be of **Centrifugal Monoblock pump as indicated in data sheet**. The dozing pumps shall have CI casing, shaft and impellers.

3. The item shall also include all necessary electrical items to run pumps-motor, main distribution board comprising incomer and outgoing MCBs, starter, cables etc.

4. The contractor shall prepare sizing calculations for the flow and head of the respective pumps and submit the same for approval.

5. The booster pumps shall generally comply with the standard specifications for water transmission and distribution pumps.

6. Each pump shall have suction and delivery isolating valves and delivery non-return valve and safety pressure relief valve. All valves shall be in accordance with the relevant IS specifications for valves and accessories.

7. The material of construction for the pipe work shall be as indicated in the particular Specifications and/or shown on drawings.

8. MOC of various parts:

Sr No	Part	Material of construction
1	Body	CI
2	Impeller	CI
3	Base	CI

I. Foundation for chlorine toners:

1. Wherever specifically mentioned, contractor shall also consider appropriate RCC foundation/structure for in process/ filled storage chlorine toners in chlorination room.

2. The appropriate capacity and numbers MS roller support of heavy duty fabrication shall also be provided on the foundation.

K. Equipment Construction

1. Cabinet shall be fully front operated and front maintained. Components of chlorine equipment shall be housed in an enclosure made of molded ABS. The gas inlet and water piping shall be readily accessible for cleaning, inspection and maintenance without the need to disturb the adjacent parts.

2. Components shall be fully resistant to the prolonged corrosive attack of chlorine, inclusive of leakage in the installation. Metal parts normally in contact with chlorine shall be monel or Hastelloy C or equal. External metallic parts such as nameplates, bolts and nuts shall be made of stainless steel.

3. Parts not designed to be in contact with chlorine shall be totally enclosed, with the degree of protection of IP54 to IEC 60529.

L. Electrical Equipments:

1. Power supply transformers, where fitted, shall be of totally encapsulated type. Indicating instruments which are surface mounted shall have a degree of protection of IP54 to IEC 60529.
2. Electrical equipment shall operate on 440/220V a.c. 50 Hz. Switch contacts of instruments shall be of changeover type rated at 2A 220V a.c. 50 Hz.

M. Other items:

1. Water-line pressure gauge;
2. Injector vacuum gauge;

4. TESTS AND INSPECTION:

Chlorination system shall be subjected to all tests as per applicable standards/approved under QAP in the presence of the client's representative. Copies of test certificates of type and routine tests, as specified in the schedule, shall be furnished for the approval.

Equipment shall be offered for visual inspection and dimensional checks. Equipment shall be tested as per relevant standards with latest revisions.

5. DRAWINGS:

The manufacturer shall submit the following drawings. Preliminary outline dimensional drawings.

Typical cross sectional drawing showing constructional details with the complete bill of material, MOC and relevant standards.
Details drawing piping, size, and pressure drop calculations, pump-motor set rating justification and calculations.

DATA SHEET FOR CHLORINATION SYSTEM

1.	**General**	
**	Standard Applicable	IS 10553 PART B-1983
**	Type of Chlorinator	Gravity feed, Vacuum operated, solution feed, Cabinate type
**	Mounting	As per Annexure.
**	Capacity	10 Kg/hr
**	Operating Range	Manual 20:1 for any Rota meter
**	Operating Vacuum	0 to 760 mm in Hg
**	Operating Temperature Range	0° to 50°C, under roof
**	Control Modes	Manual control / Automatic Convertible.
**	Distance, Supply to Control Panel	For flexibility, it should be possible to install the vacuum regulating valve a few feet to several hundred feet apart, depending on maximum feed rate, the diameter of the connecting pipe or tubing and system performance requirement.
**	Injector	Fixed-throat type.
**	Injectors size	For capacities up to rated capacity of Chlorination plant
**	Pressure at Application Point	As per Annexure.

2	**Component(s)**	As per Annexure.
3	**MOC and other details**	
**	Inter Connecting Vacuum Pipe Material Size Type Schedule	 UPVC schedule 40 Industrial grade As per Annexure. Socket Sch. – 40
**	M.O.C. of Cabinet	ABS Molded
**	Booster Pump including necessary electrical equipments to run pumps including (but not limited to) motor, starters, control/ distribution board with incomer MCB and outgoing MCBs, power and control cables etc.	As per Annexure.
**	**Piping and fittings for Raw Water &** **Solution Line** Material Size Type Schedule	 UPVC schedule 40 Industrial grade As per Annexure. Socket Sch. – 40
**	**Cl_2 Gas Header Line** Material Size Type Schedule	 Carbon Steel as per ASTM 105 Grade B ¾" Minimum or suitable Threaded/ Socket type Sch. – 80
**		

**	**Copper Tube Connecting for Header Line to Toner**	
	Material	Copper as per ASTM B 88
	Size	3/8" Minimum
	End Connection	SWG 16
	End Connectors	5/8" BSP
**	**Water Pressure Gauge**	
	Range	As per mfg design
	Type	Suitable for Raw Water
	Dial Size	100 mm Minimum
**	**Vacuum Gauge**	
	Range	As per mfg design
	Type	Chemical Seat suitable for Vacuum
	Dial Size	65 mm Minimum
**	**Chlorine Pressure Gauge**	
	Range	As per mfg design
	Type	Diaphragm less with all Monel internal part
	Dial Size	100 mm Minimum
**	**NRV**	
	Size	Suitable
	Type	Flange End.
**	**Diaphragm Valve**	
	Size	Suitable
	Type	Flange End.
**	**Rota meter tube**	As per Annexure.
**	**Isolation Valve for Cl_2 Gas**	
	Size	Suitable
	Type	Threaded as per IS 3224

6.20.11
ITEMWISE DETAILED TECHNICAL SPECIFICATIONS OF 24 X 7 WATER SUPPLY SYSTEM IN SAYAJI BAUG, VADIWADI AND AKOTA AREA - OPERATION AND MAINTENANCE FOR 10 YEARS

6.20.11 ITEMWISE DETAILED TECHNICAL SPECIFICATIONS OF 24 X 7 WATER SUPPLY SYSTEM IN SAYAJI BAUG, VADIWADI AND AKOTA AREA OPERATION AND MAINTENANCE FOR 10 YEARS

Item No. 1 : The work of O&M will consist of operation and maintenance of Electro-Mechanical, Electrical, Mechanical, Electronics equipment / item, Instruments,SCADA System, Record keeping, measuring devices, minor civil works and maintenance of recharge bore. The firm has to operate the pumps as per VMC's requirements. The firms has to repair or replace pumps, motors, valves, pipes, screen, gate, gantry, electrical work including day to day maintenance as well as preventive maintenance as required. The work also includes operation and maintenance of MS / DI / CI transmission pipeline, rising main and distribution network. The firm has to repair or replace pipes / specials and all type of valves including repairing of leakages and solving of contamination problems, ensure water quality as per slandered norms and repair to breakage of pipes repairs of road and valve chamber Work also includes day to day maintenance as well as periodical preventive maintenance of all kind of valves.

(I) Specification of Operation and Maintenance of WDS and ESR

(1) The Contractor shall maintain all the civil works like, treated water sumps, pump house, ESR, drainage etc. at each WDS in proper and good condition.

(2) The Contractor has to arrange to clean the treated water sump & ESR once per year and as and when felt necessary by VMC. The inside wall of sump shall be white wash as and when required by VMC. The contractor has to paint the all WDS and ESR once in five year(i.e. Total Two times during O & M Period)

(3) The Contractor has to keep a watch on overflow of treated water sump, ESR, leakages in manifolds in pump house etc. Under no circumstances, the water shall not be allowed to become contaminated or go to waste and also to prevent the possible damages to be caused to the surrounding areas / properties, under the influence, where this overflow/ leakages of water are likely to flow.

(4) In treated water sump / ESR, the ventilation system shall be maintained in clean and good conditions.

(5) All the storage facilities WDS, ESRs shall be supplied water, as per the requirement to ensure 24 x 7 Water Supply.

(6) The Contractor will also be responsible for –

Maintenance of electrical, ventilation, plumping as well as drainage installations in neat and clean conditions.

Carryout the general building maintenance and house keeping in good and neat conditions.

Carryout site maintenance including the upkeeping of landscaped area.

Regular periodical as well as preventive maintenance of sump, pumphouse, pipeline, ESR etc. in each WDS and to provide regular repairs to keep them all in working conditions.

Building services and house keeping maintenance shall be undertaken on all building and service installations.

Ensuring all unwanted or redundant items to be removed from the premises, as decided by VMC.

(7) Pumps of all treated water pump house at WDS will run for 16 hours / day.

(8) The contractor shall have to make necessary arrangements for the safety and security of all the structures, assets, pipeline, machineries, equipment etc. by taking services of Police or Security Agencies. No outside persons will be allowed to enter without permission. Only authorized personnel by VMC shall be allowed to enter the premises.

(9) All required goods like CFL bulb, tube lights, flood lights, choke, starter, fuse wire etc. for O&M of WDS shall be kept ready in good working condition by contractor at his own cost.

(II) Specification of Operation and Maintenance of all D.I. Rising Mains and Piped Distribution Networks Including Operation of Valves

(1) The water is to be supplied to the consumer on 24 x 7 basis (i.e. continuous water supply).

(2) All the materials required for O&M works are to be procured by the firm at their own cost.

(3) The contractor has to deploy **supervisor having diploma in civil engineering with 2 years experience in water supply, who will be in full charge and responsible for all activities of O&M work assigned to the firm.**

(4) Periodical preventive maintenance of the entire pipeline work and distribution system including online valves etc. shall be carried out by the contractor.

(5) The contractor to deploy specified number of O&M gangs, each consisting of **one fitter with one helper and mazdoors with necessary equipments and tools etc.**

(6) The contractor has also to **provide vehicle and mobile phone facilities to the Supervisor in charge for speedy communications and actions for any complaints received from the VMC for leakages / breakdown etc. in the water supply system.**

(7) The contractor to **keep a register of presence of all the personnel, engaged for O&M.**

If the presence of these personnel is found less than the prescribed personnel, an amount equal to double the rate (as mentioned in Table No. 1 and 2) per day will be deducted from the fees to be paid to the firm by VMC.

(8) Any complaint from the consumers regarding leakage, low pressure, less quantity of water supplied, breakage of pipes etc. are to be attended immediately within prescribed period and the action taken for each complaint to be reported to VMC regularly, as decided by VMC. The contractor shall create a Toll Free Number (working 24 hours) for register the complaint from consumer for O & M period.

(9) The contractor will be totally responsible during the implementation work for any accident or mishap etc. as well as any compensation thereof. Such occurrence shall intimate to VMC immediately.

(10) Monthly bill should be submitted by the contractor giving details as shown below :

(a) Register showing the number of persons present during the month and engaged exclusively for this contract.
(b) No. of complaint attended with copy of register.
(c) Length of MS / DI pipeline (diameter wise) replaced for each category showing the location on the plan.
(d) Number of valves.
(e) Valve chamber with surface box.
(f) Valve chamber cover.

