

## SPECIFICATIONS OF MATERIALS

### 1. M-1. Water

- 1.1. Water shall not be salty brackish and shall be clean, reasonably clear and free objectionable quantities of silt and traces of oil and injurious alkalis, salts, organic matter and other deleterious material which will either weaken the mortar of 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 standard specified in I.S. 456-1978.
- 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 per cent 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 will generally be found suitable for curing mortar or concrete.

### 2. 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 be carried out:
  - (1) 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 are the unburnt lime stone.
  - (2) 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. 1624-1974 to show the acceptability of materials.

### 3. M-3. Cement

- 3.1. Cement shall be ordinary Portland slag cement as per I.S. 269-1976 or Portland slag cement as per I.S. 455-1976.

#### 4. M-4. White Cement

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

#### 5. M-5. Coloured Cement

5.1. Coloured cement shall be with white of grey Portland cement as specified in the item of the work.

5.2. The pigments used for coloured cement shall be of approved quality and shall not exceed 10% of cement used in the mix. The mixture of pigment add cement shall be properly ground to have a uniform colour and shade. The pigments shall have such properties to provide for durability underexposure to sunlight and weather.

5.3. The pigment shall have the property such that it is neither affected by the cement nor detrimental to it

#### 6. M-6 Sand

6.1. Sand shall be natural sand, clean, well graded hard 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 percent of silt as determined by field test, if necessary the sand shall be washed to make it clean.

6.2. **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. Designation	Sieve passing sieve	Percentage by weightDesignation	I.S. Sieve Percentage by weight passing Sieve
4.75 mm	100	600 micron	30 - 100
2.36 mm	90 to 100	300 micron	50 - 70
1.18 mm	70 to 100	150 micron	0 – 50

#### 6.3. Fine Sand:

The fineness modulus shall not exceed 1.0 The sieve analysis of fine sand shall be as under.

I.S. Designation	Percentage by weightSieve passing	I.S. Designation	Percentage by weightSieve passing
4.75 mm	100	600 micron	40 - 85
2.36 mm	100	300 micron	5 - 50
1.18 mm	75 to 100	150 micron	0 - 10

#### 7. M-7. Stone Dust

7.1. This shall be obtained from crushing hard black trap or equivalent. It shall not contain more

than 8% of silt as determined by field test will measuring cylinder. The method of determining silt contents by fields test is given as under :

- 7.2. 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 up to 100 mm. mark. The clean water shall be added up to 150 mm. mark. The mixture shall be stirred vigorously and the content allowed to settle for 3 hours.
- 7.3. 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 content within the allowable limit.
- 7.4. The fineness modules of stone dust shall not be less than 1.80

## **8. M-8. Stone Grit**

- 8.1. 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 flakey elongated pieces shall be avoided. It shall generally comply with the provisions of I.S. 383-1970. Unless special stone of particular quarries 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 no deleterious with cement.
- 8.2. The grit shall conform to the following gradation as per sieve analysis :

<b>I.S. sieve designation</b>	<b>Percentage by weight</b>	<b>I.S. Sieve designation</b>	<b>Percentage by weight</b>
12,50 mm	100 %	4.75 mm	0-20%
1000 mm	85 - 100%	2.36 mm	0-25%

- 8.3. The crushing strength of grit will be such as to allow the concrete in which it used to build-up the specified strength of concrete
- 8.4. The necessary tests for grit shall be carried out as per the requirements of I.S.2386- (parts-I to VIII} 1963r as per instructions of the Engineer-in-charge. The necessity of test will be decided by the Engineer-in-charge.

## **9. M-9. Cinder**

- 9.1. Cinder will burn furnace residue which has been fused or sintered into lumps of varying sizes
- 9.2. Cinder aggregates shall be well burnt furnace residue obtained from furnace using coal fuel only It shall be sound clean and free from clay dirt, ash or other deleterious matter
- 9.3. The average grading for cinder aggregates shall be as mentioned below.

<b>I.S. Designation</b>	<b>Percentage by weight Sieve passing</b>	<b>I.S. Designation</b>	<b>Percentage by weight Sieve passing</b>
20 mm	10 mm	100	86
4.75 mm	2.36 mm	70	52

**10. M-10. Lime Mortar**

10.1. Lime: Lime shall conform to specification M-2, Water: Water shall conform to specification M-1 and Sand: Sand shall conform to specification M-6

**10.2. Proportion of Mix:**

10.2.1. mortar shall consist of such proportions of slaked lime and sand as may be specified in item  
The slaked lime and sand shall be measured by volume

**10.3. Preparation of mortar;**

10.3.1. 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 a 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.

**10.4. Storage:**

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

**10.5. Use:**

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

**11. M-11. Cement Mortar**

11.1. Water shall conform to specification M-1, Cement : Cement shall conform to specifications M-3 and Sand : Sand shall conform to M-6

**11.2. Proportion of Mix**

11.2.1. Cement and sand shall be mixed to specified proportion, sand being measured by measuring boxes, the proportion of cement will 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.

**11.3. Proportion of Mortar:**

11.3.1. 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

11.3.2. 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

**12. M-12. Stone Coarse Aggregate For Nominal Mix Concrete**

- 12.1. 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
- 12.2. 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 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.

I S. Sieve Designation	Percentage passing for single <u>Sized aggregates</u> <u>of Nominal size</u>			I S. Sieve Designation	Percentage passing for single <u>Sized aggregates</u> <u>of Nominal size</u>		
	40 mm	20 mm	16 mm		40 mm	20 mm	16 mm
80 mm	-	-	-	12.5 mm	-	-	-
63 mm	100	-	-	10 mm	05	0.20	0.30
40 mm	85-100	100	-	4.75 mm	-	0.5	0.5
20 mm	0.20	85-100	100	2.35 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.

- 12.3. 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 456~197f shall have to be carried out to ensure the acceptability. The aggregates shall be stored separately and handled in such a manner as to prevent the intermixing of different aggregates. If she aggregates are covered with dust, they shall be washed with water to make them clean.

**13. M-13. Black Trap or Equivalent Hard Stone Coarse**

- 13.1. 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.
- 13.2. 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 with cement
- 13.3. The necessary tests indicated in I S. 383-1970 and I.S.456-1978 shall have to be carried out to ensure the acceptability of the material.
- 13.4. If aggregate is covered with dust it shall be washed with water to make it clean.

**14. M-14. Brick Bats Aggregate**

- 14.1. Brick bat aggregate 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 brick bats shall be of 40 mm - 50 mm. size unless otherwise specified in the item The under burnt or over burnt brick bats shall not be allowed.
- 14.2. The brick bats shall be measured by suitable boxes or as directed.

**15. M-15. Bricks**

- 15.1. The bricks shall be hand or machine molded and made from suitable soils and kiln burnt. They shall be free from cracks and flaws and nodules of free lime they shall have smooth rectangular faces with sharp corners and shall be of uniform colour.
- The bricks shall be- moulded 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 thrown on the ground from a height of 600 mm.
- 15.2. The size of modular bricks shall be 190 mm.x 90 mm.x 90 mm.
- 15.3. The size of the conventional bricks shall be as under: ( 9" x 4.3/8" x 2,3/4" ) 225 x 110 x 75 mm.
- 15.4. Only bricks of one standard size shall be used on one work. The following tolerances shall be permitted in the conventional size adopted in a particular work.
- Length + 1/8" ( 3.0 mm.) Width  $\pm$  1/16" ( 1.50 mm. ) Height + 1/16" ( 1.50 mm. )
- 15.5. The crushing strength of the bricks shall not be less than 35 Kg/Sq. Cm. The average water absorption shall not be more the 20 percent 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-15A. Fly ash Lime Bricks**

- 15A.1 The bricks shall be sound, compact and uniform in shape. The bricks shall be free from visible cracks, warpage and organic matter. The bricks shall be moulded 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 have smooth rectangular faces with sharp and square corner and shall be of uniform colour. The bricks shall not break when thrown on the ground from a height of 600 mm
- 15A.2 The bricks shall be machine moulded and made from suitable Fly ash, Bottom ash, sand, lime and additives
- The fly ash shall conform to grade 1 or Grade 2 of IS 3812 : 1981.
  - The bottom ash used as replacement of sand shall not have more than 12 percent loss on ignition when tested according to IS 1727 : 1967.
  - Deleterious materials, such as clay and silt in sand, shall preferably be less than 5 percent.
  - Lime shall conform to Class C hydrated lime of IS 712 : 1984.
  - Any suitable additive considered not detrimental to the durability of the bricks may be used.

- 15A.3 The Fly ash lime bricks shall be of Class 7.5 depending upon their average compressive strength. The average compressive strength shall be between 7.5 N/mm<sup>2</sup> to 10 N/mm<sup>2</sup> when tested as described in IS 3495 (Part 1) : 1976. The compressive strength of any individual brick shall not fall below the minimum average compressive strength specified by more than 20 percent.
- 15A.4 The drying shrinkage of the bricks when tested by the method prescribed in IS 4139 : 1989, being the average of three units, shall not exceed 0.15 percent.
- 15A.5 The bricks, when tested in accordance with the procedure laid down in IS 3495 (Part 3) : 1976, shall have the rating of efflorescence not more than "moderate".
- 15A.6 The bricks, when tested in accordance with the procedure laid down in IS 3495 (Part 2) : 1976, after immersion in cold water for 24 hours, shall have average water absorption not more than 20 percent by mass.
- 15A.7 The size of modular bricks shall be 190 mm x 90 mm x 90 mm.
- 15A.8. The size of the conventional bricks shall be: ( 9" x 4.3/8" x 2,3/4" ) 225 x 110 x 75 mm.
- 15.6. Only bricks of one standard size shall be used on one work. The following tolerances shall be permitted in the conventional size adopted in a particular work.  
 Length + 3.0 mm. Width  $\pm$  2.0 mm. Height + 2.0 mm.

## **16. M-16. Stone**

- 16.1. The stone shall be of the specified variety such as Granite/Trap Stone/ Quartzite or any other type of good hard stones. The stones shall be 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 Or imperfections tending to affect their soundness and strength. The stone with round surface shall not be used. The percentage of water absorption shall not be more than 5% of dry weight. When tested in accordance with I.S. 1124-1974. The minimum crushing strength of stone shall be 200 Kg/.Sq. Cm. unless otherwise, specified
- 16.2. The samples of the stone to be used shall be got approved before the work is started
- 16.3. 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 40 mm. 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

## **17. M-17. Laterite Stone**

- 17.1. Laterite stone shall be obtained from the approved quarry it shall be compacted in texture sound, durable and free from soft patch. It shall have minimum crushing strength of 100 Kg/Sq. Cm. in its dry condition. It shall not absorb water more than 20% of its own weight, when immersed for 24 hours in water. After quarrying, the stone shall be allowed to weather for some time before using in work.
- 17.2. The stone shall be dressed into regular rectangular blocks so that all faces are free from



waviness and unevenness, and the edges true and square

- 17.3. Those types of stone in which white clay occurs should not be used
- 17.4. Special corner stones shall be provided where so directed.

## **18. M-18. Mild Steel Bars**

- 18.1. Mild steel bars reinforcement for R.C C. work shall conform to I.S. 432 (Part -II) 1966 and shall be of tested quality. It shall also comply with relevant part of I.S. 456-1978.
- 18.2. All the reinforcement shall be clean and free from dirt, paint, grease, mill scale or loose or thick rust at the time of placing
- 18.3. For the purpose of payment, the bar shall be measured correct up to 10 mm. length and weight payable worked out at the rate specified below:

1.	6 mm	0.22 Kg/Rmt.	8.	20 mm.	2.47 Kg/Rmt
2.	8 mm.	0.39 Kg/Rmt.	9	22 mm.	2.98 Kg/Rmt.
3.	10 mm.	0.62 Kg/Rmt.	10.	25 mm.	3.85 Kg/Rmt.
4.	12 mm.	0.89 Kg/Rmt.	11.	28 mm.	4.83 Kg/Rmt.
5.	14 mm	1.21 Kg/Rmt.	12.	32 mm.	6.31 Kg/Rmt.
6.	16 mm	1.58 Kg/Rmt	13.	36 mm.	7.99 Kg/Rmt.*
7.	18 mm.	2.00 Kg/Rmt.	14.	40 mm.	9,86 Kg/Rmt

## **19. M-19. Corrosion resistance steel (CRS) TMT Steel Bars**

- 19.1. Corrosion resistance steel (CRS) TMT Steel bars shall conform to I.S. 9077 respectively.
- 19.2. Other provisions and requirements shall conform to specification No. M-18 for Mild Steel Bars.

## **20. M-20. High Tensile Steel Wires**

- 20.1. The high tensile wires for use in pre stressed concrete work shall conform to I.S.2090-1962.
- 20.2. The tensile strength of the high tensile steel bars shall be as specified in the item. In absence of the given strength the minimum strength shall be taken as per Para 6-1 of the I.S. 1785-1962. Testing shall be done as per I.S. requirements.
- 20.3. 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.
- 20.4. The high tensile wire shall be obtained from manufacturers. in coils having diameter not less then 350 times the diameter of wire itself so that wire springs back straight on being uncoiled.

## **21. M-21. Mild Steel Binding Wire**

- 21.1. The mild steel wire shall be of 1.63 mm. or 1.22 mm. ( 16 to 18 gauge ) diameter and shall



conform to I.S. 280- 1972.

- 21.2. 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

**22. M-22. Structural Steel**

- 22.1. All structural Steel! shall conform to I S. 226-1985: 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. River bars shall conform to I.S. 1148-1973.
- 22.2. When the steel is supplied by the Contractor test certificate of the manufacturers shall be obtained according to I.S. 226-1975 and other relevant Indian Standards.

**23. M-23. Galvanised Iron Sheets**

- 23.1. The galvanised iron sheets shall be plain or corrugated sheets of gauges as specified in item The G.I. Sheets shall conform to I.S.277-1977. The sheets shall be undamaged in carnage 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.
- 23.2. The length and width of G.I. sheets shall be as directed as per site condition.

**M-23.A :G.I. Valleys gutter, ridges**

- 23.A.1. The G.I. ridges and hips shall be of plain galvanised sheets Class - 3 of the thickness as specified in item. These shall be 600 mm. in width and properly bent up to shape without damage to the sheets in process of bending.
- 23.A.2. Valleys gutters and flashings shall also be of galvanised sheet of thickness as specified in item Valleys Shall be 900 mm. wide overall and flashing shall be 380 mm. wide overall They shall be bent to the required shape without damage to the sheet in the process of bending.