(g) Any other specials item, if any.

(11) The maintenance of rising mains, distribution pipeline shall be carried out by the contractor. If any leakage is found, it shall be repaired within the prescribed time limit under intimation to VMC.

(12) The contractor has to immediately inform to VMC, if any illegal connection is found in distribution system, for further necessary action, as per instructions of VMC.

(13) The contractor shall be liable to maintain and update assets register, as decided by VMC.

(14) The contractor shall calibrate / service all flow meters installed at sump, ESRs, Water
Distribution Systems etc. as and when require and also maintain the register for the same. He shall ensure that all the flow meters are always in working condition.

(15) The responsibilities for accidents / legal problems shall rest with the contactor.

(16) The rising main and gravity mains as well as network distribution pipelines including chambers, valves etc. shall be maintained and repaired by the contractor.

(17) Servicing of all valves, cleaning of all pipelines, specials etc. shall be carried out regularly.

(18) Leakage repairing shall be carried out in proper way and in technically workmen like manner.

(19) All the gardens, lawns, plans situated at the work sites shall be supplied water regularly and maintained properly by the contractor. No extra payment on this account shall be made.

(20) In case of breakages of MS/DI/CI/MDPE lines/ valves/ specials / valve chambers etc by other agency or utility providers, the damage shall be immediately repaired by the bidder under the scope of this work and reported to the Engineer-in-Charge of Vadodara Municipal Corporation.

While arranging for permanent repairs, the contractor shall take immediate steps to stop the water losses and in terms financial losses to the contractor and Vadodara Corporation. However, the water losses for 72 hours will not be considered for penalty.

(21) In case of negligence of Contractor and/or operator/ staff of the contractor, any W.D.S./E.S.R./U.G.S.R/Transmission lines/Network lines/Connections etc. over flows/leakages, the contractor will be penalized at the INR5/- Per Kilo liter for the loss of water over and above the prescribed percentage wise water loss penalty. This penalty will be considered at the discretion of Engineer-in-charge. The quantity and amount of penalty for wastage of water will be decided by Engineer-in-charge and shall be accepted by the contractor.

(22) A project manager exclusive for the work having minimum 5 (five) years experience having qualification of B.E. Civil/ Mechanical /Electrical / B.E. Instrumentation or E.C. field shall be deployed to execute, liaison and Coordinate all the activities mentioned in the tender. The project manager shall be engaged full-time for this work, shall be available from 9.00 am to 6.00 P.M. and in other hours as per emergency.

The project manager shall carryout all the coordination and liaison with VMC for this particular tender work.

(23) All tanks shall be cleaned once in a year and also during emergency.

(24) Contractor will be responsible for any damage to network due to another agency and compensation for the same will be recovered from the concerned agency.

(25) Before starting of the work following works will be completed by the VMC

All network flushing
Repair of all leakages

Pre-monsoon cleaning of the premises of WDS and ESR shall be carried out under intimation to VMC.

SPECIFICATION OF O&M OF ELECTRICAL / MECHANICAL / INSTRUMENTATION AND SCADA WORKS

The contractor will be responsible for smooth, efficient and satisfactory operation and maintenance of the entire work included within the scope of contract including 3nos. WDS, 10 nos. ESR, Distribution network including metering, Zonal and Master Control SCADA, etc. under SMART City Project for Vadodara Municipal corporation , Vadodara on round the clock basis for the entire period of O&M contract (i.e 11 years for Part-1 (2.89 sq.km. area) and 10 years for Part-2 (5.87 sq.km. area) from the effective date of the contract.

SMART CITY PROJECT comprises of following major units for which contractor shall be expected for effective operation and maintenance

i. WDS including various electro-mechanical equipment, Instrumentation with PLC/SCADA with remote data transmission / data acquisition system, etc.
ii. ESR including various electro-mechanical equipment, Instrumentation with PLC with remote data transmission, etc.
iii. Zonal SCADA with remote data transmission / data acquisition system
iv. Master Control SCADA with remote data transmission / data acquisition system
v. Lease lines and GMS/GPRs based data transmission system for remote data transfer
vi. Distribution network including metering, etc.
vii. Any other forming part of the scope of work of this contract

The operation and control philosophy including monitoring, alarms and control for entire 24 x 7 shall be designed. Operated and maintained by the successful experienced bidder to ensure that all monitoring data for water audit purpose and required flow and pressure as per design are maintained to ensure proper and equitable water distribution.

1.1 **SAFETY:** The contractor shall be responsible for safety on site during the O & M of the works by the contractor. The contractor's duties with respect to safety shall include the following:

1.1.1 Contractor shall be in strict compliance with Factory Act, 1948. Facilities to staffs, operators, helpers, etc. should be in accordance to that.

1.1.2 Provision of First Aid Kit with all necessary updated materials

1.1.3 Provision of Shock proof hand gloves, helmets for all staffs, shock proof shoe for all staffs, eye glass for each operation and maintenance staff – to be made available by contractor

1.1.4 Ammonia Torch

1.1.5 Personal Protective Equipments like Safety Gloves, Canister Masks

1.1.6 Other than above safety apparatus / equipments, all other apparatus SCABA set, air line respirator, fire extinguishers etc. shall be provided by VMC. Contractor remains to ensure and update all such safety apparatus all the time. Necessary refilling and maintenance shall be done by contractor.

1.1.7 Utilize safety awareness procedures in every element of operation.

1.2 **Data / Record keeping:** Following minimum records expected to be maintained without fail by contractor:

1.2.1 Daily WDS/WSS Record which comprises of treated water flow / pressure, water level at WDS/ESR/Tanks, chemical consumption, opening and closing stock data related to chemicals, etc. This register / record to be maintained by shift chemists / operators and to be verified by Project-in-charge of contractor. Format shall be given by Vadodara Municipal Corporation

1.2.2 Water Flow & Pressure Monitoring Records for which Format shall be given by Vadodara Municipal Corporation

1.2.2.1 **WSS / WDSs MAINTENANCE REPORT:** Contractor shall furnish monthly Water Supply System (WSS) including WDS, etc. about proper functioning of all electrical /mechanical /electronic /instrumentation /equipment of WSS / WDS to concern Officer in charge. He shall clearly spell out all 'running' and 'out of order' equipments with detail reasoning thereof and expected time period of sorting out of the problem. Frequency of reporting and record keeping should be in strict adherence of Electrical / Mechanical Maintenance Schedule.

1.2.2.2 The contractor will be responsible for keeping up-to-date record of document(s) including History Card for equipment(s) and maintaining day-to-day logbook relating to various analyses performed.

1.3 **Supervision / Monitoring and Manpower Requirement -** Please clearly note that O & M job being handed over to contractor is not merely labour contract. VMC seeks to have expertise of contractor in the field, therefore, 'Experienced Person' from contractor's end must Check the site, periodically at least Twice in a month (or as and when necessary) and bring forth necessary suggestion for improvement and also discuss the water quality/quantity/flow distribution issues with concern counter part of VMC and he will render suggestion, to improve the efficiency and working of the supply system. Please note that "carried out the job as per VMC's instruction/tender" should not be attitude nor will it be considered as acceptable argument in case of any quality related issues/dispute. Further, if, as consultant, contractor finds any controllable/ uncontrollable parameters/factors that might have impact on water quality/quantity/distribution must be brought to notice of VMC well in advance timely and discuss thoroughly with probable solutions. The visit must be recorded at Corporation's document like visit book without which the visit shall not be considered. In certain cases, outcome of the visit/minutes of meeting should be got signed, if required, by Corporation's authorized representative.

1.3.1 During the visit and even before the visit, "Experienced Person" shall have inferences derived from the recent past data as well as prevailing data and he shall sense, observe, interpret and diagnose the situation / operational scenario accordingly.

1.3.2 Based on diagnosis, he shall suggest remedies to project manager or Project-In-Charge.

1.3.3 He shall also suggest possible resources required / available to Project-In-Charge.

1.3.4 He shall help Project - In - Charge to device the program with expected process time, expected results, possible milestones and symptoms, possible alternatives, possible undesired results in case of negligence during the process etc.

1.3.5 He shall explain all of the above to VMC officer in charge / chemist in charge who in

turn shall device implementation program.

1.3.6 Normally, contractor shall be responsible for effective operation and maintenance of WDS / WSS such that water supply distribution objective of 24 x 7 supply is achieved and meets required criteria. Any deviation in WDS / WSS which leads to not acceptable criteria, accountability during such situation would be of contractor.

1.3.7 Contractor is expected to understand the holistic view of the intent behind the entire work including O&M contract and shall act accordingly throughout the contractual period.

1.3.8 Last but not least, under no circumstances 'unfit' water shall reach from underground storage tank of water treatment plant to distribution network or any act of contractor shall result into improper water supply. Before raising any issue related to quality / quantity of water, he must ensure that entire water supply system is as per criteria defined under tender. He should bring to notice to Plant In-Charge – VMC & concern staff regarding poor water quality / quantity timely (with acceptable data) so that corrective action or further course of action can be decided but under no circumstances, 'unfit' water shall reach to public. Expertise needs to be rendered in all areas of operation and maintenance of WDS / WSS in general and in following areas in particular;

1.3.8.1 Appropriate formulation & optimization of Process Inputs.

1.3.8.2 Chlorine dosage

1.3.8.3 Appropriation of disinfection frequency

1.3.8.4 Testing frequency

1.3.8.5 Analysis of water supply data (level, pressure, flow, etc.) based on performance data of individual and formulation of action plan based on analysis.

1.3.8.6 Provision of sufficient knowledge inputs via training to chemists/operators/helpers

1.3.9 **MANPOWER/STAFF PATTERN:** The contractor shall provided experienced managerial, technical, supervisory, administrative & non- technical personnel & labour necessary to operative & maintain the water supply system property, safely and efficiently on a continues 24 X 7 basis for full term of the O & M contract period.

1.3.9.1 The qualification and capability of the contractor's personnel shall be appropriate for the task they are assigned to perform. The staff provided shall be fully trained in the operation of water distribution station as well as distribution network including ESR, network, metering, data acquisition system and remote data transmission system, etc. before being giving responsibility for operating any part of the water supply system. If in the opinion of the engineer, any member of the contractor's staff is considered to be insufficiently skilled or otherwise inappropriate for the task he is required to perform, the contractor shall replace him with a person with the appropriate skills and experiences for the task, to the approval of the engineer. The contractor will be required to submit to the corporation the schedule of "Manpower and Organization Chart".

1.3.9.2 The CV/Resumes of the contractors personal shall be submitted to the engineer in charge within 15 Days after receiving of work order. Any change of personnel shall be promptly informed to the engineer within a day's time. Normal time duty hours for the contractors' operation & maintenance personnel may be modified as necessary and the contractor and agreed by the engineer who will ensure that an adequate number of the contractor's staff, fluent in Gujarati as well as Hindi is on duty at WDS/WSS location /SCADA Room 24 hours per day, 7 days per week, including all holidays.

Minimum Men Power Required at Water Distribution Stations / Control Room / ESR

Sr. No	Designation	Qualification	Experience	No of persons
1.	Electrician/ Wireman	ITI (Electrician/ Wireman) having permit of Government of Gujarat.	Minimum Two Years experience of Operation & Maintenance.	03
2.	Fitter	ITI (Fitter Trade)	Minimum Two Years experience of Operation & Maintenance.	01
3.	Helper	Standard 7th Pass Should be physically healthy & able to read & write (only male)	Exp. in water Pumping Station operation is preferable OR Exp. in other such type of organization.	06
			Total	**10**

Note: The above is minimum manpower and contractor shall require to depute any additional staff as required to ensure smooth and trouble free O&M

1.3.9.3 Relaxation in qualification and number of staff shall not be allowed. If it is observed and found that WDS/ WSS is run by under qualified staff except Helper categories then "He/They" is/are treated as absent. And Penalty for the "absence of the staff" is applicable as mentioned in tender documents. The above staff shall be distributed in three shifts as per mutual agreement between Contractor and Corporation.

1.3.9.4 As per agreement the No. of staff in each shift should always remain present otherwise penalty towards absence of any staff shall be levied and recovered from the Contractor.

1.3.9.5 The contractor shall comply Labour Act and necessary weekly off, holiday etc. as per Act of provision remains to be extended to the deployed staff. However, in any case, above required staff remains to be made available for 24 houINR

1.3.9.6 The presence of staff in each shift should be marked in muster (to be brought by the contractor) to be maintained at office of shift in charge at Water Works, which shall be considered as final. The contractor's staff must mark their presence in this muster only. The contractor may maintain a separate register for his own purpose.

1.3.9.7 Please note that computer system is to be operated and maintained by the contractor's staff and therefore it is in the interest of the contractor to employ project in charge/ shift chemist who is proficient in the computer operating system.

1.3.9.8 Unsatisfactory and inefficient running of the WSS/WDS, supported by the reason(s) that are under control of contractor will be highly objected. In such case(s) Competent Authority decision will be final and binding to the Contractor.

1.3.9.9 Contractor will comply with all statutory rule(s) and regulation(s) and all inter-disciplinary measure(s) as followed by the Corporation.

1.3.9.10 The Corporation will not be responsible for any accident/ injury to the staff of the contractor. Further, the Corporation will not provide any insurance or medical facility to the staff of contractor.

1.3.9.11 Key personnel (Project-in-charge, Shift in-charge) deployed by the contractor must be

having true dedication the plant O&M works as per scope. Frequent turnover of the staff in this category shall not be allowed and hence these personnel are expected to have on permanent basis for 3 years at least. Also, shift in-charge specifically during night hours shall be expected to have vigilant monitoring and works in plant. In absence of project-in-charge, sole responsibilities of WDS / WSS O&M shall be on shift in-charge and hence, shift

–in charges shall not be allowed to do activities other than their core duties (studies etc.). In case of such observation, shift in-charge shall be marked absent and contractor shall be given notice to remove such persons with an immediate effect.

1.3.10 General Administration and Reporting

1.3.10.1 The staff of contractor will always remain in contact with the Plant-In-charge / Electrical Supervisor In charge/ Chemist of the shift at Water Works of the Corporation and follow their instructions.

1.3.10.2 All deployed staffs are expected to discharge their duties in discipline manner. Uniform, I-Card, Safety Shoe, Helmet etc. which are essential to maintain discipline. Staff without these measures shall be considered as absent.

1.3.10.3 All operational activities and process matter, trouble shooting etc. remains to be reported to VMC Plant-In-Charge – Operation through shift chemist. Satisfactory report of operation on monthly basis supported with necessary evidence, documents etc. remains to be submitted along with Bill. Without this, operational activities shall not be considered as satisfactorily done for the claimed time period.

1.3.10.4 All Electrical / Mechanical / Instrumentation breakdown / preventive / routine maintenance activities as per schedule / instruction from VMC Plant-In-Charge – Maintenance remains to be carried out by contractor. Also, such activities remains to be reported to VMC Plant – In –Charge – Maintenance (AE / JE / Plant & Eq. Engineer of VMC) through Maintenance Assistant or Supervisor – Electrical. Satisfactory report of maintenance supported with necessary evidence, documents etc. remains to be submitted. Without this, maintenance activities shall not be considered as satisfactorily done for the claimed time period.

1.3.10.5 As per norms, deployed staffs needs to be covered under EPF and Insurance, hence, time to time, receipt towards payment of EPF and Insurance remains to be submitted along with O&M Bill

1.3.11 The duration of contract shall be as mentioned above from the date of placing the order for operation & maintenance. However, Corporation reserves the right to extend and or reduce the contract period depending on the performance and willbe absolutely at the discretion of the competent authority of the corporation. Further, Corporation will give 3 month advance notice to contractor for the extension in the contract period.

1.3.12 Please note that stipulated period to start the work after 10 days of work order date. VMC will not be responsible for postal delay if any.

1.3.13 The handover/take over procedure is to be done by agency within stipulated period of 10days to start work.

1.3.14 **NOTICE BOARD/ DISPLAY BOARD: -** The contractor shall provide a notice board / display boards at appropriate locations detailing precautions to be taken by operation and maintenance personal in work as per safety rules and regulations.

B. SCOPE OF WORK

The job involves the smooth operation & maintenance of entire work within the scope of this tender **for a period as mentioned above.**

The water distribution station / water distribution network comprising of various electrical / mechanical equipments / instruments like; **All** pump sets of various head & flow, with suitable motor and allied accessories like **NRV, butterfly valve, sluice valve, KGV, Actuator,** dewatering pump set, H.O.T/ E.O.T crane, Chlorination Plant(s), etc. The Electrical system LT panel board having ACB/ SFU etc with capacitor banks, motor control panel (starter), DOL/ star-delta starter, LT distribution boards etc, streetlight & building light etc. Instrumentation system comprises of various types of instruments like as Flow, Pressure, Level, PLC/SCADA & remote data transmission & lease lines & such communication facilities, etc., repairing & replacement of spare parts of above systems.

The scope includes **All in All comprehensive maintenance** of the entire work included within scope of this tender including components in Sayaji Baug, Vadiwadi and Akota Headwork, 4 nos. ESR, Distribution network in command area of Sayaji Baug, Vadiwadi and Akota including metering, Zonal and Master Control SCADA, etc. and is including materials/spares for routine, preventive and breakdown maintenance. The Pumping Stations/network shall run 24 hINR, 365 days basis including men power.

All the operation/maintenance activities such as WDS operation (running of pumps, numbers of pumps, pumping hours, etc.), ESR supply, network supply, etc. shall be done under the guidance of Site In-Charge.

The above list of equipment is in general. The equipments which are not described in the list but which are in existence in the plant are under contractor's scope of the operation & maintenance.

CONTRACTORS SCOPE OF SERVICES ALSO INCLUDES:

The contractor would be responsible for smooth, efficient & satisfactory operation & maintenance and repairing, replacement of spares, any work related to WDS / WSS / Water Works on round the clock basis.

- The scope of the contractor includes operation, maintenance & replacement of spare for pump sets & respective delivery piping/ piping network for lubricating / cooling of each vertical turbine pump sets etc.
- The scope of work also includes providing necessary tools & tackles for day-to-day O & M routine maintenance, preventive maintenance and break down maintenance.

- Also minor and major repairs to the equipment involved in the WDS/WSS have to be carried out by the contractor during the O & M period.
- The scope of the contractor includes operation, maintenance & replacement of gear mechanism for valve. Also operation, maintenance of chain pulley block of HOT/ EOT crane at WDS.
- Repairing & replacement of damage strainer of each pump sets, repairing of dewatering pump-motor set, etc
- The scope of work includes attending of all type of cable faults including end terminations of cable, changing of lugs or changing LT cable, etc. & required items shall be provided by contractor.
- The scope of work includes O & M of capacitor bank within WDS, panel, etc. All these capacitor banks must be kept in working condition to keep supply co. power factor more then 0.98 by the contractor. Any spares required to keep these capacitor bank in working condition is in the scope of Corporation.
- The scope of work includes O & M of entire instrumentation works at various locations including PLC & SCADA system, communication devices, etc. The scope shall also include all required charges (all charges including registration, rental, monthly usage, etc. as applicable) for various lease lines, broad band connections, SIM Cards, any other remote data transmission system, etc. as applicable.

APPLICATION:

- The general condition of the contract shall apply to the extent that they are not superseded by provision in other parts of the contract.
- Most stringent condition(s) / specifications shall be followed.

ELECTRIC POWER:

Vadodara Municipal Corporation shall directly pay all the power bills but the contractor will be required to note/furnish electricity consumption in the various log sheets/schedules/ registeINR **Log sheet / Schedules / registers shall be provided by the contractor & its format shall be approved by the VMC.**

MAINTENANCE TOOL AND EQUIPMENT:

All miscellaneous items for example vehicles, tools, testing equipment, cleaning or housekeeping materials/ equipment and safety equipment, electrical equipment, etc. shall be provided by the contractor at his expense.

Nothing is to be provided by VMC excluding, chlorine, electricity & Water. All other items shall be in the scope of contractor including Major and minor spares repairing and / or replacement as well as consumables.

Further the contractor shall provide sufficient mobile phones (if possible in VMC's service provider group) at WDS / WSS location staff which shall be available 24 hours with site in-charge / various key O&M personnel.

SAFETY SECURITY WATCH &WARD

The contractor shall be responsible for safety on site for entire works during the O & M of the works by the contractor.

The contractor's duties with respect to safety shall include the following:

a) Utilize safety awareness procedures in every element of operation & maintenance.

b) Gives emphasis to site including:
   (1) Safe working and safety procedures as per rule and regulation of government regarding use of protective clothing, gloves, Safety Shoes/ shock proof boots, safety belts, emergency light, torch and helmets etc.
   (2) Cleanliness of the WDS/plant/installation location as a whole.
   (3) Awareness of hazardous condition and accident reporting and necessary compliance.
   (4) Safe practice in Water Distribution station / network.
   (5) All safety equipment of WDS/WSS shall be maintain and operated by contractor. All equipment remains healthy & in working condition throughout the contract period.

The safety, security and watch and ward of all equipment/materials etc. within the Water Distribution Station / within the scope of this work shall be in the scope of contractor, but security for entire campus of WDS will be provided by VMC. Thus, campus security is not included in the scope.

1) MAINTENANCE:

Maintenance of installed equipments at Water Distribution Stations / Water Supply Network
All machinery, plants and equipment will be handed over to contractor in healthy and running condition at the time of commencement of the contract / on completion of successful testing, commissioning & acceptance of the entire system. Same way the contractor will have to handover all the machinery, plants and equipment to the VMC in healthy and running condition.