**24. M-24. Asbestos Cement Sheets**

- 24.1. Asbestos cement sheets plain, corrugated of semi-corrugated shall conform to I.S.459-1970 The thickness of the sheets shall be as specified in the item. The sheets shall be free from all defects such as cracks, holes, deformities chipped edges or otherwise damaged.
- 24.2. Ridges & Hips:**
- 24.1.1. Ridges and hips shall be of same thickness as that of A.C. sheets. The types, of ridges shall be suitable for the type of sheets and location.
- 24.1.2. Other accessories to be used in roof such as flashing pieces eaves filler pieces, valley gutters, north light, and ventilator curves, barge boards etc, shall be of standard manufacture and shall be suitable for the type of sheets and location.

**25. M-25. Manglore Pattern Roof Tiles**

- 25.1. The mangalore pattern tiles shall conform to I S 654-1972 for Class AA or Class A type as

specified in item. Samples of the tiles to be provided shall be got approved from the Engineer-in-charge. Necessary tests shall be carried out as directed.

## **26. M-26. Shuttering**

- 26.1. 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 bullies properly cross braced together so as to make the centering rigid. In places of bullies props, brick pillar of adequate section built in mud mortar may be used
- 26.2. 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 live load of men working over it and other incidental loads associated with it. The shuttering shall have smooth and even surface and its joints shall permit leakage of cement grout
- 26.3. 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 got approved from the Engineer-in-charge, before the reinforcement bars are placed in position
- 26.4. The props shall consist of bullies having 100 mm .minimum diameter measured at mid length and 80 mm. at thin end 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.
- 26.5. Double wedges shall further be provided between the sole plate and the wooden props so as to facilitate tightening and easing of shuttering without jerking the concrete
- 26.6. The timber used in shuttering shall not be so dry as to absorb water from concrete and swell or bulge nor so green or wet as to shrink after erection. The timber shall be properly sawn 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
- 26.7. As far as practicable, clamps shall be used to hold the forms together and use of nails and spikes avoided.
- 26.8. 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.
- 26.9. The shuttering for beams and slabs shall have camber of 4 mm per meter ( 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.

**27. M- 27. Expansion Joints - Permoulded filler**

- 27.1. The item provides for expansion joints in R.C C. frame structures for internal joints, as well as exposed joints, with the use of promoulded bituminous joint filler.
- 27.2. Premoulded bituminous joints filler i.e. performed strip of expansion joints filler shall not get deformed, or broken by twisting bending or other handling when exposed to atmospheric condition. Pieces of joints filler that have been damaged shall be rejected
- 27.3. Thickness of the per-moulded joints filler shall be 25 mm. unless otherwise specified.
- 27.4. Premoulded bituminous joints filler shall conform to I S 1838-1961

**28. M-28. Expansion joints-Copper strips & hold. fasts**

- 28.1. The item provides for expansion joints in R.C.C. frame structure for internal joints, as well as exposed joints, with the use of premoulded bituminous joints filler.
- 28.2. Copper sheet shall be of 1.25 mm. width and or 1 25 mm. width and the " U " shape in the middle. Copper strip shall have holdfast of 3 mm diameter copper rod fixed to the plate soldered on strip at intervals of about 30 cm or as shown in the drawing or as directed. The width of each flange (horizontal side ) of the copper plate Jo be embedded in the concrete work shall be 25 mm depth of "U" to be provided in the expansion joint, in the copper plate shall be of 25 mm.

**29. M-29. Teak wood**

- 29.1. 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.
- 29.2. Teak wood shall generally be free from large, loose dead or cluster knots, flaws, shakes, warps, twists, 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 for as possible. Any effort like paining using any adhesive materials made to hide the defects shall render the pieces liable to rejection by the Engineer-in- charge.
- 29.3. All scantlings, planks etc., shall be sawn in straight lines and planes in the direction of grains and of uniform thickness.
- 29.4. The tolerances-in the dimensions shall be allowed at the rate of 1.5 mm. per face to be planed.

**29.5. First class teak wood**

- 29.5.1. 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.

**29.6. Second Class Teak Wood:**

- 29.6.1. No individual hard and sound knots shall be more than 15 sq. cms. in size and aggregates

area of such knots shall be not exceed 2% of the area of piece.

**M-29. A 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 where as only Kalai, Sires, 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, flows, shakes, warps, bends or any other defects, It shall be uniform in substance and of straight fibers as far as possible. It shall be free from rots, decay, harmful fungi and other defects of nature which will effect the strength, durability or its usefulness for the purpose for which it is required. The colour of wood shall be uniform as far as possible. The scantlings planks etc. shall be saw in straight lines and planes in the direction of grain and of uniform thickness. The department will use the Agency to produce certificate from Forest Department in event of dispute and the decision of the Department shall be final and binding to the contractor. The tolerance in the dimension shall be allowed at 1.5 mm. per face to be planed.

**30. M-30. Wooden flush door shutters (solid core)**

- 30.1. 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 in which they occur may be permitted. Pitch pockets, 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
- 30.2. 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 cross-bands and face veneers. The hopping, rebating, opening of glazing, venation etc., shall be provided if specified in the drawing.
- 30.3. All edges of the door shutters shall be square. The shutters shall be free from twist or warp in its plane. Both faces of the shutters shall be sand papered to smooth even texture.
- 30.4. The shutters shall be tested for-
  - (1) **End immersion test:** The test shall be carried out as per I.S.2202 ( part-1 ) 1980. There shall be no delamination at the end of the test.
  - (2) **Knife Test :** The face panel when tested in accordance with I.S 1659-1979 shall pass the test.
  - (3) **Glue adhesion test :** The flush door shall be tested for glue adhesive test in accordance with I S 2202( part -I ) 1980. The shutters shall be considered to have passed the test, if no delamination occurs in the glue lines in the plywood and if no single determination 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.

- 30.5. The tolerance in size of scud core type flush door shall be as, In Nominal thickness  $\pm 1.2$  mm. In Nominal height  $\pm 3$  mm
- 30.6. The thickness of the shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any points.

### 31. **M-31. Aluminum doors, windows, ventilators**

- 31.1. Aluminum alloy used in the manufacture of extruded window sections shall conform to I.S. designation HEA- WP of I.S. 733-1975 and also to I S. Designation WVG-WP of I.S 1285-1975 The section shall be as specified in the drawing and design. The fabrication shall be done as directed
- 31.2. The hinges shall be cast or extruded aluminum hinges of same type as in window but of larger size.
- 31.3. The hinges shall normally be of 50 mm. projecting type. 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 or inside shall be provided. In double shutter door, the first closing shutter shall have concealed aluminum alloy bolt at top and bottom.

### 32. **M-32. Rolling Shutters**

- 32.1. 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 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.
- 32.2. 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 mm.
- 32.3. Hood covers shall be made of M S. Sheets not less than 0.90 mm. thick. For shutters having width 3.5 Meter and above, the thickness of M.S. sheet for the hood cover shall be not less than 1.25 mm.
- 32.4. The spring shall be of best quality and shall be manufactured from tested high tensile spring steel wire of strip of adequate strength to balance the shutters in all position. The spring pipe shaft etc . shall be supported on strong M S of malleable C I. brackets. The brackets shall be fixed on or under the lintel as specified with raw! plugs and screws bolts etc.
- 32.5. The rolling shutters shall be of self-rolling up to 8 Sq. m. clear area without ball bearing and up to 12 Sq.m. clear area with ball bearing. If the rolling shutters are of larger, then gear operated type shutters shall be used.

- 32.6. The locking arrangement shall be provided at the bottom of shutter at both ends The shutters shall be opened from outside.
- 32.7. The Shutters shall be completed with door suspension shafts, looking arrangements, pulling hooks, handles and other accessories.

### **33. M-33. Collapsible Steel Gate**

- 33.1. 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, flats 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.
  - (a) Pickets: These shall be of 20 mm. M.S. channels of heavy sections unless otherwise shown on drawings. The distance centre to centre of pickets shall be 12 cms .with an opening or 10 Cms
  - (b) Pivoted M.S. flats shall be 20 mm x6 mm
  - (c) Top and bottom guides shall be from tee of flat iron of approved size.
  - (d) The fittings like stoppers fixing, locking cleats, brass handles and cast iron rollers shall be of approved designand size

### **34. M-34. Welded Steel Wire Fabric**

- 34.1. Welded steel wire fabric for general purpose shall be manufactured form cold drawn steel wire "as drawn" or galvanised steel conforming to I.S. 226-1975 with longitudinal and transverse wire securely connected at every intersection by a process of electrical resistance welding and conforming to I.S.4948-1974. it shall be fabricated and finished in workmanlike manner and shall be free from injurious defects and shall be rust proof The type of mesh shall be oblong or square as directed The mesh sizes and sizes if wire for square 3b well as oblong welded steel wire fabric shall be as directed The steel wire fabric in panels shall be in one whole piece in each panel as far as stock sizes permit.

### **35. M-35 Expanded Metal Sheets**

- 35.1. The expanded metal sheets shall he free from flaws joints broken strands laminations and other harmful surface defects. Expanded metal steel sheet shall confirm to IS-412-1975. except that blank sheets need not be with guaranteed mechanical properties The size of the diamond mesh of expanded metal and dimensions of strands (width and thickness) shall be as specified. The tolerance on nominal weight of expanded metal sheets shall be of + 10 percent.
- 35.2. Expanded metal in panels shall be in one whole piece in each panel as far as stock sizes permit. The expanded metal sheets shall be coated with suitable protective coating to prevent corrosion.

### **36. M-36. Mild Steel Wire (Wire Gauze Jali )**

- 36.1. Mild steel wire may be galvanized as indicated. All finished steel wire shall be well cleanly

drawn to the dimensions and size of wire as specified in item. The wire shall be sound free from splits surface flaws, rough jagged and imperfect edges and other harmful surface defects and shall conform to I.S. 280-1978.

### **37. M-37. Plywood**

- 37.1. The plywood for general purpose shall conform I.S. 303-17-1975. Plywood is made by cementing together than boards or starts of wood into panels. There are always an odd number of layers, 3,5,7,9, ply etc. The piles are placed so that grain of each layer is at right angles to the grain in the adjacent level.
- 37.2. The chief advantages of plywood 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 splitting with charge in moisture content.
- 37.3. Usually synthetic resins are used to gluing, phenolic resins are usually cured in a hot press which compresses and simultaneously heats the plies 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 anything from 2 to 60 minutes depending upon thickness
- 37.4. 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 an atmosphere of controlled humidity until the proper amount of moisture has been absorbed.
- 37.5. According to I.S. 303-1975 the plywood for general purpose shall be of the grades namely BWR, WWR and CWR depending up to 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 face being of three kinds namely A, Band C After pressing, the finished plywood should be reconditioned to a moisture content not less than 8 percent and not more than 16 percent.
- 37.6. Thickness of plywood Boards.

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

### **38. M-38. Glass**

- 38.1. All glass shall be of the brief 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 provision or as shown in detailed drawings. Thickness of glass panes shall be uniform. The specifications for different kinds of glass shall be as under.

#### **38.2. Sheet Glass**

- 38.2.1. In 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 up to 600 mm x 600 mm.

- 38.2.2. For panes larger than 600 mm x 600 mm and up to 800 mm x 800 mm the glass weighing not less than 8.75 Kg/Sq m shall be used For bigger panes up to 900 mm x 900 mm. glass weighing not less than 8.75 Kg/Sq. m shall be used. For bigger panes up to 900 mm x 900 mm. glass weighting not less than 11.25 Kg/Sq. m. shall be used
- 38.2.3. Sheet glass shall be patent flattened glass of best quality and for glazing and framing purposes shall conform to I.S. 1761-1960. 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 dimension over 900 mm plate glass of specified thickness shall be used

### **38.3. Plate Glass:**

- 38.3.1. 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 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

### **38.4. Obscured Glass:**

- 38.4.1. 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

### **38.5. Wired Glass:**

- 38.5.1. Glass shall be with wire netting embedded in a sheet of plate glass. Electrically welded 13 mm Georgian 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

## **39. M-39. Acrylic Sheets**

- 39.1. Acrylic sheets shall be of thickness as specified in the item and of an specified shape and size as the case may be panels may be flat or curved It should be light in weight it shall be colourless or coloured or opaque as specified in the item. Colourless sheet shall be as transparent as the finest optical glass. Its light transmission rate shall be about 95% Transparency shall not be affected for the sheets of larger thickness, it shall be extremely resistant to sunlight weather and low temperatures.

It shall not show any significant yellowing or change in physical properties or loss of light transmission over a longer period of use. The sheet shall be impact resistant also Sheets should be of such quality that they can be cut, bent jointed as desired Solution for the joints shall be used as per the requirement of manufacturer.

## **40. M-40. Particle board**

- 40.1. The particle boards used for face panels shall be of best quality free from any defects. It shall be

particle boards shall be made with phenol aldehyde adhesive. The particle boards shall conform to IS 3087-1905 "Specification for wood particle board for general purpose". The size and the thickness shall be as indicated.

**41. M-41. Expanded polystyrene or framed styroper slabs**

41.1. The expanded polystyrene ceiling boards and tiles shall be of approved make and shall be of sizes, thickness, finish and colour as indicated. It shall be of high density and suitable for use as insulating material. The insulating material shall be like slabs of Thermocole etc.

**42. M-42. Resin bonded fiber glass.**

42.1. The resin bonded fiber glass tiles or roils shall be of approved make and shall be of sizes, thickness, and finish as indicated.

42.2. For test of Mineral wool thermal insulation [Blanket IS 3144-1965 shall be followed

42.3. Insulation wool blanks shall be with the following coverings on one or both sides as indicated

- (1) Bituminous Hessian Kraft paper suitable for use in position where moisture has to be excluded.
- (2) Hessian cloth or Kraft paper for keeping out dust
- (3) G.I wire netting, suitable for surfaces to be plaster over

**43. M-43. Fixtures and fastenings**

**43.1. General:**

43.1.1. The fixtures and fastenings, that is butt hinges, tee and strap hinges, sliding door bolts, towerbolts, door latch, bath-room latch, handles, door stoppers, casement window fasteners, casement stays and ventilators catch shall be made of the metal as specified in the item or its specification.

43.1.2. They shall be of iron, brass, aluminum, chromium plated iron, chromium plated brass, copper oxidised iron, copper oxidised brass or anodised aluminum as specified.

43.1.3. 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 operations.

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

43.1.5. Brass and anodised aluminium fixtures and fastenings shall be bright finished.

**43.2. Holdfasts:**

43.2.1. 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. diameter 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.

**43.3. Butt hinges:**

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

43.3.2. Tee and strap hinges shall be manufactured from M S Sheet

**43.4. Siding door bolts (Aldrops):**

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

**43.5. Tower bolts (Barrel Type):**

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

**43.6. Door Latch:**

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

**43.7. Bathroom Latch:**

43.7.1. Bathroom latch shall be similar to tower bolt.

**43.8. Handle:**

43.8.1. 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.