- The maintenance service provided by the contractor for the period specified in the contract shall ensure the continuity of All Water Distribution Stations/ Water Supply Network / Distribution Network locations that the breakdown or deterioration in performance, under normal operating conditions, of any items, of plant and equipment and component parts thereof is kept to a minimum.
- All routine maintenance like lubricating/ greasing of pumps and motors, valves, actuators, any other equipment, instrumentation works including PLC & SCADA systems, data transmission / communication systems, cleaning of fix moving contacts of starters/contractors/ Panels etc. shall be done on regular basis. The routine and preventive maintenance schedule shall be prepared and got approved by **Engineer In- charge** of the department. All the material like lubricating oil, grease, gland packing, nuts/ bolts/ washers etc. shall be supplied by contractor. The routine and preventive maintenance shall be done in most punctuality and in best engineering manner so as to minimize or eliminate any major breakdown of the machinery.
- For routine maintenance work Qty. of following consumable shall be maintain throughout the Contract period by the contractor.

Sr. No.	Description	Qty.
1.	Gland Packing	15 Kg.
2.	Lubricating Oil	10 Liter
3.	Rubber packing	15 Kg.
4.	Transformer oil	35 Liter
5.	Bearing Grease	10 Kg.

6.	Rubber Bush set with Bolt	Set for 1 pump of each category

- In the case of any major breakdown the maintenance shall be done by the contractor on highest priority basis and in no case Water Distribution network of such area to be interrupted.
- Root cause analysis for every minor as well as major fault must be done in details and to be well documented.
- All the electrical & mechanical installation including HT and its equipments in the Water Distribution Stations premise are in scope of work. Also the liasioning with Power supply co. and electrical inspector shall remain in the scope of contractor.
- If any motor(s) or Transformer(s) burns during the contract period, the contractor will have to at his cost get it restated using same quality of conductor/ insulating materials. Same is applicable in the case of burning of any transformers, starter panel.
- All the tools, tackles, Jigs and fixtures required for maintenance shall be brought by the contractors and shall be permanently kept at Water Distribution Stations.
- All the maintenance activities shall be done by qualified, experienced and skilled staff as asked in the schedule.
- The contractor shall adhere to the manufacturer's recommendation with respect to equipment maintenance, the type and grade of lubricants to be used, frequency of lubricant, adjustments to be made regularly and recommended spares to be kept in store.
- All the records and documentation shall be prepared and updated for all maintenance activities as per directed by Engineer-in-charge.
- Contractor shall have to supply free of cost and maintain 01 no. cupboard for safe storage of above consumable items and records throughout the Contract period at Water Distribution Station.

Maintenance of workshop equipments

Tools & tackles required by the contractors as a minimum are: Spanners set suitable to open vertical turbine pump/ Submersible pumps and other equipment like hammer, sling, D-shekel, screw driver set, master level, vibration meter, noise meter, dial gauge, welding machine, grinding machine, megger, multi meter, grease, grease gun, earth rod, safety glows for discharging HT panel etc.

In addition to above all other necessary tools as and when required must be with the contractor for satisfactory operation & maintenance of Water Distribution Stations.

Maintenance of Buildings & site.

The contractor shall be responsible for:

a) The maintenance of electrical, ventilation, plumbing & Hydraulic installation.
b) General building & compound maintenance as well as cleanliness, including gardening & housekeeping.
c) Full maintenance of the site services, cabling, and earthling system together with the site road street lighting system.
d) Site maintenance including approaches and gate.
e) The building services and housekeeping and cleanliness maintenance shall be undertaken on all building including HT Substation, Switchyard, roads, open spaces and services installation etc. within the premises.
f) The contractor shall ensure that all unwanted or redundant items are removed from

the building and site. Depending on their condition such items shall either be placed into storage or disposed off site.

APPLICATION:

- The general condition of the contract shall apply to the extent that they are not superseded by provision in other parts of the contract.

General Routine Maintenance:-

General routine preventive maintenance scheduled for various equipment shall be adopted from O & M manual. However the general routine maintenance to be carried out by the contractor's personals will include but not limited to the following: -

a) If it is observed that power consumption per MLD of Water Distribution Station water pumped is increased, the contractor has to trace out the fault and rectify the same to bring it the standard/normal value.
b) De – watering and cleaning of the transformer yard and other places.
c) Drying and refilling of silica gel in the breather of the transformer.
d) Regular watering on the earth – pits.
e) Check for any oil leakage in the transformer and initiating and repairing of the same.
f) Air blowing of motors, HT & LT panel etc.
g) Check for any loose connection in all electrical equipment and rectification of same.
h) Replacement of gland packing for the sluice valves / knife gate valves, etc., whenever required.
i) De-watering of all chambers on regular basis.
j) Greasing of bearing and lubricating all moving parts as per the scheduled.
k) Tightening of all loose nuts – bolts and other fasteneINR
l) General cleaning of all equipment and buildings.
m) Checking and replacement of bulbs, tubes, chocks, starters, switches, LED etc. Throughout the plant and including street and head lights.
n) Watering of plants and tree.
o) Cleaning of entire premise including toilets.

PREVENTIVE MAINTENANCE CHECKS: -

The contractor shall adopt a preventive maintenance check's scheduled as agreed mutually between the contractor and the corporation. The preventive checks and their tasks frequencies for major equipment are mentioned here in / shall be as recommended by manufacturer.

INSURANCE:

The contractor shall indemnify the corporation against all losses and claims in respect of

a) Death of or injury to any person, or,
b) Loss of or damage to any property (other than the work)
c) Which may arise out of in consequent of the operation & maintenance of the facility and the rectifying of any defects therein and against all claims proceedings, damages, costs, and expenses whatsoever in respect thereof or in relation there to.

The corporation shall not liable for or in respect of any damages or compensation payable to any workman or other person in the employment of the contractor or any sub-contractor, resulting from any act or default of the contractor, his agents or servant.

The Contractor shall take "All contract risk insurance policy" for all workers & labourers of contractor & client working at site & Third Party throughout the contract period.

The Contractor shall take "Workmen Compensation Policy" for all workers & labourers of contractor & client working at site & Third Party.

"Insurance Policy" must fully cover of all type risk. The Insurance policy so taken by the contractor for such purposes shall be in the joint name of the contractor & the client & the policy shall be deposited with the client & it must be taken by contractor before the start of contract.

SPARE PARTS AND STORAGE:

- The storage inventory, the issuing and recording of spare parts will be responsibility of the contractor.
- The contractor is also responsible for providing spare parts and material required for the operation & maintenance during the operation period, including the cost of storing and safeguarding.
- The contractor will make all necessary arrangements to ensure the continuous supply of spare parts and material for the work, and the rate of supply of these material shall be in such quantities amounts as would ensure uninterrupted operation.
- The contractor shall supply spare parts and the same will be used during operation & maintenance contract period. Any parts not used during the O & M period shall be handover to the corporation.

PLANT VISIT:

Vadodara Municipal Corporation reserve the right to arrange the visit of VIP's dignitaries, public representative and other person of social or political repute any organization as and when necessary to the All Water Distribution Stations / Distribution Network Locations. The contractor shall offer co-operation to the Corporation on the occasions of such visit.

All disciplinary measures as observed by Corporation and rituals being followed by VMC shall also be adopted by the concern employee of contractor' staff.

COMPLETION OF THE CONTRACT:

On the date of contract completion or if contract is terminated, all the installations, works and equipment placed under the contractor's responsibility shall be handed over to the corporation in good working order. The corporation may perform any inspection, test or expert appraisals he shall consider necessary with a view to checking that the property is in good working order and will certify to that effect to the contractor while taking over.

A joint visit shall be made by officer in charge and concern counter part of VMC well before the completion date of contract and all points needing rectifications/replacements shall be noted and shall be set aright by the contractor. A Minutes of Meeting is to be created indicating that all machineries mechanical, electrical and others are in order and no part is needs now to be replaced. If any defects found during handing over, the cost of rectification shall be recovered from final bill/ security deposit. This formal document must be created in

presence of Engineer-in-charge, the contractor and manufacturer and duly signed and sealed by all of them. Further following shall be noted:

- No accommodation /guest house/ transportation facility will be provided by the corporation to contractor.
- In case of any interruption of Water Distribution Stations / Water Supply due to any reason like failure of power supply etc. will be duly and immediately communicated to Engineer-in-charge. The contractor's staff must remain in association with Engineer-in-charge responsibly till that interruption is removed.
- All operation required for Water Distribution Stations / Water Supply Distribution System must be done in accordance with the instruction of Engineer-in-charge and all instructions given by him must be followed-up by the staff of the contractor. Any dispute, emergency or disturbance raised due to non-follow-up of instructions given by Engineer-in-charge shall be viewed seriously and the contractor may be penalized for the same as decided by the Corporation.
- The contractor will be responsible for the operation and maintenance of all valves & gates up to common header line installed within Booster House of Water Distribution Stations.
- Contractor shall be attending any work as instructed by Station In-Charge Engineer with in the campus of WDS / at all distribution network locations.

DOCUMENT RECORDS / LOG BOOK:

The contractor will be responsible for keeping up to date records of documents including History Card for equipment and maintaining every day log book relating to various operational parameters like Water Distribution Station hours, Amperes, H.T. voltage, Power factor, energy meter reading, pressure; distribution network parameters like level, flow, pressure, valve status, etc. and other reading required are recorded in every shift at regular interval e.g. hourly or as agreed mutually by VMC.

Log books/ routine maintenance books / registers and all printed necessary stationery required for maintaining records of O & M will be prepared under the guidance and will be provided by Contractor free of cost and also maintain these books in order will be the responsibility of Contractor.

Notice Board/ Display Board: -

The contractor shall provide a notice board/ Display boards at appropriate location detailing precautions to be taken by operation and maintenance personal in work conforming to Industries and Labor Regulation and Department of Explosives.

PAINTING:-

This work is inclusive of painting of Elect. & Mech. machinery like Motor Pump Sets, NRV, Sluice Valves, Bellows, BFV, pipe line, MCC Panel, MCC & LT-HT Panel, Transformers, Street Light Pole, Checkered Plate, EOT & HOT crane with accessories (girder, I Beam) window grill etc. once in 24 month contract period instructed Engineer In charge. (Time schedule for it, well be decided by VMC). **All buildings of water distribution station shall not be in the scope of painting works.**

Specifications for painting material:

Civil work outer side: ACE Exterior Emulsion.

Civil work inner side: White wash for water retaining structure & Distemper for pump house & buildings.

Doors, Windows, Street light, Flood Light: Synthetic Enamel.

All type of Electrical & Mechanical machineries and structures like Pump sets, valves, C.I. fittings, Sluice gate, M.S grill, transformers etc.: Synthetic Enamel.

Note: - 1. However, if any unit/mechanism will found to have some defect in paint work at any time, the Contractor has to repaint the same under the instruction of Executive Engineer.

Important Note :-

[1.] Please note that during the work, all required and necessary Electrical Safety Rules must be followed by the contractor. Corporation will not take any responsibility towards any damage/accident caused to workmen deployed by the contractor. Therefore, it is in the interest of contractor to ensure all safety precautions before commencement of the work.

[2.] Schedule for painting should be submitted to Engineer in-charge before starting the work.

[3.] It is the responsibility of contractor to keep all the installation and system up-to-date & well maintained & to comply & execute all the short falls, suggestions given by concerned government authority like elec. inspector and factory inspector etc., within stipulated time. All the such activities shall be done by contractor free of cost.

[4.] In case of continuous operating equipment like electronic equipment, capacitors etc. for which, supplier certify that, it is unrepairable, replacement is must, and VMC's competent staff also suggested replacement, the said equipment shall be supplied by VMC for replacement. In such case the Life span as suggested by supplier/manufacturing Company must be got over or the detritions of the equipment like capacitor is of up to unusable level. However, if in case of unrepairable breakdown of equipment due to negligence of contractor or misuse etc. on part of contractor, such replacement shall be supplied by contractor.

MAINTENANCE ACTIVITIES:

It includes maintenance of the all equipments, electrical /mechanical /electronic /instrumentation / equipments / pipelines etc. and Cleanliness of plant and surroundings **with all kind of spares and equipment.**

These activities includes: -

1.OVERALL MAINTENANCE OF ALL EQUIPMENTS:

Overall maintenance of all equipments electrical / mechanical / electronic / instrumentation / equipments / pipelines with **all major & minor spares.** These activities includes shall be in the scope of Contractor. Tools and tackles necessary for the efficient maintenance shall be arranged by contractor. The good workman ship should also be ensured supported by fundamental technical knowledge. Therefore, qualification as mentioned must be met with for various categories of staff.

1. **DAY TO DAY OVERHAULING AND CLEANING, TROUBLE SHOOTING:** The maintenance activities also include day to day overhauling and cleaning, trouble shooting of all instruments / equipments in adherence to Maintenance Schedule or as per the requirement aroused due to any breakdown.
2. **BREAKDOWN:** Whereas good overhauling and maintenance of equipment shall ensure long trouble free operation, therefore, breakdown shall be viewed seriously. Where spare (extra or standby) equipments have been installed, breakdown more than 7 days shall attract strict actions. All other equipments are expected to run continuously trouble free. Any serious effect on the day to day activities of

WDS/WSS hampering quality and/or quantity of treated/filter water due to lack of poor operation and maintenance shall be viewed seriously and actions as deemed fit shall be initiated by competent authority of corporation and shall be binding on part of contractor.

Maintenance Schedule

Sr. No	Items	Preventive Maintenance	Frequency
1	Sluice Valve	1. Leakage through Stuffing Box/Gland.	Monthly
		2. Noise/Vibrations while Opening or Closing the valve.	
		1. Lubricating of Exposed Moving Parts	Quarterly
		1. Condition of Body Seat Ring/Wedge Seat Ring faces-scratches, dent marks, intactness	
		2. Condition of Spindle & Spindle nut/Yoke sleeve threads	
2	Butterfly Valve	1. Leakage through DE/NDE ends	Monthly
		2. Noise/Vibrations while Opening or Closing the valve.	
		1. Lubricating of Exposed Moving Parts	Quarterly
		1. Condition of resilient Disc Seal-for cuts, deformation & resilience	
		2. Condition of Shaft Seals-for cuts, deformation & resilience	
3	NRV	1. Leakage through Valve Seat.	Monthly
		2. Noise/Vibrations while Opening or Closing	
		1. Condition of Door Face/Body Ring faces-scratches, dent marks, intactness.	Quarterly
		2. Condition of Hinge Pin	
4	Air Valve	1. Leakage through gasket for small orifice nipple	Quarterly
		2. Leakage through Rubber Seal in Low Pressure Chamber	
		3. Continuous leakage through the Low Pressure (Large) Orifice/High Pressure (Small) Orifice	
		4. Eventual passage of air through vent in small orifice plug (for High Pressure Chamber)	
		1. Condition of Float Balls, Rubber Seal in Low pressure chamber.	Yearly

5	Pump Sets	**A. Self priming pump set**	
		1. Check priming time	**Monthly**
		2. Check pump noise	
		3. Check All pipe connections	
		4. Check suction- strainer (if any)	**Quarterly**
		1. Open the pump. check & clean interior parts	
		1. Check impeller	
		2. Check clearance between impeller and wearing plate (Range:0,25 & 0.35 mm)	
		3. Check shaft sleeve. Replace if workout	
		4. Replace Gland potting	
		5. Replace wear plates, if worn out	
		B. Submersible Pump Set	
		1. Check delivery pressure, current and voltage	**Daily**
		2. Check Noise and vibrations	
		1. Check the oil in the chamber once in every 1000 operating houINR	**Quarterly**
		1. Check the condition of the Mechanical seals	**Quarterly**
		1. Check clearance between Impeller and setting plate	**Yearly**
		1. Overhauling for all pump sets having operating Time <=8 Hours per day (This work is to be done by Autho. personnel only.)	**Yearly**
		1. Overhauling for all pump sets having operating Time >8 Hours per day (This work is to be done by Autho. personnel only.)	**Yearly**
		E. VT Pump Set (Dirty Water Pump sets, Backwash Water Pump sets)	
		1. Check Oil / Grease in thrust bearing housing (If applicable)	**Monthly**

		2. Check oil level in lub oil tank	
		3. Check pressure Gauge Reading	
		4. Check Bearing Temperature	
		5. Check leakage through stuffing box	
		6. Check noise and vibration	
		7. Check water level, voltage and current	
		1. Change of Oil / Grease in thrust bearing housing (If applicable)	**Quarterly**
		2. Change of Gland packing	
		1. Overhauling for pumpsets having operating hours more then 8 Hours per day	**Yearly**
6	**EOT/HOT Crane**	1. Check push bottom operations	**Monthly**
		2. Check limit switch	
		1. Lubricate load chain wheel and load chain	**Quarterly**
		2. Check brake operations	
		3. Check smooth movement of hook	
		4. Check oil	
		1. Check Clearance between trolley and runway beam flange (range : 5 to 10 mm)	**Yearly**
		2. Check wearing in chain	
		3. Seeking safety license / certificate / load test certificate from consultant / authorized agency	
7	**Chlorinator (Vacuum feed)**	1. Check all the joints by Ammonia for any leakage	**Daily**
		2. All the valves on gas line must be operated irrespective of the function	
		3. Cleaning of the chlorinator	
		Note : While replacing the chlorine tonner always use new lead gasket	
		1. Check all the probes on the system	**Quarterly**

16	**Air Conditioner**	1. Cleaning of air filters	**Yearly**
		2. General cleaning with air blower	
		3. Thermo-state Checking	
		4. Compressor checking	

Sr. No	**Items**	**Electrical & Instrumentation preventive maintenance required to be done**			**Frequency**
1	**LT / Starter Panel**	1	Air Circuit Breaker	Tighten if found loose	**Once in Year**
				Clean with air blower & clean the accessible parts by dry lint free cloth.	
				Remove cause and replace the part	
				Apply PTFE grease, Beacon Q2 grease or its equivalent	
				Check operating mechanism for mechanical functions	
				Check auxiliary switch and re-tighten / replace	
				Check protection relay, replace if required	
				Check fix and moving contacts, erosion	
		2	MCCB	Tighten if found loose	**Once in Year**
				Check fix and moving contacts, erosion	
				Take necessary action if not found OK	
		3	Soft-Starter & its cubical	Check for operation of all Electronic Cards and tighten terminals	**Monthly**
				Take necessary action if not found OK	
				Blow dust by Air blower	
				Take necessary action if not found OK	
			Contactor, Fuse	Clean the contact by using smooth Emery paper or CRC spray	

Sr. No	Items	Electrical & Instrumentation preventive maintenance required to be done			Frequency
		4	Unit, Bus bars, Meters, ON/OFF Switch, MCB Etc.	1. General Cleaning 2. Cable Lugs Tightening 3. Check of Earthing	
		5	Auto-Transformer	Tighten if found loose	**Yearly**
				If megger value not achieved, placed for heating & re-varnishing if req.	
				Filter the oil & replace if required.	
				Take necessary action if not found OK	
		6	Capacitor	Check Capacitance Value and replace if not found OK	
				Tighten bus bar / wires	
				Check resisters	
				Take necessary action if not found OK	
		7	Panel cubical	Blow dust by Air blower	**Monthly**
				Re-tighten if found loose	
				Replace if required.	
				Take necessary action if not found OK	
		8	Earth resistance	Take suitable action if earth resistance is high	**Yearly**
				If found damage, replace/repair the earth strip.	

Sr. No	Items	Electrical & Instrumentation preventive maintenance required to be done			Frequency
		1	Terminal Box	Tighten if found loose	
				Clean with compressed air & clean the accessible parts by dry lint free cloth.	
				Replace if not found OK	

2		2	Winding	If megger value not achieved, placed for heating & re-varnishing if req.	**Quarterly**
		3	Earthing Strip	Replace if not found OK	
		4	Heater	Replace if not found OK	
				Take necessary action if not found OK	
3	**LT / HT Cable**	1	Terminal	Tighten if found loose	**Once in Year. Diagnostic testing to detect faults in cable & cable joints once in two yeaINR**
		2	Cable Insulation	Take necessary action if not found OK	
		3	Earthing Strip	Take necessary action if not found OK	
				Tighten if found loose	
4	Flow-meter			1. Physical cleaning, 2. Physical condition of sensor, 3. Display checking of Indicator 4. Gland and cable connection checking	**Monthly**
5	Level Indicator / transmitter			1. Physical cleaning, 2. Physical condition of sensor, 3. Display checking of Indicator, 4. Cable connection checking	**Monthly**
6	Pressure Transmitter or any other instrument in scope of work			1. Physical cleaning, 2. Physical condition of sensor, 3. Display checking of Indicator, 4. Cable connection checking	**Monthly**
7	PLC / SCADA Panel			1. Physical cleaning of panel, JB panel 2. Indicating lamps checking, 3. Communication failure checking	**Monthly**
				through display, 4. UPS checking ensuring its online connectivity.	
8	APFC Panel			1. General Cleaning2. Cable Lugs Tightening3. Check operation and tightness of Contactors, Fuse Unit, Bus bars, Meters, ON/OFF Switch, Earthing. Relay operation checking in auto mode	**Monthly**

3. Operation and maintenance of 3 nos. WDS, 10 nos. ESR, Distribution network including water meters, 2 nos. Zonal SCADA and 1 no. Master Control SCADA under the scope of maintenance work. Therefore, in order to maintain SCADA system in operational mode all the time, contractor remains to produce adequate

evidence towards successful operation and maintenance of SCADA system of entire smart city project. Contractor remains to have MoU with agency (**Authorized System integrator of same PLC/SCADA**) who got hands on experience in SCADA implementation and maintenance in water distribution station / water distribution network.Contractor shall be responsible for smooth operation and trouble shooting of entire SCADA system, whereas in case of any breakdown intimation shall be given by contractor to VMC.

a) SCADA System Control Panels all Hardware & all Software.
b) PLC System Hardware & Software
c) Communication

Preventive maintenance: The contractor shall adopt a preventive maintenance checks scheduled as agreed mutually between the contractor and the Vadodara Municipal Corporation. Please note that during the work, all required and necessary Safety Rules must be followed by the contractor. Vadodara Municipal Corporation will not take any responsibility towards any damage/accident caused to workmen deployed by the contractor. Therefore, it is in the interest of contractor to ensure all safety precautions before commencement of the work.