**43.9. Door Catch:**

43.9.1. 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 rubber cushion.

**43.10. Door Stoppers:**

43.10.1. Door catch shall be fixed at a height to about 900 mm from the floor level such that one part of the catch is fitted on the inside of the shutter and the 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.

**43.11. Wooden Door Stop with hinges:**

43.11.1. Wooden door stop of size 100 mm x 40 mm x 40 mm shall be fixed on the door frame with a hinges 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

**43.12. Casement Window Fastener:**

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

**43.13. Casement stays (Straight Red Stay):**

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

**43.14. Ventilator Catch:**

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

**43.15. Pivot:**

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

**44. M-44. Paints:****44.1. (A) Oil paints :**

44.1.1. Oil paints shall be of the specified colour 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 stainer will be allowed. In such a case the contractor shall ensure that the shade of the paint so allowed shall be uniform.

44.1.2. All the paints shall meet with the following general requirements

- (i) Paint shall not show excessive setting in a freshly opened full can and shall easily be ready spread with a paddle to a smooth homogeneous state. The paint shall show no curdling, 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
- 44.1.3. Ready mixed paint shall be used exactly as received from the manufacturers and generally according to their instructions and without any admixtures whatsoever

**44.2. (B) Enamel paints:**

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

**45. M-45. French Polish**

45.1. 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) Chandras
  - (iii) Pigment.
- 45.2. The French polish so prepared shall conform to I S : 348-1 9C8.

**46. M-46. Marble chips for marble mosaic terrazzo**

46.1. The marble chips shall be of approved quality and shades. 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.

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

46.3. 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.

**47. M-47. Flooring Tiles****47.1. (A) Plain Cement tiles;**

- 47.1.1. 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.
- 47.1.2. The tiles shall be manufactured from a mixture of cement and natural aggregates by pressure process. During manufacture the tiles shall be subjected to pressure of not less than 140 Kg/Sq. Cm. The proportion of cement to aggregate in the backing of the tiles shall be not less than 1.3 by weight. The wearing face, through the tiles are of plain cement, shall be provided with stone chips of 1 to 2 mm. size. The proportions of cement to aggregate in the wearing layer of the tiles shall be three parts of cement to one parts chips by weight. The minimum thickness of wearing layer shall be 3 mm. The colour and texture of wearing layer shall be uniform throughout its face and thickness. On removal from mould, the tiles shall be kept in moist condition continuously at least for seven days and subsequently, if necessary, for such long period as would ensure their conformity to requirements of I.S.1237-1980 regarding strength resistance to wear and water absorption.
- 47.1.3. The wearing face of the tiles shall be plane, 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.
- 47.1.4. The size of tiles generally be square shapes 24.85 Cm x24.85 Cm. or 25 Cm x 25 Cm The thickness of tiles shall be 20 mm.
- 47.1.5. Tolerance of length and breadth shall be plus of minus one millimeter Tolerance on thickness shall be plus 5mm.
- 47.1.6. The tiles shall satisfy the tests as regards transverse strength, resistance to wear and water absorption as per I.S 1237-1980.

**47.2. (B) Plain Coloured Tiles:**

- 47.2.1. The tiles shall have the same specification as for plain cement tiles as per (A) above expect that they shall have a plain wearing surface wherein pigments are used. They shall conform it I.S. 1237-1980.
- 47.2.2. The pigments used for colouring cement shall not exceed 10 percent by weight of cement used in the mix. The pigments, synthetic or otherwise, used for colouring tiles shall have permanent colour and shall not contain materials detrimental to concrete
- 47.2.3. The colour of the tiles shall be specified in the item or as directed

**47.3. (C) Marble mosaic tiles:**

- 47.3.1. These tiles have same specification as per plain cement tiles except the requirements as stated below
- 47.3.2. 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 from 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.
- 47.3.3. Chips used in the tiles be from smallest up to 20 mm. size. The minimum thickness of wearing layer of tiles shall be 6 mm. For pattern of chips to be had on the wearing face; a

few samples with or without their full size photographs as directed shall be approved by the Engineer-in-charge, for approval.

47.3.4. Any particular samples if found suitable shall be approved by the Engineer-in-charge, or he may ask for a few more samples to be presented. The samples shall have to be made by the contractor till a suitable sample is finally approved for use in the work. The Contractor shall ensure that the tiles supplied for the work shall be in conformity with the approved sample only, in terms of its dimensions, thickness of backing layer and wearing surface, materials, ingredients, colour, shade, chips, distribution etc. required.

47.3.5. The tiles shall be prepared from cement conforming to Indian Standards or coloured portland cement generally depending upon the colour of tiles to be used or as directed.

#### **47.4. (D) Chequered Tiles:**

47.4.1. 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

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

47.4.3. 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

47.4.4. Tiles shall conform to relevant I.S 1237-1980. 47.5.

#### **47.5. (E) Chequered Tiles For Stair Cases :**

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

(1) The length of a tile including nosing shall be 300 mm (2) The minimum thickness shall be 28 mm (3) The nosing shall have also the same wearing layer as at the top. (4) The nosing edge shall be rounded (5) 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 chequer pattern.

#### **48. M-48. Rough Kotah Stone**

48.1. 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 shall not be allowed for use. They shall be without any soft veins, cracks or flaws.

48.2. 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 required pattern. Thickness shall be as specified

48.3. The edges of stones 30 mm on accounts of chisel dressing of edges shall be permitted for length as well as breadth. Tolerance in thickness shall be + 3 mm

48.4. The edges of stones shall be truly chiseled and table rubbed with coarse sand before paving.

All angles and edges of the stones shall be true, square and free from chipping and surface shall be true and plain

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

**49. M-49. Polished Kotah Stones**

- 49.1. Polished kotah stone shall have the same specification as per rough kotah stone except as mentioned below
- 49.2. The stones shall have machine polished 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, sink, veneering, sills, steps etc. where machine polishing after the stones are fixed in situ is not possible shall be double polished

**50. M-50. Dholpur Stone Slab**

- 50.1. Dholpur stone slab shall be of best quality as approved by the Engineer-in-charge. The stone slab shall be without any veins, cracks, and flaws. The stone slab shall be even, sound and durable, regular in shape and of uniform colour
- 50.2. The size of the stone shall be as specified in the item or detailed drawing or as approved by the Engineer-in-charge. The thickness of the stone shall be as specified in the item of work with the permissible tolerance of plus or minus 2 mm. The provision in respect of polishing as for polished kotah stone shall apply to polished Dholpur stone also. All angles and edges of the face of the stone slab shall be fine chiseled or polished as specified in the item of work and all the four edges shall be machine cut. All angles and edges of the stone slab shall be true and plane
- 50.3. The sample of stone shall be got approved by the Engineer-in-charge for a particular work. It shall be ensured that the stones to be used in a particular work shall not differ much in shade or tint from the approved sample

**51. M-51. Marble Slab**

- 51.1. Marble slab shall be white or of other and of best quality as approved by the Engineer-in-charge
- 51.2. Slabs shall be hard, close, uniform and homogeneous in texture. They shall have even crystalline grain and free from defects and cracks. The surface shall be machine polished to an even and perfect plane surface and edges machine cut true and square. The rear face shall be rough to provide key for the mortar
- 51.3. 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 slab shall be minimum 460 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.
- 51.4. The slab shall not be thinner than the specified thickness at its thinnest part. A few specimens



of finished slab to be used shall be deposited by the Contractor in the office for reference

51.5. Except as above the marble slabs shall conform to I.S. 1130-1969

## **52. M-52. Granite Stone slab**

52.1. Granite shall be of approved colour and quality. The stone shall be hard, even sound and regular in shape and generally uniform in colour. It shall be without any soft veins, cracks or flaws

52.2. The thickness of the stone shall be specified in items

52.3. All exposed faces shall be double polished to tender truly smooth and even reflecting surface. The exposed edges and corners shall be rounded off as directed. The exposed edges shall be machine cut and shall have uniform thickness.

## **53. M-53. P.V.C. Flooring**

53.1. P.V.C. sheets for P.V.C., floor covering shall be of homogenous flexible type conforming to I S 3462-1966. The P.V.C. covering shall neither develop any toxic effect while put to use nor shall give off any disagreeable odour.

53.2. Thickness of flexible type covering tiles shall be as specified in the description of the item

53.3. The flexible type shall be backed with Hessian or other woven fabric. The following tolerances shall be applicable on the nominal dimensions of the rolls or tiles :

(a) Thickness  $\pm 0.15$  mm.

(b) Length or Width

(1) 300 mm. Square tiles  $\pm 0.20$  mm. (3) 900 mm Square tiles  $\pm 0.60$  mm.

(2) 600 mm. Square tiles  $\pm 0.40$  mm. (4) Sheets and roll  $\pm 0.10$  percent.

### **53.4. Adhesive:**

53.4.1. The adhesive for PVC flooring shall be of the type and make recommended by the manufacturer of PVC sheets/tiles.

## **54. M-54. Facing Tiles**

54.1. The facing tiles (burnt clay facing bricks) shall be free from cracks, and nodules of free lime. They shall be thoroughly burnt and shall have plane rectangular faces with parallel sides and sharp straight right angled faces. The texture of the finished surface that will be exposed when in place shall conform to an approved sample consisting not less than for stretcher bricks each representing the texture desired. The facing tiles shall have a pleasing appearance, sufficient resistance to penetration by ram and greater durability than common bricks. The tiles shall conform to I.S. 2691-1972.

54.2. The standard size of facing brick tiles shall be 19 x 9 x 4 cms. The facing brick tiles shall be provided with frog which shall conform to I.S. 11077-1976.

54.3. The permissible tolerance in dimensions specified above shall be as follows:

Size	Tolerance for	
	1st Class Brick	2nd Class Brick
19 cm.	$\pm 6$ mm.	$\pm 10$ mm.
9 cm.	$\pm 3$ mm.	$\pm 7$ mm.
4 cm.	$+ 1.5$ mm.	$+ 3$ mm.

The tolerance for distortion or warpage of face or edges of individual brick from a plane surface and from a straight line respectively shall be as follows:

Facing dimensions	Permissible tolerance
Max. below 19 cms.	Max. 2.5 mm.
-do- above 19 cms.	Max. 3.0 mm.

- 54.4. The average compressive strength obtained as a sample of five tiles when tested in accordance with the procedure laid as per I S 1077-1976 shall be not less than 175 Kg/Sq Cm. The average compressive strength of any individual bricks shall be not less than 160 Kg / Sq.Cm.
- 54.5. The average water absorption for five bricks tiles shall not exceed 12 percent of average weight of brick before testing. The absorption for each individual bricks shall not exceed 25 percent.
- 54.6. The brick tiles when tested in accordance with I.S. 1077-1976, the rate of efflorescence shall not be more than "Slightly effloresced"

#### **55. M-55. White glazed tiles**

- 55.1. The tiles shall be of best quality as approved by the Engineer-in-charge. They shall be flat and true to shape They shall be free from cracks, crazing spots chipper) edges and corners. The glazing shall be of uniform shade.
- 55.2. The tiles shall be nominal size of 150 mm x 150 mm unless otherwise, specified. The maximum variation the stated sizes other than the thickness of tile shall be plus or minus 1.5 mm. The thickness of tile shall be 6 mm. Except as above the tiles shall conform to I.S. 1977-1970

#### **56. M-56. Galvanised iron pipes and fittings**

- 56.1. Galvanised iron pipes 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 galvanised iron fittings shall be of the standard ' R ' or equivalent make

#### **57. M-57. Bib cock and stop cock**

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

the flow

- 57.2. 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.
- 57.3. The minimum finished weight of bib cock and stop cock shall be as given below

Diameter	Bid cock	Stop cock	Diameter	Bid cock	Stop cock
8 mm	0.25 kg.	0.25 kg.	15 mm	0.40 kg.	0.40 kg.
10 mm	0.30 kg.	0.35 kg.	20 mm	0.75 kg.	0.75 kg.

**58. M-58. Gun metal wheel valve**

- 58.1. 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 specified. These shall conform to I.S. 778-1971.

**59. M-59. White glazed porcelain wash basin**

- 59.1. 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 item. 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 as specified. Each basin shall have a circular waste hole which is either riveted or beveled internally with 65 mm. diameter at 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 which shall fully drain into the bowl.
- 59.2. White glazed pedestal of the quality and colour as that the basin shall be provided where specified in the item. It shall be completely recessed at the back for reception of supply and wash pipe. It shall be capable of supporting the basin rigidly and adequately and shall be so designed as to make the height from the floor the floor to top of the rim of basin 750 mm. to 800 mm. as directed.

**60. M-60. European type water closet/with low flushing**

- 60.1. The European type water closet shall be white glazed porcelain first quality and shall be of wash down type conforming to I.S. 2556-1973 and I.S. 771-1979
- 60.2. 'S' trap shall be provided as required with water seal not than 50 mm. The solid plastic seat and cover shall be of best Indian make conforming to I.S 2548-1980. They shall be made of moulded synthetic materials which shall be tough and hard with high resistance to solvents and shall be free from blisters and surface defects and shall have chromium plated brass hinges and rubber buffer of suitable size.

**61. M-61. Orrissa type water closet**

- 61.1. The Specification of Orrissa type white glazed water closet of first quality shall conform to I.S. 2256 (Part-III) -1981 and relevant specification of Indian type water closet except that pan will be with the integral squatting pan of size 580 mm x 400 mm with raised footrest.

**62. M-62. Indian type water closet**

- 62.1. The Indian type white glazed water closet of first quality shall be of 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 around as directed to have satisfactory flushing.. It shall also have an inlet at black an or front for connecting flush pipes as directed. The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and surface shall be uniform and smooth. Pan shall be provided with 100 mm. diameter 'P' or 's' trap with approximately 50 mm. Water seal and 50 mm. diameter vent horn.

**62. A. Foot Rests**

- 62.A.1.** A pair of whit glazed earthen ware rectangular foot to minimum size 250 mm.x 130 mm. x 20 mm shall be provided with the water closet.

**63. M-63. Glazed Earthen Ware Sink**

- 63.1. The glazed earthen-ware sink shall be of specified size, colour and quality. They sink shall conform to I.S. 771 part – II – 1979. The brackets for sinks shall conform to I.S 775-1970
- 63.2. 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 rubble plug shall be provided with sink.

**64. M-64. Glazed earthen-ware Lipped type flat back urinal/corner type urinal**

- 64.1. The lipped type urinal shall be fiat 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 of corner type urinal must be of 1st quality free from any defects, cracks etc.

**65. M-65. Low level Enamel flushing tank**

- 65.1. The low level enamel flushing tank shall be of 15 liters capacity. It shall conform of I S 774-1971. The flushing cistern shall be of best quality and free from any defects. The flushing tank shall have outlet 32 mm. diameter. The outlet shall be connected with W.C. pan by lead pipe or P.V.C. pipe as specified. The flushing tank shall be provided with inlet and outlet for fixing G.I. inlet pipes and over-flow pipes. The flushing cistern shall be provided with chromium plated handle for flushing The flushing tank shall be provided with bracket of cast iron so that it can be fixed on wall at specified height. The brackets shall conform to I.S. 775-1970.

**66. M-66. Cast iron flushing cistern.**

- 66.1. The cast iron flushing cistern shall be of 15 liters capacity. It shall conform to I.S. 774-1971. The flushing cistern shall be of best quality free from any defects. The flushing cistern shall have outlet of 32 mm diameter. The lead pipe shall conform to I.S 404 (Part-I) - 1962; For fixing G.I. inlet pipes and overflow pipe 20 mm. dia. inlet and outlet shall be provided. The flushing cistern shall be provided with galvanised iron chain and pull of sufficient length and shall be got approved from the Engineer-in-charge. The cast iron flushing cistern shall be painted with one coat of anticorrosive paint and two coats of paints. The flushing cistern shall be fixed on two C I brackets. The C I brackets shall conform to I S 775-1970.

**67. M-67. Flush cock.**

- 67.1. 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 Standard.

**68. M-68. Cast iron pipes and fittings.**

- 68.1. All soil water, vent and anti syphonage pipes and fitting shall conform to I S.1729-1964. The pipes shall have spigot and socket ends with head on spigot end. The pipes and fitting 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, pinholes or there imperfection and shall be neatly dressed and carefully fettled.
- 68.2. The end of pipes and fittings shall be reasonable square to their axis.
- 68.3. The size of cast iron pipes shall be of the diameter as specified in the description and shall be in lengths of 1.5 M., 1.8 M. including socket ends of the pipe unless shorter lengths are either specified or required at junctions etc. The pipes and fittings shall be supplied without ears unless specified or directed otherwise.

**68.4. Tolerances:**

- 68.4.1. The Standard weights and thickness of pipes shall be as shown in the following table. A tolerance up to minus 10 per cent may however be allowed against these standard weights

Sr. No.	Nominal dia. of bore	Thickness	Overall	Weight of pipe	excluding ears
1.	75 mm.	5.0 mm.	12.38 Kg.	16.52 Kg.	18.37 Kg.
2.	100. mm.	5.0 mm.	18.14 Kg.	21.67 Kg.	24.15 Kg.

- 68.4.2. A tolerance up to minus 15 percent in thickness and 20 mm. length will be allowed. For fittings tolerance in lengths shall be plus 25 mm. and minus 10 mm.
- 68.4.3. 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.

**69. M-69. Nahni Trap**

- 69.1. 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 from craze, chips and other flaws or any other kind of defects which affect serviceability. The size of nahni trap shall be specified and shall be of self cleaning design.
- 69.2. The Nahni trap shall be of-quality approved by the Engineer-in-charge and shall generally conform to the relevant Indian Standards.
- 69.3. The Nahni trap provide shall be with deep seal, minimum 50 mm. except at places where trap with deep seal cannot be accommodated. The cover shall be cast iron perforated cover shall be provided on the trap of appropriate size.

**70. M-70. Gully Trap**

- 70.1. Gully trap shall conform to I.S. 651-1980. It shall be 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.
- 70.2. The size of the gully trap shall be as specified in the item.
- 70.3. Each gully 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 with frame inside dimensions 300 mm. x 300 mm. the cover and 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.

**71. M 71. Glazed Stone Ware pipe And Fittings**

- 71.1. 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 through 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 pressures or 1.5 M lead without showing sign of leakage. The thickness of the wall shall not be less than 1/12th 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.
- 71.2. The pipes shall generally conform to relevant I S 651-1980.

**72. M-72. Wall Peg Rail**

- 72.1. The aluminum wall peg rail shall have three aluminum pegs approved quality and size. It shall be fixed on teakwood plank of size 450 mm x 75 mm x 20 mm. The teakwood shall be French polished or oil painted as specified.

**73. M-73. G.I. Water Spot**

- 73.1. The G.I. pipes of 40 mm dia shall be of medium quality and specials shall be of 'R' brand or equivalent brand of best approved quality
- 73.2. The pipe shall have length as required for the thickness of wall in which it is fixed and at outside end tee bend cut at half the length shall be provided and at other end coupling shall be provided to have better fixing. The water spout shall be provided as per detailed drawing or as directed

**74. M-74. Asbestos Cement pipe (A.C. pipe)**

- 74.1. The asbestos cement pipe of diameter as specified in the description of the item shall conform to I.S. 1626- 1980. Special like bends, shoes, cowls, etc. shall conform to relevant Indian Standards The intent of pipe shall have is smooth finish, regular surface and regular internal diameter. The tolerance in all dimensions shall be as I.S. 1626-part- I-1980.

**75. M-75. Crydon Ball valve**

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

**76. M-76. Bitumen Felt For Water proofing And Damp Proofing**

- 76.1. Bitumen felt shall be on the fiber bases and shall be of type 2, self finished felt grade-2 and shall conform to I.S. 1322-1970

**77. M-77. Selected Earth**

- 77.1. The selected earth shall be that obtained from excavated material or shall have to be brought from outside as indicated in the items If item does not indicate anything the selected earth shall have to be brought from outside.
- 77.2. 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 arrangement at his own cost for land for borrowing selected earth. The stacking of material shall be done as directed by the Engineer-in-charge in such a way not to interfere with any construction all activities and in proper stacks.
- 77.3. 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

**78. M-78. Barbed Wire**

- 78.1. The barbed wire shall be of galvanised steel and it shall generally conform to I.S. 278-1978. The barbed wire shall be of types-I whose nominal diameter for line wire shall be 2.5 mm. and point wire 2.24 mm. The nominal distance between two barbs shall be 75 mm



- unless otherwise specified in the item. The barbed wire shall be formed by twisting together two fine wires. One containing the barbs. The size of the line and point wires and barb spacing shall be as specified above. The permissible deviation from the nominal diameter of the line wire and point wire shall not exceed + 0.08 mm
- 78.2. The barbs shall carry four points and shall be formed by twisting two point wires, each two turns tightly round one line wire making altogether four complete turns. The barbs shall have a length of not less than 13 mm and not more than 18 mm. The point shall be sharp and cut at an angle not greater than 35 degree of the axis of the wire forming the barbs.
- 78.3. The line and point wires shall be circular in section, free from scale and other defects and shall be uniformly galvanized. The line wire shall be in continuous length and shall not contain any welds other than those in the rod before it is drawn. The distance between two successive splices shall not be less than 15 meters.
- 78.4. The lengths per 100 Kg. of barbed wire I.S. type I shall be as under: Nominal 1000 meter Minimum 934 meter Maximum 1066 Meter.

### **Item Wise Technical Specifications**

#### **Item No. 1**

**Boring holes of 3.5 m depth in ordinary soil (for cast in situ piles) and getting out the soil and disposal of the surplus excavated soil as directed , following diameter of piles including single under reaming inside the bore holes for under reamed.**

**300mm dia. Single under reamed pile**

#### **1. Workmanship**

- 1.1. The ground shall be roughly leveled and after making the position of piles, the holes shall be bored with a spiral angle to the specified depth in description and specified diameter using boring guide.
2. The bore holes shall be truly vertical and uniform bore through out of specified diameter; after boring to the required depth, the bore shall be cleared off the loose soil and disposal of surplus excavated stuff as directed within a lead of 50 M. Mode of Measurement & Payment
- 2.1. The rate for boring holes shall include:
  - (a) roughly leveling the ground in positions where piles are to be provided (b) Making the position of piles by pegs and boring guide and also for shifting of boring guide. (c) Bailing out water, if any met with during boring, (d) Disposal or surplus excavated soil within a lead of 50 M and (e) All tools, plants, equipment's and labour required for satisfactory completion or. work.
- 2.2. The bore shall be enlarged at the bottom by an under rammer 2 to 2 1/2 times the diameter of the bore as directed It shall be ensured that the bore for the pile shall be enlarged to the correct diameter.
- 2.3. The rate shall be for a unit of one Number including ream portion.

#### **Item No. 2**

**Providing and placing with tremie reinforced cement concrete M30 grade in bored cast in situ under reamed pile using 6 mm to 20 mm machine crushed well graded stone aggregate, natural or crushed sand of approved quality, Portland slag cement mixing in batch mix plant, transport, curing, casting of pile of any dia cut off level & chipping of pile up to cut off level, disposal of chipped material with all leads & lifts, etc. complete as per execution drawing & specification & as directed by engineer In charge. Including mobilization, demobilization, remobilization, transportation of required plant and machineries if required. as directed by engineer in charge.**

#### **1. Excluding reinforcement, pile load test and M.S. Liners.**

1. The relevant specifications given for cement concrete M30 grade and use Portland slag cement as per Section -1100, 1700 & 1900 of MORT&H fifth revision specification.
2. The measurement shall be in Cum basis.
3. The rate includes necessary, mixing in batch mix plant, transport, curing, casting of pile with all leads & lifts, etc. complete as per execution drawing & specification & as directed by engineer In charge. Including mobilization, demobilization,

remobilization, transportation of required plant and machineries if required.

4. The rate is Excluding reinforcement

### **Item No. 3**

**Carrying out Static load test (Initial load test) as per standard procedure laid down in the IS 2911 specification and maintaining complete records of load v/s settlement on test any load and dia of pile constructed for the purpose including erection and removal of loading platform with all materials, labor, tools & plants, etc. complete with all necessary instrumentation, high capacity hydraulic jacks, etc. complete as per specification and for the test load as directed by Engineer-in-charge.**

1. **Load test shall be continued till test load or soil failure whichever is earlier.**
2. **Testing shall be carried out with loading frame with ground anchors/anchor piles/kentledge with platform including all necessary arrangement required for the test, as approved by Engineer-in-charge.**
3. **Boring, concreting & reinforcement of test pile shall be measured separately in respective items subject to successful completion of test.**
4. **If load test of pile is not completed successfully, payment shall not be made for this test item as well as boring, concreting and reinforcement of test pile for which test carried out and another test pile shall be constructed.**
  - (i) Relevant Specifications of MORT&H fifth revision Section – 1100 & RDSO specification shall apply to this item.
  - (ii) The relevant specifications given in IS-2911 for carrying out load test as per mentioned in this item shall apply to this item.
  - (iii) The measurement shall be Nos. of tested piles.
  - (iv) The rate includes Anchor Pile, erection and removal of loading platform with all contractor's materials, labour, tools & plants, etc. complete with all necessary instrumentation, high capacity hydraulic jacks, etc. complete as per specification and for the test load as directed by Engineer-in-charge

### **Item No. 4**

**Carrying out High strain Dynamic Test on any working pile / Test pile as selected by the Engineer-in-charge. The test shall be carried out by agency approved by engineer in charge as per IRC-Notification 54 and submitting results / reports in three hard copies with soft copy in CD. Item includes all necessary arrangements required for the test. (with guided frame arrangement) as directed by engineer in charge**

1. Relevant Specifications of MORT&H fifth revision Section – 1100 & RDSO specification shall apply to this item.
2. The work of load testing, routine test shall be carried out in accordance with IRC and IS code and MOST specifications for testing of piles.
3. Relevant specifications of load testing of piling work shall apply to this item.
4. If the test is decided to be carried out on any working pile then the cost of test pile will not be admitted for payment under respective other item.
5. The measurement shall be in No.
6. The rate includes cost of required materials, plants, labour, equipment etc. to complete the

item.

#### **Item No. 5**

**Performing Integrity Test (low strain) on all vertical pile. The item shall include chipping of weak concrete at the top of pile, leveling, bending of reinforcing bars, preparation of pile head including testing with pile driving analyzer or approved equivalent. To be carried out at least 15 days after concreting of piles. A specialist approved Agency shall be employed by the Contractor for the test. The test shall be carried out as per relevant IS code. The item is including complete testing with approved apparatus, analysis of results and conclusions including submission of test reports in three hard copies with soft copy in CD. as directed by engineer in charge.**

1. The work of load testing, routine test shall be carried out in accordance with IRC and IS code and MORT&H fifth revision section-1100 for testing of piles.
2. Relevant specifications of load testing of piling work shall apply to this item.
3. If the test is decided to be carried out on any working pile then the cost of test pile will not be admitted for payment under respective other item.
4. The measurement shall be in Nos.
5. The rate includes cost of required materials, labour, equipment etc. to complete the item.

#### **Item No. 6**

**Earth work in Excavation for foundation etc. in all categories of soils, such as sand, clay, murrum, gravel, pebble, boulder, cobble, soft rock etc. as per specification for depth below ground level as mention. The rate is inclusive of contractor's own machinery and equipment, labour, taxes, temporary works, consumables, leading & lifting, shoring, strutting, timbering and buttressing with sand / clay bags and all such measures necessary to retain in position the sides of foundation pit and including refilling the approved excavated soil, clearing and carting excess earth as directed within site limit. The rate is also inclusive of dewatering by manual or mechanical means, if require.**

**Depth from GL to 3.00 m**

**Depth from 3.00 m to 6.00 m**

1. The relevant specification MORT&H fifth revision Clause-301 & 304 except 301.9.2, 301.9.3 & 301.9.4 shall be applied to this item.
2. The Item shall be measured in Cum.
3. The rate includes shoring, Shutting if required, dewatering, as necessary and disposing of the excavated stuff as directed.

#### **Item No. 7**

**Excavation for foundation upto following depth in all type of hard and soft soil including sorting out stacking of useful material and disposing of excavated stuff with all lead and lift etc. complete.**

**0.0 to 1.5 m.**

**1.5 to 3.0 m.**

**1.0. General**

- 1.1. Any soil which generally yields to the application of pickaxes and shovels, phawaras rakes or any such ordinary excavating implement or organic soil, gravel silt, sand turf loam, clay, peat etc., fall under this category

**2.0. Clearing the site**

- 2.1. The site on which the structure is to be built shall be cleared, and all obstructions loose stone, materials and rubbish of all kind bush wood and trees shall be removed as directed. The materials so obtained shall be property of the Government and shall be conveyed and stacked as directed within 50 m lead. The roots of the trees coming in the sides shall be cut and coated with a hot asphalt
- 2.2. The rate of side clearance is deemed to be included in the rate of earth work for which no extra will be paid.