Maintenance activities and frequencies for SCADA systems and their components remain to be carried out without fail. Preventive maintenance schedules for SCADA components and subsystems should be coordinated with those for the systems they serve to minimize overall scheduled down time.

Activity	Frequency
Pneumatic systems/Components/Instruments	
Calibrate Level Transmitters	Yearly
Calibrate Flow Transmitters	Yearly
Calibrate Pressure Transmitters	Yearly
Calibrate LOH/ROF transmitters	Yearly
Electronic System	
Lamp Test/Verify Indicators	3 months
Inspect Enclosures for Dirt, Water, Heat	3 Monthly
Run PLC Diagnostics	3 Months
PLC Communication Modules	3 Monthly
PLC Batteries	Yearly

Test Automatic control Sequences	3 months
Software Maintenance and patching	3 Months
Inspect Wire, Cable and Connections	3 Monthly
Communication Network	3 Monthly
Dead Bus Relays	3 Months
UPS setting with SCADA	3 Monthly
Historian Package(capacity)	3 Months
Data Archiving	3 Monthly

Many components of SCADA systems, such as dead-bus relays, are not required to function under normal system operating modes. For this reason the system should be tested periodically under actual or simulated contingency conditions. These tests should approach as closely as possible the actual off- normal conditions in which the system must operate.

Periodic system testing procedures can duplicate or be derived from the functional performance testing procedures.

The SCADA software, PLC programming software maintenance should include timely updates of any new versions from the supplier and testing to verify proper installation on the SCADA computer. In addition, software antivirus updates should be maintained. This should be performed any time after the computer is connected to the Internet or the antivirus patch should be downloaded as and when the updates are available. Normal operation requires that the SCADA computer not be connected to the Internet.

Scope of work of System Integrator (To be appointed by O&M agency through MoU):-

- Routine services: Quarterly visits for cleaning, routine checking & testing entire system software & hardware.
- Breakdown/shutdown services/ other than routine services: contractor shall have to identify & rectify faults in entire project hardware and software including reloads any software if required and application program, if required.
- Telephonic/personal technical support at any time. Engineer will have to provide existing system software backups on compact disk during each quarterly visit. Also you will have to keep one set of back up at your works for emergency use if required.
- Contractor shall have to carry out all the repairing/ replacement of defective hardware/software on top priority. However the decision for replacement shall always be taken with VMC's consultation.
- Replacement of defective hardware to reduce WDS/WSS down time on a replacement basis.
- Contractor shall have to carry out any *minor* changes in existing application *software/logic* to accommodate any process requirement with no extra costs during the contracted period. However such requirements shall be communicated to contractor in advance.
- The maintenance work includes each and everything mentioned or not mentioned herein but required for running the system in healthy condition shall be included in maintenance scope.

3.1 In order that SCADA system remains all the time in healthy condition, all essential components related to SCADA system like, Level , Flow , Pressure, Actuator etc., communication line, software etc. requires to be maintained by contractor.

3.2 Deployed Instrumentation Technician by Contractor should have knowledge of maintaining SCADA system. Necessary training records towards such knowledge remains to be submitted by contractor. In absence of this, it is desirable to have association with SCADA implementing agency for three years for smooth operation and maintenance of SCADA system.

3.3 REPLACEMENT OF AN ITEM: If due to poor Operation & Maintenance or so, any item is causing frequent troubles and demanding frequent repairs, same item will be needed to be replaced instead of repairing.

4. **INVENTORY OF SPARES, CONSUMABLES:-** All necessary consumables like Oil, Grease, Gland Packing, Cotton Waste, Rust removing spray, PU Pipe, PU Connectors, Limit Switch, oil Seal, seal kit, O rings, Coupling rubber bush, Indicating lamp, Nut-Bolts, Lighting Materials, fuse & switches, Maintenance of Entire Electrical Lighting system with materials / consumables like wire, switch board, lighting – fittings, fixtures, HPSV / Mercury lamps / tubes / CFLs, pole(s), HOT/EOT cranes with materials etc. of Electrical / Mechanical machineries/ Equipments shall be in the scope of Contractor. Hence, proper inventory management with consumption records remains to be generated time to time.

Sr. No.	Description	Suggested Qty of Consumable to be kept in Inventory.

1.	Gland Packing	15 Kg.
2.	Lubricating Oil	10 Liter
3.	Rubber packing	15 Kg.
4.	Bearing Grease	10 Kg.
5.	Rubber Bush set with Bolt	Set for 1 pump of each category
6	Tubes as actually deployed on site	15
7	Tube light with fittings	20 sets
8	Petrol for cleaning	5 liters

5. All the materials / spares, which are required for maintenance shall be supplied by Contractor without any cost to VMC

6. **Tools and Tackles:-** All Tools an Tackles like megger, spanner sets, screw driver sets, grease gun, multi-meter, hammer, earth rod, vibration analyzer, noise measuring meter, etc. requires for routine, breakdown and preventive maintenance remains to be arranged and deployed by contractor.

7. **Maintenance of Buildings & site:-** The contractor shall be responsible for:

   7.1 The maintenance of electrical, ventilation, plumbing & drainage installation.

   7.2 General building maintenance & housekeeping.

   7.3 Full maintenance of the site services, cabling, and earthing system.

   7.4 The building services and housekeeping maintenance shall be undertaken on all building and services installation.

   7.5 In order that WDS/ESR/Control Rooms/Instrument Locations are maintained neat and clean inside and outside, the contractor shall ensure that all unwanted or redundant items are removing from the building and site. Depending on their condition such items shall either be placed into **storage or disposed off site** as per instruction of Engineer-in-charge.

8. **PAINTING:-** This work is inclusive of painting of Elect. & Mech. machinery like Motor Pump Sets, NRV, Butter Fly valves, Sluice Valves, Bellows, pipe line, MCC Panel, MCC & LT Panel, Starter panel, Light Pole within WDS premises, Chequered Plate, HOT / EOT cranes with accessories (girder, I Beam) etc. Painting works shall have to be carried out in professional manner once in 60 months of contract period.

Schedule for painting, will be decided by VMC. Painting shall be carried out with two coats of Red Oxide and Two Coats of Synthetic Enamel Paint. MS Grit on Clarifier Inlet Chambers, Agitator & Flash Mixers with Girders and angles to be painted with two coats of Red Oxide and Two coats of Epoxy Paint. At any point of time, if this painting works is found not satisfactorily done on above machineries, the Contractor remains to repaint the same under the instruction of Executive Engineer – HWW

Monthly bill Payment for Contractor during O & M:-

Contractor is required to enclose bank certification of salary payment to his employee with the monthly bill. Contractor is instructed to make arrangement of salary/ payment (as per minimum wages Act-1948 & Rules) through bank account only, and copy of the bank payment transaction must be submitted with certificate of bank at the time of summation of monthly bill.

If Payment/salary of any employee of contractor is not deposited in bank account of any of employee, the amount of salary/ payment of said employee will not be paid to contractor in monthly bill till the bank certificate / passbook of the employee is not submitted.

TABLE NO. 1
MINIMUM MAN POWER REQUIRED

Sr. No.	Designation	Qualification	Experience	Component wise Manpower to be deployed						
				Form and Billing	WDS-1	WDS-2	WDS-3	Existing ESR SE-11, E-9A and E-10	Rising Main WDS to ESR and Distribution Network	Water Meter Connection
				Staff Required						
1	Project Manager	Minimum Graduate (B.E. Civil / Electrical / Mechanical / B.E. Instrumentation or E.C.)	Minimum five years experience for similar field	01						
2	Assistant Engineer	B.E. Electrical	Minimum two years experience for similar field	--	01				--	--
3	Instrumentation Engineer	B.E. (Instrumentation)	Minimum two years experience for similar field	--	01				--	--
4	SCADA Monitoring Engineer	B.E.	Minimum two years experience for similar field	--	05				--	--
5	Instrumentation Technician Engineer		Minimum two years experience for similar field	--	05				--	--
6	Diploma Engineer	Diploma in Mechanical / Electrical Engineer	Minimum two years experience for similar field	--	01 (Mechanical) + 01 (Electrical) = 02			--	--	--
7	Diploma Engineer	Diploma in Civil Engineer	Minimum two years experience for similar field	04	01			02	--	--
8	Mechanic of Water Meter	ITI Mechanical	Minimum one year experience for similar field	--	--	--	--	--	--	01

Sr. No.	Designation	Qualification	Experience	Component wise Manpower to be deployed						
				Form and Billing	WDS-1	WDS-2	WDS-3	Existing ESR SE-11, E-9A and E-10	Rising Main WDS to ESR and Distribution Network	Water Meter Connection
				Staff Required						
9	Meter Reader	Minimum HSC pass	Minimum one year experience for similar field	08	--	--	--	--	--	--
10	Computer Operator cum Clerk	Minimum BCA	Minimum one year experience for similar field	03	--	--	--	--	--	--
11	Fitter	ITI in Fitter Trade	Minimum one year experience in Water Distribution System	--	--	--	--	--	04	05
12	Helper	Should be physically healthy & able to read & write (only male)	Minimum one year experience in Water Distribution System	--	06	06	06	08	--	02
13	Security Guard	Should be physically healthy & able to read & write (only male)	Minimum one year experience as Security Guard	--	06	06	03	09	--	--
14	Electrician	ITI (Electrician / Wireman) having Lisence of Govt. of Gujarat.	Minimum one year exp. for O&M of Govt. of Gujarat.	--	03	03	03	--	--	--
15	Fitter	ITI in fitter Field	Minimum one year exp. for O&M in Similar Field	--	02			--	--	--
16	Chemist	B.Sc with Chemistry	Two years exp. in similar field	--	02			--	--	--
17	Helper for Sampling	S.S.C.	Two years exp. in similar field	--	01	01	01	01		

Payment Conditions

Payment of Part-A

For initial twelve months (0 year of O&M Schedule) will be paid to the contractor based on the components handed over for Operation and Maintenance of the area of existing 24 x 7 Water Supply System.

Manpower for each component shall be as per the Table No. 1 and Table No. 2 mentioned above.

The Quantity mentioned in Schedule is the total quantity of water supplied at the consumer end.

The payment shall be made on the basis of water supplied as per Item No. (1) of Operation and Maintenance phase. The payment shall be made every month.

Mode of Payment :

The payment shall be made on basis of water supplied as per Item No. 1 of Operation and Maintenance Phase.

Item No. 2 : The work of O&M will consist of operation and maintenance of water meter connection. The firms have to repair or replace pipes / specials, valves, water meter, breakages of pipes, repairs of road and valve chambers including day to day maintenanace as well as periodical preventive maintenanace of the assembly of water meter connection as required.

2.3 Scope for Maintenance Work:

2.3.1 On receipt of the complaint, the representative of the bidder should go to the site, of the work with all spares, necessary tools and tackles, tested meter and remove the defective water meter and replace the same with tested working water meter. Any works like replacement of MDPE pipes / Specials, cutting gland and breaking of the concrete, etc., shall be carried by the contractor at his cost.

2.3.2 The removed water meters shall be preferably inspected at site and all minor repairs/replacement of parts, strainer, etc. which shall not affect the performance of water meter will be done at the site itself in case the totalizer is found damaged, the same shall be take for repair as shown below:-

2.3.3 The defective water meters should be removed and new tested water meter should be installed immediately after receipt of intimation from the V.M.C.

2.3.4 Complaints regarding abnormal/subnormal readings will also be treated as defective meteINR The bidder has to arrange for the replacement of such water meters with duly tested meters which is supplied by VMC.

2.3.5 If the factory seal of the company/V.M.C.. seal is found tampered with water meter, then the signature of the departmental personal and the consumer should be obtained on the complained sheet and cost of such repairs will be charged to the consumer and paid to the bidder directly by the consumer.

2.3.6 Minimum team for maintenance : One mobile unit (four wheeler) equipped with minimum 10 Nos. tested meters and spares for meters, seals, tools, fitter, valves, strep saddles, MDPE pipe, ferrule and necessary manpower shall be available at the office of Contractor at Vadodara (No reimbursable). The absence will be liable to penalize INR 5,000/- per day.

2.3.7 The item also includes all necessary material, tools- tackles, along with skilled/ unskilled labour, supervisor etc complete for the maintenance of installed Water meteINR

2.3.8 The item also includes the periodic preventive maintenance, if required of the installed

connection with water meters to avoid any defect during its working and for the better performance of the connections.

2.4 This item also includes:

2.4.1 Cost of all labour required for excavation for this job work in all strata including dewatering (also dewatering by Pump if necessary).

2.4.2 Testing and Commissioning of Volumetric Domestic/Bulk water meter.

2.4.3 This item also include labour cost for lowering, laying, carting of materials and refilling the trenches for this work. The prior permission required from V.M.C.. for replacement, shall be the responsibility of the Contractor.

2.5 Terms of Payment:

The payment shall be made on monthly basis of all in all maintained meters in good condition in all respect.

Item No. 3 : Taking reading bimonthly from all the water meter connections preparation, printing and distribution of bills to all consumers in different administrative zones of Vadodara city. The item also includes AMR meter reading software, Handle Unit with latest version of computer for software programme, Data entry and same shall be transferred to VMC system.

Note:- VMC supplied (Elster / Itron / Baylan / Zenner / Arad / or equivalent) Automatic Meter Reading (AMR) mechanical water meter for which reading, billing to be done by contractor so he has to obtain compatible software as well as Hand Held Unit (HHU) which must be approved by VMC.

1.1 This includes taking the bi-monthly reading of groups of consumer meters installed in this contract. Contractor will have to submit the program of meter reading and details of method proposed to be used. The details shall be exhaustive and distinctive, elaborating about the instrument/gadgets and all other paraphernalia and methodology adopted, which shall be compatible for any type, size and make of meter.

1.2 Meter Reading:

(a) The contractor will have to take the bi-monthly reading of the consumer meter installed in this contract.

(b) Contractor will have to submit the details of the method adopted. The details shall be exhaustive and distinctive, elaborating the instruments/gadgets and other paraphernalia.

(c) The methodology adopted shall be compatible for any type size and make of meter.

(d) The date of first reading shall be followed in taking reading of consecutive months.

1.2.1 Meter Reading (AMR)

a) The successful bidder shall submit a detailed scheme for obtaining and recording remote reading of the AMR water meters to be installed.

b) The scheme of remote reading shall be formulated by forecasting the required nos of hand held units (HHU) & easy route host, etc, to collect & upload data for the respective region.

c) The meter reading (AMR) scheme shall be formulated keeping, in the view the AMR water meter readings to be obtained by RF based AMR technology, which shall be appropriate for the make & size of the water meters & its software and the output. Format

shall be compatible with the system of VMC. The bidder will be responsible to integrate their system with existing system of VMC for printing of bills.

d) The VMC reserves the right to accept or reject any/ all such AMR water meter reading schemes.

e) It will be mandatory for the successful bidder to provide the demonstration of his remote AMR water meter reading and the bill preparation scheme to the VMC staff and appointed officers as & when required during the contract period.

f) The system of AMR and HHU shall be maintained in proper working condition for the water meters during the Post installation period for 10 (ten) year INR

g) The agency will be responsible for taking reading of AMR water meters in bimonthly billing cycle I/c uploading the reading data in VMC billing unit and integration with existing system of VMC for generation/ printing of consumer bills by VMC during the contract period i.e installation and 10 yrs maintenance period thereafter. Distribution of bills will also in scope of agency.

h) The reading of MAR meter for generation of the bills shall be commence with 2 months from the date of installation of each meteINR

i) The reading shall be done progressively as the installation work progresses.

j) In case of all AMR meters eligible for the reading, are not read during the billing cycle then no deduction from due payment will be made so far the number of unread meter do not exceed 0.5% of the readable meteINR

k) A deduction of INR 10 (Ten rupees only) for reading in each billing cycle shall be made for number of reading not collected / taken exceeding 0.5% of the readable meteINR

1.3 Preparation and printingof bills:

(a) Billing system shall be computerized based on Oracle and Developer or latest version of application software wherein the consumer data shall be stored and the bill shall be processed and printed in the pre-printed stationary.

(b) Contractor will have to develop suitable software based on the existing water rate which can be tailored in case of revision in water rate byelaws. The software shall be compatible to the existing billing software of V.M.C.. with regards to down loading and uploading of consumer data.

(c) Contactor will have to demonstrate the billing software by printing the sample bills for all categories of consumers with different status of consumption before actually starting the billing.

(d) The contractor will have to take approval of pre-printed billing format of Hydraulic Engineer.

(e) The contractor will have to provide necessary hardware like server suitable to store and process the consumer data, computers for entering the data, suitable printer, stationary & consumables for printing bills at his own cost.

(f) Contactor will have to maintain this billing system along with the hardware and consumables during the contract period.

(g) The contractor will have to record the status/condition of meter and status on which the bill is issued at the time of billing.

(h) The total work of billing specially with regard to input and output data through software will have to be compatible with present software of V.M.C.. The data structure specification of V.M.C.. will be provided to the Contractor for uploading and downloading of data. Copy of the bill format shall be finalized with Hydraulic Engineer after awarding of Contract.

(i) V.M.C.. will up-load the data from its system in respect of consumers who will be issued bills and will also get the data downloaded from billing machine to its

computer system, in respective zones and its centralized computer center at water works department. The hardware and software have to be compatible with the existing computer system.

(j) The contractor shall have to submit the reports regularly as per the requirement of field offices.

Special conditions for billing

- Feature of the Billing Machine:
- The billing machines should not be editable in nature i.e. no data should be edited once it is entered into bill machine. The said provisions should be automatically invoked on issue of bill i.e. immediately after the print out of bill is taken from machine.
- The format of bill should be as specified by V.M.C..
- Complete security of V.M.C.. data should be maintained by Contractor and updated data of V.M.C.. should be downloaded on machine of V.M.C.. only (respective Zonal
  office, etc.) The data security as well as data encryption should be provided in both the softwares. This will ensure, that no data is tampered by the unauthorisad persons. For this, necessary algorithms such as check sum fields should be provided in the data download and upload software.

- Necessary reports as required by V.M.C.. will have to be generated by the said Contractor whenever required as per Field requirement and as per Annexure enclosed.
- The basic software of billing machine (SBM) will be required to be developed centrally
  (field programmability of basic software not permitted). The said software will be required to be approved by the consultant and or expertise engaged by V.M.C..
- During the contract period, the contractor will have to make necessary changes in the software due to changes in act, rule and water rate Bye-Laws on account of Govt. directive or V.M.C.. decision.
- Before actual start of work, contractor will have to first prepare the software compatible to the existing software program of VMC. The actual work of billing shall commence only after trial of billing is given by the contractor to the satisfaction of the consultant and / or expertise engaged by V.M.C.. from the commencement implementation of order.

1.4 Distribution:-

This includes distribution of bills to the respective consumeINR

(a) Bill shall be distributed within two days after printing of bills.
(b) Receipt of bill shall be obtained from the consumer.
(c) In case of connections to Govt. premises, it may be required to distribute the bill into the Govt. offices situated at places other than the places where meters fixed.

1.5 General:

(a) It is mandatory to provide demonstration of his meter reading and bill preparations scheme prior to its final acceptance.
(b) Meter reading should be generally taken between time period 7.00 AM to 7.00 PM.
(c) All the data after processing of bill shall be down loaded to VMC data base at respected Zones / ISD Department.
(d) Two hard copies of demand generated after entering the meter consumption of consumers shall be submitted every month immediately after printing of bills and one copy shall be obtained from VMC to incorporate the corrections before

generation of bills for the next month.

(e) While recording the meter reading if the water meter is found damaged /tampered (seal broken) the same shall be reported immediately to the V.M.C.. authorities of respected Zone. Such meter shall be replaced only after permission of V.M.C..

(f) In case of improper/erratic/abnormal recording of the meter reading, the responsibility for variation in bills of consumer will vest with the contractor recording such false readings.

(g) All manpower deployed by the Contractor should be suitably qualified and trained for the job intended to be performed by them.

(h) The manpower should be conversant with Gujarati in addition to working knowledge of English, Hindi, so as to interact with consumeINR

(i) The deputed manpower should be extremely polite with consumers and should be able to address consumer grievances about bills issued.

(j) It will be mandatory for employees of Contractor to display the Identity Card issued by V.M.C. to the employees of the Contractor. The expenditure of which shall be borne by the Contractor.

(k) Sufficient number of coordinators will have to be employed by Contractor to ensure smooth working with different V.M.C.. offices.

(l) The contractor shall appoint coordinating officer/supervisor for keeping liaison with V.M.C.. for said meter reading work.

(m) The staff should use the photo identity card issued by bidder and counter signed by the V.M.C.. authorities, while on duty.

(n) In case of complaint of any consumer, the meter reader should take written complaint and hand it over the V.M.C.., through coordinating officer. The contractor shall immediately inform to V.M.C.. Engineer about any illegal water connections that come to the notice of his staff.

(m) V.M.C.. will carry out independent checks as and when required

1.6 Mode of Measurement and payment:

The measurement shall be per consumer basis to be paid after completion of activity for the consumers in the entire group. 100% payment will be made after completion of total activity.