**3.0. Setting out**

After clearing the site the centre lines will be given, by the Engineer-in-charge. The contractor shall assume full responsibility for alignment, elevation and dimension of each and all parts of the work. Contractor shall supply labours, materials, etc. required for setting out the reference marks and bench marks and shall maintain them as long as required and directed.

**4.0. Excavation**

The excavation in foundation shall be carried out in true line and level and shall have the width and depth as shown in the drawings or as directed. The contractor shall do the necessary shoring and shutting or providing necessary slopes to a safe angle, at his own cost. The payment for such precautionary measures shall be paid separately if not specified. The bottom of the excavated area shall be leveled both longitudinally and transversely as directed by removing and watering as required. No earth filling will be allowed for bringing it to level. If by mistake or any excavation is made deeper or wider than, that shown on the plan or directed. The extra depth or width shall be made up with concrete of same proportion as specified for the foundation concrete at the cost of the contractor. The excavation up to 1.5 m depth shall be measured under this item.

**5.0. Disposal of the excavated stuff**

- 5.1. The excavated stuff of the selected type shall be used in filling the trenches and plinth or leveling the ground in layers including ramming and watering etc.
- 5.2. The balance of the excavated quantity shall be removed by the contractor from the site of work to a place as directed with lead up to 50 M. and all lift.

**6.0. Mode of measurements & payment**

- 6.1. The measurement of excavation in trenches for foundation shall be made according to the sections of trenches shown on the drawing or as per sections given by the Engineer-in-charge. No payment shall be made for surplus excavation made in excess of above requirements or due to stopping and sloping back as found necessary on account of conditions of soil and requirements of safety.

The rate shall be for a unit of one cubic meter

**Item No. 8**

**Providing and laying in positions machine mixed Plain Cement Concrete M15 grade for leveling course below foundation or below pile cap, pile cap beam, plinth beam etc. at other places as directed by Engineer-in-charge with graded broken stone aggregate from 6 mm to 40 mm including tamping, vibrating, leveling and curing complete with all formwork, dewatering wherever required including all materials, labours, plants, machineries & tools, all leads and lifts, etc. complete as per specification.**

1. The relevant specifications given for machine mixed plain cement concrete M15 grade as per Section -1500 & 1700 of MORT&H fifth revision specification.
2. The Item shall be measured in Cum.
3. The rate includes tamping, vibrating, leveling and curing complete with all formwork, dewatering wherever required including all materials, labours, plants, machineries & tools, all leads and lifts, etc. complete as per specification.

**Item No. 9**

**Providing and casting in-situ Reinforced Cement Concrete M30 grade controlled cement concrete in pile cap using 6 mm to 20 mm machine crushed well graded stone aggregate, sand of approved quality, Portland slag cement complete as per specification.**

**The rate is inclusive of all materials, including necessary dewatering, mixing in batch mix plant, transport, curing, vibrating, placing in position, shuttering, formworks, deshuttering carefully, making good the damages, fixing embedment, inserts, pockets, wherever necessary, with all lead and lift with labour, tools & plants, machineries, as directed by engineer in charge.**

1. The relevant specifications given for cement concrete M30 grade and use Portland slag cement as per Section -1500, 1700, 2100 & 2200 of MORT&H fifth revision specification.
2. The measurement shall be per cum basis.
3. The rate is inclusive of all materials, including necessary dewatering, mixing in fully automatic batch mix plant, transport, curing, vibrating, placing in position, shuttering, formworks, de-shuttering carefully, making good the damages, fixing embedment, inserts, pockets, wherever necessary, with all lead and lift with contractor's labour, tools & plants, machineries, as required.

**Item No. 10**

**Coal tarring two coats on new work using 0.16 Litre and 0.12 litre coal tar per sqm in the first coat and second coat respectively on foundations /concrete surfaces in contact with soil complete.**

**1. GENERAL****INTENT**

This Section covers the Work of chemically resistant coating to the surfaces of the RCC retaining wall.

**APPLICATOR**

Ensure that all Work is done by a competent applicator licensed and/or approved by the chemically resistant coating material manufacturer. Submit the manufacturer's certification of this approval.

**GUARANTEE**

Furnish a written guarantee covering the materials and workmanship for a period of 5 years from the date of acceptance of the Work, and be responsible for making good, at your expense, any and all defects due to the failure of the coating materials or workmanship. Provide completely corrosion resistant work with no leakage through or around the coating.

**SUBMITTALS**

Submit the proposed materials, schedule of applications and the manufacturer's literature for the materials and the recommended methods of application.

Submit sketches showing standard and special details for the corrosion protection. Submit the manufacturer's approval of the applicator.

Immediately prior to commencing Work in each Area, submit a letter of acceptance for the wall surfaces to be coated, signed by the applicator's authorized representative.

Upon acceptance, submit a written guarantee.

**2. PRODUCTS****Coating for Application on RCC Retaining wall/ pier surface System Design – Epoxy Tar Based Coating**

The coating shall be corrosion resistant coal tar epoxy coating with minimum of 50% solids content. The dry film thickness shall not be less than 200 microns per coat and should be applied in minimum two (2) coats. The cured film shall be tough and abrasion resistant.

The Contractor must follow the manufacturer's guidelines for the preparation of surfaces, for mixing and application of coating.

**3. EXECUTION****a. General**

Deliver materials to job site in factory sealed containers with manufacturer's identification on each package.

The Contractor shall store the materials to protect them from damage.

**b. Surface Preparation and Inspection**

Clean surfaces of deleterious material in accordance with the manufacturer's recommended practice.

Prepare surfaces to be coated in accordance with manufacturer's instructions.

Verify the surfaces are dry. (ASTM D4263)

Have the coating manufacturer's authorized agent inspect surfaces to be coated and certify



in writing to the Engineer-in-Charge that the surfaces are acceptable for the application of the coating. Do not apply the coating until written certification is received by the Engineer-in-Charge.

**c. Concrete Repairs**

Chip out damaged concrete to sound concrete.

Repair rebar if damaged.

Clean concrete surfaces, dampen and hand place patching concrete in accordance with the pipe manufacturer's recommended practice. Wet cure immediately and as recommended by the manufacturer.

**d. Application of Coating**

Confirm to the coating manufacturer's instructions for application.

Schedule the Work to allow application to be performed in a manner that it conforms to the Manufacturer's recommendations.

Apply coating only when atmospheric conditions are suitable and as recommended by the Manufacturer.

**e. Protection of coating**

Protect the coating from damage.

Allow to cure before further work or putting the coating into service.

**f. Clean-up**

Promptly, as the Work proceeds and upon completion, clean up and remove from the site, rubbish and surplus material resulting from the Work of this Section.

**4. RATE**

The measurement shall in sq.mt basis.

The rate includes labour, material, equipment as per specification and as directed by the engineer including all lead and lifts etc. complete.

The mode of payment shall be in per sq.mt. basis.

**Item No. 11**

**Providing and laying controlled cement concrete M25 with vibrating, curing etc. complete excluding the cost of form work & reinforcement for RCC work stated below etc. complete at any height as directed. For Tie Beam, Column & Coping.**

**1. Materials & Workmanship**

- 1.1.** The relevant specifications of item No. 59. shall be followed except the grading of concrete shall be controlled concrete M-250 grades for the works as specified in the item.

**2. Mode of measurements & payment**

- 2.1.** The relevant specifications of item No. 59. shall be followed.
- 2.2.** The rate shall be for a unit of one cubic meter.

**Item No. 12**

**Providing and laying controlled cement concrete M25 for manhole & chamber with vibrating, curing etc. complete excluding the cost of form work & reinforcement for RCC work stated below etc. complete at any height as directed. For Base, Wall & Slab.**

The relevant specification for item no. 59 shall apply to this item except the grading of concrete shall be controlled concrete M-25 grades for the works as specified in the item.

**Item No. 13**

**Providing form work of ordinary timber planking so as to give a rough finish including centering. Shuttering strutting and propping etc. Height of propping and centering below supporting floor to ceiling not exceeding 4M. And removal of the same for in including reinforced concrete and plain concrete work in : For Tie beam, Column & Coping**

**SPECIFICATIONS FOR FORMWORK, CENTERING AND SCAFFOLDING**

**1. Framework**

**1.1. Materials:**

Formwork shall be in plywood, sawn timber or steel as required for walls, stairs, slab, beams, columns, parapets, etc. for all concrete work.

**1.2. Workmanship:**

The formwork shall conform to the shape, lines and dimensions as shown on the drawings and shall be so constructed so as to remain sufficiently rigid and water-tight, during placement and compaction of the concrete. Adequate arrangement shall be made by the Contractor to safe guard against any settlements of the formwork during the course of concreting and after concreting.

**2. Centering:**

The centering, which has been got approved should be sufficiently strong and safe before, during and after pouring concrete and should be so erected that it would allow removal of forms in proper sequence without damaging either the concrete or the forms to be removed.

The props of centering shall be provided on firm foundation or base of sufficient strength to carry the loads, without any settlement.

Scaffolding:

All scaffolding, hoisting arrangements and ladders etc. required for facilitating of concrete shall be provided and removed on completion work by Contractor, at his own expense. The

scaffolding, hoisting arrangement, ladders etc. shall be strong enough to withstand all live, dead and impact loads expected to act. The Contractor shall be solely responsible for the safety of the scaffolding, hoisting arrangement, ladders, work and workmen etc.

The scaffolding, hoisting arrangement and ladders shall allow easy approach to the work spot and afford easy inspection.

## **2.1. Materials:**

The shuttering to be provided shall be of ordinary timber planks and shall conform to M-26.

The dimensions of scantlings and battens shall conform to the dising. The strength of the wood shall not be less than that assumed in the design.

## **2.2. Workmanship:**

**2.2.1.** The form work shall conform to the shape lines and dimensions as shown on the plans and be so constructed as to remain sufficiently rigid during the placing and compacting of the concrete. Adequate arrangements shall be made by the contractor to safe-guard against any settlement of the formwork during the course of concreting and after concreting. The form work of shuttering, centering, scaffolding, bricking etc. shall be as per design.

### **2.2.2. Cleaning and Treatment of forms:**

**2.2.2.1.** All rubbish, particularly chippings shaving and saw dust shall be removed from the interior of the form before the concrete is placed and the form work in contact with concrete shall be cleaned and thoroughly wetted or treated. The surface shall be then coated with soap solution applied before concreting is done. Soap solution for the purpose shall be prepared by dissolving yellow soap in water to get consistency of paint. Alternatively, a coat of raw linseed oil/or form oil of approved manufacturer may be applied in case steel shuttering is used. Soap solution or raw linseed oil shall be applied after thoroughly cleaning the surface.

**2.2.2.2.** Care shall be taken that the coating does not get on construction joint surface and reinforcement bars.

### **2.2.3. Stripping Time :**

In normal circumstances and where ordinary cement is used forms may be struck after expiry of following period :

<b><u>Period</u></b>	
[a] Sides of wall columns and vertical faces of beams.	24 to 48 hours
[b] Beams soffits [Props. left under]	7 days
[c] Removal of props under slabs	
[i] Slabs spanning upto 4.5 Mt.	7 days
[ii] Spanning over 4.5 Mt.	14 days

[d] Removal of props to beams and Arches	
[i] Spanning upto 6 Mt.	14 days
[ii] Spanning over 6 Mt.	21 days

#### **2.2.4. Procedure when removing the form work :**

All form work shall be removed without such shock or vibrations as would damage the reinforced concrete surface. Before the soffit form work and struts are moved, the soffits and the concrete surface shall be exposed where necessary in order to ascertain that the concrete has sufficiently hardened.

#### **2.2.5. Centering:-**

**2.2.5.1.** The centering to be provided shall be got approved. It shall be sufficiently strong to ensure absolute safety of the form work and concrete work before, during and after pouring concrete. Watch should be kept to see that behavior of centering and form work is satisfactory during concreting. Erection should also be such that it would all allow removal of forms in proper sequence without damaging either the concrete or the forms to be removed.

**2.2.5.2.** The props of centering shall be provided on firm foundation or base of sufficient strength to carry the loads without any settlement.

**2.2.5.3.** The centering and form work shall be inspected and approved by the Engineer-in-charge before concreting. But this will not relieve the contractor of his responsibility for strength, adequacy and safety of form work and centering.

**2.2.5.4.** If there is a failure of form work or centering, contractor shall be responsible for the damages to the work, injury to life and damage to property

### **3. Scaffolding: -**

**3.1.** All scaffolding, hoisting arrangement and ladders etc. required for the facilitating of concreting shall be provided and removed on completion of work by contractor at his own expense. The scaffolding hoisting arrangement and ladders etc. shall be strong enough to withstand all live, dead and impact loads expected to act and shall be subject to the approval of the Engineer-in-charge.

However, contractor shall be solely responsible for the safety of the scaffolding, hoisting arrangements, ladders, work and workmen etc.

**3.2.** The scaffolding, hoisting arrangements and ladders shall allow easy, approach to the work spot and afford easy inspection.

**3.3.** The rate is applicable to all conditions of working The rate shall include the cost of materials and labour for various operations involved such as :

- (a) Splayed edges, notching, allowance for overlaps and passing at angle, battens centering, shuttering, propping bolting, Nailing, wedging, easing, striking and removal.
- (b) Filleting to form stop chamfered edges of splayed external angles not exceeding 20 mm width to beams, columns and the like.
- (c) Temporary openings in the forms for pouring concrete, if required, removing rubbish etc.
- (d) Dressing with oil to prevent adhesion of concrete with shuttering, and

(e) Raking or circular cutting.

- 3.4. **Re-Use:-** Before- re- use all forms shall be inspected by Engineer-in-charge and their suitability ascertained. The forms shall be scarred, cleaned and joints gone over, repaired. Inside surface shall be retreated to prevent adhesion of concrete.

**3.5. Mode of measurement and payment :**

Form work shall be measured as the area in square metres of shuttering in contact with concrete except in the case of inclined member and portion curved profile and upper side in which case only area of underside shall be measured for payment.

Form work to secondary beams shall be measured upto the side of main beams but no deduction shall be made from the work of the main beams at the intersection point.

No deduction shall be made from the form work of a column at intersection of beams. The rate is for the completed item.

The rate shall be for a unit of one sq. metre.

**Item No. 14**

**Extra for providing formwork with sheathing steel sheets so as to give a fair finish in all structure work: For Column & Coping**

The relevant specifications of Section 9, in R & B Specification Booklet, shall be followed.

**Item No. 15**

**Providing and fixing in position Corrosion resistance steel (CRS) TMT Fe500 conforming to IS 1786 reinforcing bars of various diameters for Pile, Pile cap, Column, Plinth beam, Coping etc. as per detailed designs and drawings and schedule complete as per specification and as directed by Engineer in charge.**

**5.1.0 MATERIALS**

- 5.1.1 Corrosion resistance steel (CRS) Thermo Mechanically Treated steel bars shall conform to M-19, Mild steel binding wires shall conform to M-21.