PENALTY CLAUSE

PENALTY CLAUSE (PENALTY SCHEDULE) FOR O & M WORKS

During the O&M period penalty will be charged as per below :-

Penalty will be charged as per below:-

1.1 For absence of staff, following shall be levied

Sr.	Category	Penalty Amount
1	Project-in-charge	1500
2.	Electrical supervisor	600
3.	Chemist / Electrician / Inst. Technician / Fitter	550
4.	Helper	500

1.2 If average P.F. (Power Factor) of the monthly energy bill remains as bellow penalty, in addition to penalty loaded by DGVCL or Torrent Power Ltd. will be charged extra as bellow.

0.98 to 0.96	INR2000 per day
Less than 0.96 up to 0.90	INR3000 per day
Less than 0.90	INR3000 per day + penalty levied by DGVCL or TORRENT POWER LTD.

1.3 Power supply failure due to poor maintenance / any other reason in electrical yard / switch gear / LT panel , capacitor shall be highly objected & shall be rectified and restore within one hour by contractor. Otherwise penalty shall be levied @ INR 200/ Hr. till restoration of power supply.

1.4 If any Electrical/Mechanical machinery (Other than pumpsets) in working condition but their sub parts are damaged or in non-working condition than penalty per machinery will be applied as bellow

INR100/-per day	From the 16th days to 25 days.
INR200/-per day	After 25 Days penalty will be applied for whole the period of not working of machinery.

1.5 If any pump set remains out of order for more than 12 days penalty per pump set for the same will be applied as bellow

INR150/- per day	from the 12th day to 15 th day
INR800/- per day	from the 16th day to 25th day
INR1500/- per day	After 25 Days penalty will be applied for whole the period of not working of machinery.

1.6 For SCADA / automation system, any instruments / equipment shall not remain in non- working condition for the want of spares for more than 15 days from date of intimation. Otherwise, penalty @ INR500 per day per instrument equipment shall be levied. If any instrument / equipment remains out of order for more than 25 days, penalty @ INR500 per day per instrument / equipment since the date of out of order. Major instrument / equipment which is not in scope and if it remains out of order, engineer-in-charge / Instrumentation Engineer must be informed.

1.7 If contractor seems failed to do daily maintenance, housekeeping or periodic / routine works, the penalty levied will be INR500/- per day/work.

1.8 If painting is not done on order, actual cost of painting as decided by engineer in charge will be recovered from bills. Further, if Painting work is not completed within FOUR(4) month in all respect from the date of written intimation, penalty of INR800/- per day (max. up to 10%) of total order value will be recovered from payments.

1.9 Above all penalty will be deducted from relevant Running bill /security deposit

1.10 For circumstances out of control of contractor, Head of the Department is authorized to decide waiver of full/part of the above penalties listed above in clause 1.3 to 1.5.

1.11 If under ground water tank (UGSR) will be overflowed by any reason of negligence, Then penalty shall be levied at INR3000.00 per incidence.

1.12 INR100/-per day per person will be penalised in case of person on duty found not wearing the uniform.

1.13 In any case, total penalty exceeding 10% of monthly bill then maximum 10% of monthly charges will be consider as a penalty (excluding the charges towards damages

and penalty towards absenteeism of manpower). If such a situation is continue for three consecutive months, VMC may terminate the contract without any prior notice

(4) Penalty for non attendance leakage in network.

If there is any type of leakage which is informed by VMC staff to authorized person of contractor, it will be repaired within 24 hours other wise penalty will be charged as below.

- 24 to 48 hours INR 2,000/-
- 48 to 72 hours INR 3,000/-
- More than 72 hours INR 5,000/- for each day

(5) Penalty for non-attendance of contamination in the network.

If there is any type of Contamination of water is found which is informed by VMC staff to authorized person of contractor, it will be solved within 48 hours other wise penalty will be charged as below.

- After 48 hours and up to 5 (Five) days, per day INR 1,000/-
- Then after For 5 (five) days and upto 10 days per day INR 2,000/-
- Then after For each day INR 3,000/-

(6) Penalty for delay in provision of water connection.

Water connection should be completed in all respect within 7 (seven) days after approval given from VMC. other wise penalty will be charged as below.

(i) After 7 (seven) days, INR 1,000/- per day.
(ii) If connection is not as per specification of the tender, penalty of INR 5,000/- for each connection.

(7) Penalty for delay in replace/repairs of faulty meter.

(i) All the faulty meters shall be repaired within 48 hours from the time of intimation. On failing of attend the complaint within 48 hours penalty of INR 250/- per day shall be levied from the Running Account Bill.
(ii) The faulty meter shall be repaired in such a manner that there will be no complain of the same at least for 3 (three) months. If within three month the same meter will become faulty the same shall be repaired at free of cost by the contractor.

(8) Penalty for delay of non-issue of bi-monthly bill to consumer.

At every even number of month, within the first week of the months contractor has to complete measurement reading, printing, sanction from approved authority, keeping all the bills ready to deliver to the consumer. In the second week of said month contractor should complete the delivery of all bills of water meter to the consumer. The proof of dispatch of bill / receipt note shall be submitted within third week of the same month to the Engineer- in-Charge.

If contractor fails to complete any activities mention above he will penalized INR 100/- per non-billing of each meter, for not issuing a bill bi-monthly.

Penalty for Not Submitting Demand / Recovery Statement / faulty meter detail / Temper Meter Detail, etc. within 10 days from the date of bill issue of billing cycle. Contractor will penalized INR 500 for each report.

Reading, billing complaint must be solved within 72 hrs from the receipt of complaint otherwise contractor will penalized INR 250 per complaint.

(9) Penalty for water losses.

Penalty for water losses for zero year of O&M

(a) The water losses upto 20% will be allowed without any penalty or bonus.
(b) For the losses in water quantity more than 20% but up to 22%, one and half times penalty of production cost
- Losses more than 22% to 24% - two times of production cost
- Losses more than 24% to 30% - three times of production cost,
- Losses above 30% - five times of production cost will be levied by Vadodara Municipal Corporation.
- Production cost will be considered @ INR 3/- per 1000 liter.

Penalty for water losses for first year of O&M

(b) The water losses upto 20% will be allowed without any penalty or bonus.
(b) For the losses in water quantity more than 20% but up to 22%, one and half times penalty of production cost
- Losses more than 22% to 24% - two times of production cost
- Losses more than 24% to 30% - three times of production cost,
- Losses above 30% - five times of production cost will be levied by Vadodara Municipal Corporation.
- Production cost will be considered @ INR 3/- per 1000 liter.

Penalty for water losses for second year of O&M

(a) The water losses upto 17% will be allowed without any penalty or bonus.
(b) For the losses in water quantity more than 17% but up to 19%, one and half times penalty of production cost
- Losses more than 19% to 21% - two times of production cost
- Losses more than 21% to 26% - three times of production cost,
- Losses above 26% - five times of production cost will be levied by Vadodara Municipal Corporation.
- Production cost will be considered @ INR 3/- per 1000 liter.

Penalty for water losses from third year to tenth year of O&M

(a) The water losses upto 12% will be allowed without any penalty or bonus.
(b) For the losses in water quantity more than 12% but up to 14%, one and half times penalty of production cost
- Losses more than 14% to 17% - two times of production cost
- Losses more than 17% to 22% - three times of production cost,
- Losses above 22% - five times of production cost will be levied by Vadodara Municipal Corporation.
- Production cost will be considered @ INR 3/- per 1000 liter.

(10) Penalty for inadequate pressure.

8 m pressure at consumer end will be allowed without any penalty or bonus. Pressure less than 8 m penalty of INR 5000/- per incident.

6.20.3
DETAILED TECHNICAL SPECIFICATIONS OF DISMANTLING OF EXISTING RCC STRUCTURE

6.20.3 DETAILED TECHNICAL SPECIFICATIONS OF **Dismantling of Existing R.C.C ESR's, GSRs, Pump House and Office Building**

Dismantling of ESRs, GSRs, Pump House and Office Building of various capacities and heights using crane (10 MT capacity) and However taking steel reinforcement and M.S./ C.I.D.F pipes by the dismantling agency including removing dismantled materials from site and disposing them at suitable place as directed by Engineer-In-Charge, etc. complete.

For ESRs, GSRs and Pump House –

As the ESR is an elevated structure supporting a water tank constructed at a height sufficient to pressurize a water supply system for the distribution of potable water, and to provide emergency storage for fire protection, so it is assumed that the water container is filled with water at a certain height, so that the water should be removed from container before start of the process of dismantling. Same process should be followed for GSRs and Pump Houses.

Furthermore, from the Pump house, the pumps and other electromechanical instruments also should be removed from structure as directed by Engineer-In-Charge.

The flow of work for ESR dismantling as will be from top to bottom of tank. Dismantling should be starts from roof slab – container – Bottom Slab – columns and Braces (from top to bottom) – Foundation (Footing). Proper care shall be taken while dismantling of ESR for debris falling and the process shall not be disturbing to the manual movement around the work and all the surrounding structures shall remain safe.

Same flow should be carried for GSRs and Pump house. Dismantling flow will be starts from top and progress towards bottom.

All debris of concrete, reinforcement steel and all dismantled material shall have to stack at proper place on site shown by engineer-in-charge and ultimately transport and disposed to the disposal site shown by VMC officials within maximum 20 Km. from the site of work.

All the structure, which are proposed for dismantling are in the heart of the city, so that each and every safety protection measures should be taken care by contractor.

MODE OF PAYMENT:
The payment shall be made as per the price bid submitted by the contractor.

6.20.12
APPROVED LIST OF VENDORS

6.20.12 APPROVED LIST OF VENDORS

Cement : Ambuja, Ultra tech, conforming to IS: 12269 of 53 grade (OPC only)

Steel : Reinforcement Steel: TMT Fe 415/ Fe500
TATA, SAIL, RINL (VIZAG),
Electrotherm (I) Ltd. & JSW Steel Ltd. (Conditional).

Butterfly valve: Indian Valve Co., Nasik
Kirlosker Brothers Ltd., Mumbai
Fouress Engineering (I) Ltd., Banglore

Air Valve : IVC, Fouress, Kirloskar

Sluice Valve :

Sr.No.	Name of Manufacturer	Brand Name/Make
1	KIRLOSKAR BROTHERS LTD., MUMBAI	KIRLOSKAR
2	INDIAN VALVE CO., NASIK	IVC
3	FOURESS ENGINEERING (I) LTD., BANGLORE	FOURESS

Water stopper : Sinecos Profiles Pvt. Ltd. or equivalent., Arti

D.I. Pipe : Jindal, LANCO.

GI Pipe : Tata, Asian, Jindal

***Note*: Above Equipments / items / Products are indicative. The Product / Make shall have to pre-approve from the Engineer-in-charge prior to Execution / Procurement. The decision of the Engineer-in-charge shall be final and binding to the contractor.**