**5.2. WORKMANSHIP**

- 5.2.1 The work shall consist of furnishing and placing reinforcement to the shape and dimensions shown as on the drawings or as directed.
- 5.2.2 Steel shall be clean and free from rust and loose mill scale at the time of fixing in position and subsequent concreting.

- 5.2.3 Reinforcing steel shall conform accurately to the dimensions 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 straight part of the bar beyond the end of the curve shall be at least four times the diameter of the bar. In case 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.
- 5.2.4 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 handers, 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.
- 5.2.5 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.
- 5.2.6 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 125 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.

- 5.2.7 Where ever 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.
- 5.2.8 When permitted or specified on the drawings, joints of reinforcement bars shall be 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 position 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.
- 5.2.9 Steel shall be Corrosion resistance steel (CRS).

### **5.3 MODE OF MEASUREMENT & PAYMENT**

- 5.3.1 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 do 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-18,19,20,21 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.
- 5.3.2 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 and spacer bars.
- 5.3.3 The rate shall be for unit of one MT.

#### **Item No. 16**



**Masonry work using Aerated light weight concrete block having crushing strength not less than 35kg/sqcm for super structure above plinth level up to floor two level in cement mortar 1:5 (1cement : 5 fine sand) complete as per Technical Specification.**

## **1.0 Materials**

- 1.1 Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS: 2185 (Part I). Masonry units of hollow and solid light-weight concrete blocks shall conform to the requirements of IS: 2185 (Part 3). Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS:2185 (Part 3). The height of the concrete masonry units shall not exceed either its length or six times its width.
- 1.2 The nominal dimensions of concrete block shall be as under.  
Length 400, 500 or 600 mm  
Height 100 or 200 mm  
Width 100 to 300 mm in 50 mm increments
- 1.3 Half blocks shall be in lengths of 200, 250 or 300mm to correspond to the full-length blocks. Actual dimensions shall be 10mm short of the nominal dimensions.
- 1.4 The maximum variation in the length of the units shall not be more than  $\pm 5$  mm and maximum variation in height or width of the units shall not be more than  $\pm 3$ mm.
- 1.5 Concrete blocks shall be either hollow blocks with open or closed cavities or solid blocks. Concrete blocks shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall as specify. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shall be square.
- 1.6 The bedding surfaces shall be at right angles to the faces of the block.
- 1.7 The concrete mix for the hollow and solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume. Concrete blocks shall be of approved manufacture, which satisfy the limitations in the values of water absorption, drying shrinkage and moisture movement, as specified for the type of block as per relevant IS code. Contractor shall furnish the test certificates and also supply the samples for the approval of ENGINEER IN CHARGE.

## **2.0 Workmanship:**

- 2.1 The type of the concrete block, thickness and grade based on the compressive strength for use in load bearing and/or non-load bearing walls shall be as specified. The minimum nominal thickness of non-load bearing internal walls shall be 100mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.
- 2.2 The workmanship shall generally conform to the requirements of IS:2572 for concrete

- block masonry, IS:6042 for light weight concrete block masonry and IS:6041 for autoclaved cellular concrete block masonry works.
- 2.3 From considerations of durability, generally concrete block masonry shall be used in superstructure works above the damp-proof course level.
- 2.4 Concrete blocks shall be embedded with a mortar which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works. Preparation of mortar shall be as specified above.
- 2.5 Thickness of both horizontal and vertical joints shall be 10mm. The first course shall be laid with greater care, ensuring that it is properly aligned, leveled and plumb since this will facilitate in laying succeeding courses to obtain a straight and truly vertical wall. For the horizontal (bedding) joint, mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of 10mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or on the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity Mortar while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10mm as each course is laid to ensure good bond for the plaster.
- 2.6 Dimensional stability of hollow concrete blocks is greatly affected by variations of moisture content in the units. Only well dried blocks should be used for the construction. Blocks with moisture content more than 25% of maximum water absorption permissible shall not be used. The blocks should not be wetted before or during laying in the walls. Blocks should be laid dry except slightly moistening their surfaces on which mortar is to be applied to obviate absorption of water from the mortar.
- 2.7 As per the design requirements and to effectively control cracks in the masonry, RCC bound beams/studs, joint reinforcement shall be provided at suitable locations. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS:280 or welded wire fabric/high strength deformed basis.
- 2.8 For jambs of doors, windows and openings, should concrete blocks shall be provided. If hollow units are used, the hollows shall be filled with concrete of mix 1:3:6. Hold fasts of doors/windows should be arranged so that they occur at block course level.

- 2.9 At intersection of walls, the courses shall be laid up at the same time with a true masonry bond between at least 50% of the concrete blocks. The sequence for construction of partition walls and treatment at the top of load bearing walls for the RCC slab shall be as for the brick work. Curing of the mortar joints shall be carried out for at least 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet. Double scaffolding as per clause shall be adopted for execution of block masonry work. Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in respectively, adopting modular co-ordination for walls, opening locations for doors, windows etc.
- 2.10 Concrete blocks shall be stored at site suitably to avoid any contact with moisture from the ground and covered to protect against wetting.

**Item No. 17**

**Providing and applying 20mm thick sand faced cement plaster on walls upto all floors above ground level consisting of 12mm thick backing coat of C.M. 1:3 (1-cement : 3-sand) and 8mm thick finishing coat of C.M. 1:1 (1-cement : 1-sand) etc. complete. Including scaffolding, curing, finishing, making grooves, forming pattas etc. complete as directed by the Engineer-in-charge.**

**1.0. Materials**

- 1.1. Water shall conform to M-1. Cement mortar shall conform to M-11.

**2.0. Workmanship**

- 2.1. The work shall be carried out in the coats. The backing coat (base coat) shall be 12 mm. thick in C.M. 1:3. The relevant specifications of item No. 17.58(I) shall be followed except that the thickness of back coat shall be 12 mm. average. Before the first coat hardens its surface shall be beaten up by edges of wooden tapers and close dents shall be made on the surface. The subsequent coat shall be applied after this coat has been allowed to set for 3 to 5 days, depending upon the weather conditions. The surface shall not be allowed to dry during this period.
- 2.2. The second coat shall be completed to 8 mm. thickness in C.M. 1:1 as described above, including raising sand facing by bushing. The sample of sand face shall be got approved before the work is started. The whole work shall be carried out uniformly as per sample approved.
- 2.3. **Curing :**  
The curing shall be started overnight after finishing of plaster. The plaster shall be kept wet for a period of 7 days. During this period, it shall be protected from all damages.

**3.0. Mode of measurement & payment**

- 3.1. The relevant specifications of item No. 17.58 shall be followed except that the sand face plaster on outside up to 10 m. above ground level shall be measured under this item.
- 3.2. The rate shall be for a unit of One sq. meter.

**Item No. 18**

**Providing 15mm thick cement plaster in single coat on Rough (Similar) side of single or half brick walls for interior plastering upto floor two level and finishing with a floating coat of neat cement slurry (i) Cement mortar 1:3 (1-cement:3-sand)**

**1.0. Materials**

- 1.1. Water shall conform to M-1. The cement mortar of proportion 1:3 shall conform to M-11.

**2.0. Workmanship**

**2.1. Scaffolding:**

Wooden bullies, bamboos, planks, trestles 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 back-ground:**

- 2.2.1. The surface shall be cleaned of all dust, loose mortar droppings, traces of algae, efflorescence and other foreign matter by water or by brushing. Smooth surface shall be toughened by wire brushing if it is not hard and by hacking if it is hard. In case of concrete surface, if a chemical retarded has been applied to the formwork, 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 readers if left on the surface. Trimming of projections on brick/concrete surfaces where necessary shall be carried out to get an even surface.
- 2.2.2. Raking of joints in case of masonry where necessary shall be allowed to dry out for sufficient period before carrying out the plaster work.
- 2.2.3. The work shall not be soaked but only damped evenly before applying the plaster. If the surface becomes dry, such area shall be moistened again.
- 2.2.4. For external plaster, the pestring 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:**

- 2.3.1. The plaster about 15x15 cms shall be first applied horizontally and vertically at not more than 2meters intervals over the entire surface to serve as gauge. The surfaces of these gauges shall be truly in plane of the finished plastered surface. The mortar shall then be applied in uniform surface slightly more than the specified thickness, and 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 or wooden float according as a smooth or a smooth or a sandy granular texture is required Excessive toweling 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. Hounding or chamfering, corners, arises junctions etc. shall be carried out with proper templates to be size required.
- 2.3.2. Cement plaster shall be used within half an hour after addition of water. And mortar or plaster which is partially set shall be rejected and removed forthwith from the site.
- 2.3.3. 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 recommencing the plaster, the edges of the old work

shall be scraped 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 than 15 cm. 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 arises. Horizontal joints in plaster work shall not also occur on parapet tops and copings as these invariably lead to leakage. No portion of the surface shall be left out initially to be packed up later on.

- 2.3.4. Each coat shall be kept damp continuously till the next coat is applied or for a minimum period of 7 days. Moistening shall commence as soon as plaster is hardened sufficiently. Soaking of 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 or dry weather shall be prevented by hanging matting or gunny bags on the outside of the plaster and keeping them wet.

### **3.0. Mode of measurements & payment**

- 3.1. The rate shall include the cost of all materials, labor and scaffolding etc. Involved in the operations Described under workmanship.
- 3.2. All plastering shall be measured in square meters unless otherwise specified. Length breadth or height shall be measured correct to a centimeter.
- 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 up to floor two levels.
- 3.5. The measurement of wall plastering shall be taken between the walls or partition (dimensions before plastering being taken) for length and from the top of floor or skirting to ceiling for height. Depth of cover of cornices if any shall be deducted. 3.6. Soffits of stairs shall be measured as plastering on ceilings, following soffits shall be measured separately.
- 3.7. For jambs, soffits, sills etc. for openings not exceeding 0.5 sq. met each in area for ends of joints beams, posts, girders, steps etc. not exceeding 0.5 sq. mt each in area and for openings exceeding 0.5. sq.mt and not exceeding 3.00 sq.mt. in each area deductions and additions shall be made in the following manners.
  - (a) No deductions shall be made for ends of joints, beams, posts etc. and openings not exceeding 0.5 sq.mt 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. mt but not exceeding 3 sq.mt. each shall be made as follows and no addition shall be made for ravel, 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 plasters 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 door, window etc. on which width of reveals is less than that on the other side but no deductions 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.

- 3.8. For openings having door frames equal to or projecting beyond the thickness of wall, full deduction for opening shall be made from each plastered face of the wall.
- 3.9. In case of openings of area above 3 sq. mt. each, deduction shall be made for openings but jambs, soffits and sills shall be measured.
- 3.10. The rate shall be for a unit of one sq. meter

**Item No. 19**

**Providing 15mm thick cement plaster in single coat on Rough (Similar) side of single or half brick walls for interior plastering upto floor two level and finishing with a floating coat of neat cement slurry (i) Cement mortar 1:3 (1-cement:3-sand) For Third Floor**

**1.0. Materials**

- 1.1. Water shall conform to M-1. The cement mortar of proportion 1:3 shall conform to M-11.

**2.0. Workmanship**

- 2.1. The relevant specifications of item No. 18 shall be followed except that Providing 15mm thick cement plaster in single coat on Rough (Similar) side of single or half brick walls for interior plastering upto floor two level and finishing with a floating coat of neat cement slurry (i) Cement mortar 1:3 (1-cement:3-sand).

**3.0. Mode of measurement & payment**

- 3.1. The relevant specifications of item No. 18 shall be followed.
- 3.2. The rate shall be for a unit of One sq. meter.

**Item No. 20**

**Providing 15mm thick cement plaster in single coat on Rough (Similar) side of single or half brick walls for interior plastering upto floor two level and finishing with a floating coat of neat cement slurry (i) Cement mortar 1:3 (1-cement:3-sand) For Forth Floor**

**1.0. Materials**

- 1.1. Water shall conform to M-1. The cement mortar of proportion 1:3 shall conform to M-11.

**2.0. Workmanship**

- 2.1. The relevant specifications of item No. 18 shall be followed except that Providing 15mm thick cement plaster in single coat on Rough (Similar) side of single or half brick walls for interior plastering upto floor two level and finishing with a floating coat of neat cement slurry (i) Cement mortar 1:3 (1-cement:3-sand).

**3.0. Mode of measurement & payment**

- 3.1. The relevant specifications of item No. 18 shall be followed.
- 3.2. The rate shall be for a unit of One sq. meter.

**Item No. 21**

**Providing 15mm thick cement plaster in single coat on Rough (Similar) side of single or half brick walls for interior plastering upto floor two level and finishing with a floating coat of neat cement slurry (i) Cement mortar 1:3 (1-cement:3-sand) For Fifth Floor**

**1.0. Materials**

- 1.1. Water shall conform to M-1. The cement mortar of proportion 1:3 shall conform to M-11.

**2.0. Workmanship**

- 2.1. The relevant specifications of item No. 18 shall be followed except that Providing 15mm thick cement plaster in single coat on Rough (Similar) side of single or half brick walls for interior plastering upto floor two level and finishing with a floating coat of neat cement slurry (i) Cement mortar 1:3 (1-cement:3-sand).

**3.0. Mode of measurement & payment**

- 3.1. The relevant specifications of item No. 18 shall be followed.  
 3.2. The rate shall be for a unit of One sq. meter.

**Item No. 22**

**Applying two coats of putty & two coats of primer of approved brand and manufacture on new wall surface to give an even shade including thoroughly brushing the surface free from mortar dropping and other foreign matter and sand papered smooth.**

- 1.0. Item shall be executed as mentioned in item description and as per Drawing.  
 2.0. The mode of payment shall be in per Sqm.

**Item No. 23**

**Finishing wall with weather proof exterior emulsion paint on wall surface (two coats) to give an required shape even shade after thoroughly brushing the surface to removal dirt, and remains of loose powdered materials.etc complete**

Item should be include as Providing and applying one coat of water based exterior primer of approved brand and make as mentioned below on wall surfaces after thoroughly brushing the surface free from mortar droppings and other foreign matter. Item includes making the surface even and smooth by sand papers. Rates are inclusive of all the material and labourers and scaffolding work, cleaning of the floors etc. required for the work with weather proof exterior emulsion paint on wall surface (two coats) to give an required shape even shade after thoroughly brushing the surface to remove all dirt, and remains of loose powdered materials etc. complete.

**Mode of measurement:**

The rate shall be for a unit of one square meter.

**Item No. 24**



**Providing in line level plumb, fabricating and fixing three row horizontal barbed wire fencing and punched tape concertina coil of 9 turns per meter of 610 mm diameter fixed with clips on top of the angle iron posts. The punched tape concertina coil having sharp barbs at every 25 mm spacing shall be 0.5 mm thick and 19 mm width and weighing 13 kg/ 100 mtr. (Average) as per manufacture's specification. the rate shall also include providing and fixed 1.20 mt total long MS angle 40 x 40 x 6mm @ 3.00 mt c/c spacing embedded in RCC column, angle posts shall be painted with one coats of red oxide and two coats of enamel paint of approved quality at top of compound wall.**

- 1.0** Materials as per relevant specifications  
(1) MS Angle as per M22 Barbed wire as per M78
- 2.0 Workmanship**
  - 2.1 The barbed wire shall be stretched and fixed in 3 horizontal rows and and punched tape concertina coil of 9 turns per meter of 610 mm.  
The M.S. Angle posts shall be painted with 3 coats of old paint of approved tint and shade.
- 3.0.** Mode of measurements and payment
  - 3.1. The work shall be measured for the finished work from center to center of the posts.
  - 3.2. The rate shall include the cost of labor and materials involved in the operations described above.
  - 3.3. The rate shall be for a unit of one running meter.  
It shall be completed as per the instruction and as directed by engineer in charge

#### **Item No. 25**

**Supplying, cleaning, cutting, bending, welding, fabricating, erecting structural steel in position irrespective of locations and levels as per drawing including handling and transport etc. complete including applying two coats of primer red oxide and two coats of approved quality of paint over it etc. complete as directed for Steel truss, stair, channel, beams, column, hollow pipe, solid pipe, plate, gusset plates etc. as per drawings.**

**2.1 m height and 6 m wide main and wicket gate**

- 1.0. Materials**
  - 1.1. Water shall conform to M-22.  
It shall be completed as per the instruction and as directed by engineer in charge  
Rate shall be for a unit of one Kg.

#### **Item No. 26**

**Carryout soil investigation work including drilling 150 mm dia bore holes in all sorts of soil, ordinary rock and hard rock, up to maximum depth as mentioned, collection undisturbed samples and conduction standard penetration tests alternate at an interval of 1.5 to 2.0 m depth, conducting necessary laboratory tests for all type of classification and determination of soil parameters if required, including submission**

**of report in three copies covering investigation data and recommendation for SBC and the pile capacity considering the design criteria, all per specification.**

- 1) The rate is inclusive of submitting soil investigation report in three sets in hard copy as well soft copies.**
- 2) The rate is inclusive of all materials with contractor's labour, tolls and plants, machineries, as required.**
- 3) The rate is inclusive of all taxes including services tax. For up to 40Mt. depth.**
1. Relevant Specifications of MORT&H fifth revision Section – 1102, 2400 shall apply to this item.
2. The measurement shall be in Rmt. basis.
3. The rate includes of submitting soil investigation report in three sets in hard copy as well soft copies.
4. The rate is inclusive of all materials with contractor's labour, tools & plants, machineries, as required.
5. The mode of payment shall be in per Rmt. basis.

#### **Item No. 27**

**Carry out 1m x 1 m grid survey work by total station in reference to GTS benchmark or Benchmark suggested by engineer in charge along the corridor including marking of center line of alignment with GPS , taking ground level ,details of all existing structures, Electric poles, trees, overhead electrical lines including fixing necessary reference RCC pillars, establishing bench mark, establishing day light lines on ground and submission of Survey Drawing with readable spot level, longitudinal section, cross section and drawing report of survey work as directed.**

1. The work shall consist of carrying out topographic survey with total station.
2. The work shall involve :
  - a. Establishing control points using DGPS. 4 nos. along the project corridor. The DGPS points shall be marked on 300x300x300 mm (out of ground projection) permanent concrete pillars.
  - b. Carrying out Survey of entire plot using Total Station.
  - c. Connection of the Permanent Bench Mark with GTS Benchmark of Survey of India.
  - d. Cross Section of the Entire Proposed ROW @ 10 m intervals with levels at not more than 5 m spacing.
3. The mode of payment shall be in hectare basis.
4. The rate includes marking of center line of alignment, taking ground level details of existing structures, details of all manholes, catch pits, pipe line, valves, light poles, trees, overhead electrical lines, BSNL section pillar / box, electrical boxes, PMT including number marked on them, road dividers, footpaths, etc. within 60 m from center line and providing, fixing necessary reference pillars, establishing bench mark, establishing foundation layout on ground, including submission longitudinal section, cross section and drawing report of survey work in three hard copies with soft copy in CD to Engineer-in-charge as directed.

#### **Item No. 28**

**Laying and spreading available soil in the sub-grade on a prepared surface, pulverising, mixing the spread soil in place with Soil Stabilizer & Binder Spreader with 2 per cent slaked lime using Binder spreader Machine, having minimum content of 70 per cent of CaO, grading with motor grader and compacting with the road roller at OMC to the desired density to form a layer of improved sub grade.**

1. The relevant specifications of MORT&H fifth revision clause 402 shall apply to this item & directed by engineer in charge.
2. The item shall be measured in Cum by taking cross section.

#### **Item No. 29**

**Box cutting the road surface to proper slope and camber for making a base for road work including removing the excavated stuff and deposit it as directed with all lead & lift.**

The relevant specifications as per relevant MORTH specification Section 301.

The measurement & Payment shall be per cum basis.

#### **Item No. 30**

**Construction of earthwork with approved good soil material obtained from borrow pits with all lifts and leads, transporting to site spreading, grading to required slope and compacting to meet requirement to MoRTH table 300-2.in layers not more than 200 mm thick as directed by engineer in charge.**

1. The relevant specifications of MORT&H fifth revision clause 305 shall apply to this item & directed by engineer in charge.
2. The item shall be measured in Cum by taking cross section.

#### **Item No. 31**

**Construction of subgrade with approved material obtained from borrow pits with all lifts & leads, transporting to site, spreading, grading to required slope and compacted to meet requirement of table No. 300-2) all complete as per MoRTH Specification Clause 305.**

1. The relevant specifications of MORT&H fifth revision clause 305 shall apply to this item & directed by engineer in charge.
2. The item shall be measured in Cum by taking cross section.

#### **Item No. 32**

**Construction of granular sub-base (Grade - V) by providing coarse graded material, spreading in uniform layers with motor grader on prepared surface, mixing by mix in place method with rotavator at OMC, and compacting with vibratory roller to achieve the desired density, complete as per MoRTH clause 401.**

1. The relevant specifications given in Section –401 of MORT&H fifth revision specification

- shall apply to this item.
2. The measurement shall be per Cum. basis.

**Item No. 33**

**Providing, laying, spreading and compacting graded stone aggregate to wet mix macadam (in two layers) specification including premixing the Material with water at OMC in mechanical mix plant carriage of mixed Material by tipper to site, laying in uniform layers with paver in sub- base / base course on well prepared surface and compacting with vibratory roller to achieve the desired density, complete as per MoRTH clause 406.**

1. The relevant specifications given in Section –406 of MORT&H fifth revision specification shall apply to this item.
2. The measurement shall be per Cum. basis.

**Item No. 34**

**Construction of dry lean cement concrete Sub - base over a prepared sub-grade with coarse and fine aggregate conforming to IS: 383, the size of coarse aggregate not exceeding 25 mm, aggregate cement ratio not to exceed 15:1, aggregate gradation after blending to be as per table 600-1, cement content not to be less than 150 kg/ cum, optimum moisture content to be maintain during construction, concrete strength not to be less than 10 Mpa at 7 days, mixed in a batching plant, transported to site, laid with a paver compacting with 8-10 tonnes vibratory roller, finishing and curing as per MoRTH clause 601**

1. The relevant specifications given in Section –601 of MORT&H fifth revision specification shall apply to this item.
2. The measurement shall be per Cum. basis.

**Item No. 35**

**Cement Concrete Pavement (Construction of un-reinforced, dowel jointed, plain cement concrete pavement over a prepared sub base with 43 grade cement @ 440 kg per cum, coarse and fine aggregate conforming to IS 383, maximum size of coarse aggregate not exceeding 25 mm, mixed in a batching and mixing plant as per approved mix design, transported to site, laid with a fixed form or slip form paver, spread, compacted and finished in a continuous operation including provision of contraction, expansion, construction and longitudinal joints, joint filler, separation membrane, sealant primer, joint sealant, debonding strip, dowel bar, tie rod, admixtures as approved, curing compound, finishing to lines and grades as per drawing )**

1. The relevant specifications given for cement concrete M40 grade as per Section -602 of MORT&H fifth revision specification.

2. The measurement shall be per cum basis.
3. The rate is inclusive of all materials, including necessary dewatering, mixing in fully automatic batch mix plant, transport, curing, vibrating, placing in position, shuttering, formworks, de-shuttering carefully, making good the damages, fixing embedment, inserts, pockets, wherever necessary, with all lead and lift with contractor's labour, tools & plants, machineries, as required.

**Item No. 36**

**Providing and applying Prime coat with Slow Setting Bitumen Emulsion binder (SS-1) @ rate of 7.5 Kg./10 sq.m. of road surface using Emulsion pressure sprayer etc., cleaning the road surface complete including cost of material labour etc complete as directed by engineer in charge.**

*\*The relevant specifications given in Section – 502 of MORT&H fifth revision specification shall apply to this item.*

**1. Scope**

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular/ stabilized surface preparatory to the superimposition of bituminous treatment or mix.

**2. Materials**

The primer shall be cationic bitumen emulsion SS1 grade conforming to IS: 8887.

Quantity of SS1 grade bitumen emulsion for various types of granular surface shall be as per given Table.

Type of Surface	Rate of Spray (kg/Smt)
WMM / WBM	0.7-1.0

The correct quantity of primer shall be decided by the Engineer and shall be such that it can be absorbed by the surface without causing run-off of excessive primer and to achieve desired penetration of about 8-10 mm.

**3. Weather and Seasonal Limitations**

Primer shall not be applied during a dust storm or when the weather is foggy, rainy or windy Surfaces which are to receive emulsion primer should be damp, but no free or standing water shall be present. Surface can be just wet by very light sprinkling of water.

**4. Construction**

**4.1 Equipment**

The primer shall be applied by a self-propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying shall not be allowed except in small areas, inaccessible to the distributor, or in narrow strips where primer shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

**4.2 Preparation of Road Surface**

The granular surface to be primed shall be swept clean by power brooms or mechanical sweepers and made free from dust. All loose material and other foreign material shall be removed completely. If soil/murum binder has been used in the WBM surface, part of this should be brushed and removed to a depth of about 2 mm so as to achieve good penetration.

#### 4.3 Application of Bituminous Primer

After preparation of the road surface, the primer shall be sprayed uniformly at the specified rate. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. No heating or dilution of SS1 bitumen emulsion and shall be permitted at site.

#### 4.4 Curing of Primer and Opening to Traffic

A primed surface shall be allowed to cure for at least 24 hours or such other higher period as is found to be necessary to allow all the moisture/volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with a light application of sand, using the minimum quantity possible. A primed surface shall not be opened to traffic other than that necessary to lay the next course.

#### 4.5 Quality Control of Work

Control on the quality of materials and works shall be exercised by the Engineer as per Table 36-1.

**Table 36-1 : Test and Frequency for Primer Coat**

Type of Construction	Test	Frequency
Prime Coat	Quality of Binder	MTC should be provided.
	Binder Temperature for application	Three test per day
	Rate of spread of binder	Three test per day

#### 4.6 Arrangements for Traffic

During the period of construction, arrangements for the traffic shall be provided. The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, marking, flags, lights and flagmen as per instruction of the Engineer-in-charge.

### 5. Measurement for Payment

Prime coat shall be measured in terms of surface area of application in Smt.

#### Item No. 37

**Providing and laying Dense Graded Bituminous Macadam in layers (single layer not more than 75 mm ) using BT stone chips as per MoRTH gradation and specification with Bitumen Grade (VG 30) for mixing @ 45.00 Kg /MT of total Wt. of mix i.e (4.50 % of total weight mix)including tack coat @ 2.5 kg/10 smt with Bitumen Emulsion (Rapid setting) and mixing aggregate & asphalt by batch mix plant and spreading the same by sensor paver finisher including rolling & consolidation with 10-12 tonne vibratory roller & providing all materials equipment's tools & plants, fire wood, oil , kerosene,labour charges , using contractor 's own machinery etc Complete as directed by engineer in charge as per MoRTH Specification**

*\*The relevant specifications given in Section – 505 of MORT&H fifth revision specification shall apply to this item.*

**1. Scope**

The work shall consist of construction in a single or multiple layers of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be 50 mm to 100 mm.

**2. Materials**

**Bitumen**

The bitumen shall be viscosity grade (VG-40) paving bitumen complying with the Indian Standard Specification IS:73.

**Coarse Aggregates**

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious substances. The aggregates shall satisfy the requirements specified in Table 13-1 and these property of aggregate should be checked by the Engineer in charge in the Mix Design submitted by the contractor.

**Table 37-1 : Physical Requirements for Coarse Aggregate for Dense Bituminous Macadam**

Property	Test	Specification	Method of Test
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	IS: 2386 Part I
Particle shape	Combined Flakiness and Elongation Indices*	Max 35%	IS: 2386 Part I
Strength	Los Angeles Abrasion Value or Aggregate Impact Value	Max 35% Max 27%	IS: 2386 Part IV
Durability	Soundness either :Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS: 2386 Part V
Water Absorption	Water Absorption	Max 2%	IS: 2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate Mix	Minimum retained coating 95%	IS:6241
Water Sensitivity	Retained Tensile Strength*	Min 80%	AASHTO 283

To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total



non-flaky particles. The values of flakiness index and elongation index so found are added up.

If the minimum retained tensile test strength falls below 80 percent, use of anti-stripping agent is recommended to meet the requirement.

Where crushed gravel is proposed for use as aggregate, not less than 90 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

### **Fine Aggregates**

Fine aggregates shall consist of crushed or naturally occurring mineral material, or a combination of the two, passing the 2.36 mm sieve and retained on the 75 micron sieve. These shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter. Natural sand shall not be allowed in binder courses. However, natural sand upto 50 percent of the fine aggregate may be allowed in base courses.

### **Filler**

Filter shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the Engineer. The filler shall be graded within the following limits :-

**Table 37-2 : Grading Requirements for Mineral Filler**

<b>IS sieve (mm)</b>	<b>Cumulative Percent Passing by Weight of Total Aggregate</b>
0.6	100
0.3	95-100
0.075	85-100

The filler shall be free from organic impurities and have a plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime. 505.2.5 Aggregate

### **3. Grading and Binder Content**

When tested in accordance with IS.2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and filler for the particular mixture shall fall within the limits given in Table 37-3 for grading 2.

**Table 37-3 : Composition of Dense Graded Bituminous Macadam**

<b>Grading</b>	<b>2</b>
<b>Nominal aggregate size*</b>	26.50
<b>Layer Thickness</b>	50 - 75 mm

IS Sieve1 (mm)	Cumulative % by weight of total aggregate passing
37.50	100
26.50	90 - 100
19	71 – 95
13.2	56 – 80
4.75	38 – 54
2.36	28 – 42
0.3	7 – 21
0.075	2 – 8
Bitumen content % by mass of total mix	Min 4.5**

\* The nominal maximum particle size is the largest specified sieve size upon which any of the aggregate is retained.

\*\* Corresponds to specific gravity of aggregates being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 30°C or lower and lowest daily air temperature is - 10°C or lower, the bitumen content may be increased by 0.5 percent.

Bitumen content indicated in above Table is the minimum quantity. The quantity shall be determined in accordance with Clause of Mix Design.

#### 4. Mix Design

The bitumen content required shall be determined following the Marshall mix design procedure contained in Asphalt Institute Manual MS-2.

The Fines to Bitumen (F/B) ratio by weight of total mix shall range from 0.6 to 1.2.

#### Requirements for the Mix

Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 37-4.

**Table 37-4 : Requirements for Dense Graded Bituminous Macadam**

Properties	Viscosity Grade Paving Bitumen	Test Method
Compaction level	75 blows on each face of the specimen	
Minimum stability (kN at 600C)	9.0	AASHTO T245
Marshall flow (mm)	2 - 4	AASHTO T245
Marshall Quotient (Stability / flow)	2 - 5	MS-2 and ASTM D2041
% air voids	3-5	
% Voids Filled with Bitumen (VFB)	65-75	
Coating of aggregate particle	95% minimum	IS:6241
Tensile Strength ratio	80% Minimum	AASHTO T 283

% Voids in Mineral Aggregate (VMA)	11.0 – 13.0	
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## 5. Binder Content

The binder content shall be optimized to achieve the requirements of the mix set out in Table 37-4. The binder content shall be selected to obtain 4 percent air voids in the mix design. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2.

Where maximum size of the aggregate is more than 26.5 mm, the modified Marshall method using 150 mm diameter specimen described in MS-2 and ASTM D 5581 shall be used. This method requires modified equipment and procedures. When the modified Marshall test is used, the specified minimum stability values in shall be multiplied by 2.25, and the minimum flow shall be 3 mm.

### Minimum Percent Voids In Mineral Aggregate (VMA)

Nominal Maximum Particle Size <sup>1</sup> (mm)	Minimum VMA Percent Related to Design Percentage Air voids		
	3.0	4.0	5.0
26.5	11.0	12.0	13.0
37.5	10.0	11.0	12.0

Note : Interpolate minimum voids in the mineral aggregate (VMA) for designed percentage

### Job Mix Formula

The Contractor shall submit to the Engineer for approval at least 21 days before the start the work, the job mix formula proposed for use in the works, together with the following details:

- i) Source and location of all materials;
- ii) Proportions of all materials expressed as follows:
  - a) Binder type, and percentage by weight of total mix;
  - b) Coarse aggregate/Fine aggregate/Mineral filler as percentage by weight of total aggregate including mineral filler;
- iii) A single definite percentage passing each sieve for the mixed aggregate;
- iv) The individual gradings of the individual aggregate fraction, and the proportion of each in the combined grading;
- v) The results of mix design such as maximum specific gravity of loose mix (G<sub>mm</sub>), compacted specimen densities, Marshall stability, flow, air voids, VMA, VFB and related graphs and test results of AASHTO T 283 Moisture susceptibility test;
- vi) Where the mixer is a batch mixer, the individual weights of each type of aggregate, and binder per batch;

- vii) Test results of physical characteristics of aggregates to be used;
- viii) Mixing temperature and compacting temperature.

While establishing the job mix formula, the Contractor shall ensure that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that the mix and its different ingredients satisfy the physical and strength requirements of these Specifications.

Approval of the job mix formula shall be based on independent testing by the Engineer for which samples of all ingredients of the mix shall be furnished by the Contractor as required by the Engineer.

The approved job mix formula shall remain effective unless and until a revised Job Mix Formula is approved. Should a change in the source of materials be proposed, a new job mix formula shall be forwarded by the Contractor to the Engineer for approval before the placing of the material.

6. **Permissible variation from job mix formula:**

It shall be the responsibility of the Contractor to produce a uniform mix conforming to the approved job mix formula subject to the permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used within the limits as specified in below Table.

**Table 37-5 : Permissible Variations in the Actual Mix from the Job Mix Formula**

Description	Base/binder course
Aggregate passing 19 mm sieve or larger	±8%
Aggregate passing 13.2 mm, 9.5 mm	±7%
Aggregate passing 4.75 mm	± 6%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	±5%
Aggregate passing 0.3 mm, 0.15 mm	±4%
Aggregate passing 0.075 mm	±2%
Binder content	± 0.3%
Mixing temperature	± 10°C

**Construction Operations**

**Preparation of Base**

The base on which Dense Bituminous Macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grades and cross sections as directed by the Engineer. The surface shall be thoroughly swept clean free from dust and foreign matter using mechanical broom and dust removed or blown off by compressed air. In portions where mechanical means cannot reach, other approved method shall be used. A priming coat where needed, shall be applied as directed by the Engineer

**Prime Coat**

Where the material on which the dense bituminous macadam is to be laid is other than a bitumen bound layer, a prime coat shall be applied, as specified in the tender specification or as directed by the Engineer.

### **Tack Coat**

Where the material on which the dense bituminous macadam is to be laid is either bitumen bound layer or primed granular layer, tack coat shall be applied, as specified in the tender specification or as directed by the Engineer.

### **Mixing and Transportation of the Mix**

Pre-mixed bituminous materials shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. Appropriate mixing temperatures are given in Table 37-6 of these Specifications, the difference in temperature between the binder and aggregate shall at no time exceed 14°C. In order to ensure uniform quality of the mix and better coating of aggregates, the hot mix plant shall be calibrated from time to time.

**Table 37-6 : Mixing, Laying and Rolling Temp for Bituminous Mixes (Degree Celsius)**

<b>Bitumen Viscosity Grade</b>	<b>Bitumen Temperature</b>	<b>Aggregate Temperature</b>	<b>Mixed Material Temperature</b>
VG-40	150-165	150-170	150-165

Bituminous materials shall be transported in clean insulated and covered vehicles. An asphalt release agent, such as soap or lime water, may be applied to the interior of the vehicle to prevent sticking and to facilitate discharge of the material.

### **Spreading**

The mix transported from the hot mix plant to the site shall be spread by means of a self-propelled paver with suitable screeds capable of spreading, tamping and finishing the mix to specified grade, lines and cross-section. The paver finisher shall have the following essential features:

- (a) Loading hoppers and suitable distributing mechanism.
- (b) All drives having hydrostatic drive/control.
- (c) The machine shall have a hydraulically extendable screed for appropriate width requirement.
- (d) The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface. It shall have adjustable amplitude and variable frequency.
- (e) The paver shall be equipped with necessary control mechanism so as to ensure that the finished surface is free from surface blemishes.
- (f) The paver shall be fitted with an electronic sensing device for automatic levelling and profile control within the specified tolerances.
- (g) The screed shall have the internal heating arrangement.

- (h) The paver shall be capable of laying either 2.5 to 4.0 m width or 4.0 to 7.0 m width as stipulated in the Contract.
- (i) The paver shall be so designed as to eliminate skidding/slippage of the tyres during operation.

However, in restricted locations and in narrow widths where the available equipment cannot be operated in the opinion of the Engineer, he may permit manual laying of the mix. Similarly for smaller jobs, mechanical paver may be used with the approval of the Engineer.

The temperature of mix at the time of laying shall be more than 120° C.

Mixes with a temperature of less than 120° C shall not be put into paver spreader. Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. Longitudinal and transverse joints shall be offset by at least 250 mm from those in the lower courses and the joint on the top most layer shall not be allowed to fall within the wheel path. All transverse joints shall be cut vertically to the full thickness of the previously laid mix with asphalt cutter and the surface painted with hot bitumen before placing fresh material. Longitudinal joints shall be preferably hot joints. Cold longitudinal joints shall be properly heated with joint heater to attain a suitable temperature of about 80° C laying of adjacent material.

### **Rolling**

After spreading the mix by paver, it shall be thoroughly compacted by rolling with a set of rollers moving at a speed not more than 5 km/h, immediately following close to the paver. Generally the initial or breakdown rolling shall be done with 80-100 kN static weight smooth wheeled roller. The intermediate rolling shall be done with 80-100 kN static weight vibratory roller or with a pneumatic tyred roller of 150-250 kN weight having a tyre pressure of at least 0.7 MPa. The finish rolling shall be done with 60-80 kN weight smooth wheeled tandem roller. All the compaction operations, i.e., breakdown rolling and intermediate rolling can be accomplished by using vibratory tandem roller of 80-100 kN static weight. During initial breakdown rolling and finish rolling, no vibratory compaction shall be resorted to. The exact pattern of rolling shall be established after trial compaction as approved by the Engineer. Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good. The rollers shall not be permitted to stand on pavement which has not been fully compacted and where temperature is still more than 70° C. Necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign matter on the pavement either when the rollers are operating or standing.

The wheels of roller shall be kept moist to prevent the mix from adhering to them. But in no case shall fuel/lubricating oil be used for this purpose nor excessive water poured on the wheels. Rolling shall commence longitudinally from edges and proceed towards the centre, except that on super elevated and unidirectional cambered portions, it shall progress from the lower to upper edge parallel to the centre line of the pavement. The roller shall proceed on the fresh material with rear or fixed wheel leading so as to minimise the pushing of the

mix and each pass of the roller shall overlap the preceding one by half the width of the rear wheel.

Rolling shall be continued till the proper density is achieved and all roller marks are eliminated. Skin patching of an area that has been rolled will not be permitted. Rolling operations shall be completed in all respects before the temperature of the mix falls below 100° C.

#### **Opening to Traffic**

It shall be ensured that the traffic is not allowed on the surface until the dense bituminous layer has cooled to the ambient temperature.

#### **Surface Finish and Quality Control of Work**

##### **Surface evenness:**

The surface finish of construction shall conform to the requirements of Clause in Item No. 9.

#### **7. Quality control:**

Control on the quality of materials and works shall be exercised by the Engineer as per Table 37-7.

**Table 37-7 : Control Tests for Bituminous Works and their Minimum Frequency**

<b>Type of Construction</b>	<b>Test</b>	<b>Frequency (Min.)</b>
Dense Bituminous Macadam/Bituminous Concrete	Quality of binder	Material Testing Certificate (MTC) is required from IOC as per number of samples per lot.
	Aggregate Impact Value/ Los Angeles Abrasion Value	One test per 100 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
	Flakiness and Elongation Indices	One test per 100 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
	Water absorption of aggregates	One test for each source and whenever there is change in the quality of aggregate
	Mix grading	One test per 200 cmt subject to minimum of two tests per day per plant.
	Marshall stability and voids analysis of mix	Three tests for stability, flow value, density and void contents for each 400 tonne of mix subject to minimum of two tests per day per plant.



	Temperature of binder in boiler, aggregate in dryer and mix at the time of laying and compaction	At regular intervals
	Binder content	One set for each 400 tonnes of mix subject to minimum of two tests per day per plant
	Density of Compacted layer	One test per 300 mt length of road

### Arrangement for Traffic

During the period of construction, arrangements for the traffic shall be provided. The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, marking, flags, lights and flagmen as per instruction of the Engineer-in-charge.

### 8. Measurements for Payment

The rate shall be for a unit of one MT.

In addition to above, the contract unit rate of bituminous work shall also include:

1. Finding of buried man hole during resurfacing activity if any
2. Cleaning of bitumen from all catch pits.
3. Submission of colored photographs of cleaned catch pits
4. Removal of all debris from site.

**Note:-** All aggregates used in the Hot mix material should be confirmed to the relevant standards and it should be procured from the approved source/region specifically from the **Sayla** area only. After completion of Bituminous concrete work, 90% amount of Bituminous concrete work will be released. Remaining 10% amount will be released after satisfactorily completion of raising of all Manholes & Catchpits of individual road included in the scope of work or tender.

### Item No. 38

**Providing and laying 40 mm thick of compacted Bituminous concrete using BT aggregate as per MORTH gradation ,specification and asphalt Grade VG 30 mixing @54.00 Kg /MT of total Wt. of mix i.e. (5.40% of total weight mix) including heating and mixing aggregate & asphalt by batch mix plant spreading the same by sensor paver finisher including rolling & consolidation with 10-12 tonne vibratory roller, Tandem Roller ,PTR & providing all materials equipment's tools & plants, fire wood, oil , kerosene,labour charges , using contractor 's own machinery etc. Complete as directed by engineer in charge as per MoRTH Specification**

*\*The relevant specifications given in Section – 507 of MORT&H fifth revision specification shall apply to this item.*

### Scope

This work shall consist of construction of Bituminous Concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single layer of bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 30 mm/40 mm/50 mm thick.

### Materials

#### Bitumen

The bitumen shall be viscosity grade (VG-40) paving bitumen complying with the Indian Standard Specification IS:73.

#### Coarse Aggregates

Clause of Dense Bituminous Macadam (DBM) shall apply. The aggregates shall satisfy the requirements specified in Table 38 -1 and this property of aggregate should be checked by the Engineer in charge in the Mix Design submitted by the contractor.

**Table 38-1 : Physical Requirements for Coarse Aggregate for Dense Bituminous Macadam**

Property	Test	Specification	Method of Test
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	IS: 2386 Part I
Particle shape	Combined Flakiness and Elongation Indices*	Max 35%	IS: 2386 Part I
Strength	Los Angeles Abrasion Value or Aggregate Impact Value	Max 30% Max 24%	IS: 2386 Part IV
Durability	Soundness either :Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS: 2386 Part V
Polishing	Polished Stone Value	Min 55	BS:812-114
Water Absorption	Water Absorption	Max 2%	IS: 2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate Mix	Minimum retained coating 95%	IS:6241
Water Sensitivity	Retained Tensile Strength**	Min 80%	AASHTO 283

To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The values of flakiness index and elongation index so found are added up.

If the minimum retained tensile test strength falls below 80 percent, use of anti-stripping agent is recommended to meet the requirement.

**Fine Aggregates**

Clause of Dense Bituminous Macadam (DBM) shall apply.

**Filler**

Clause of Dense Bituminous Macadam (DBM) shall apply.

**Grading and Binder Content**

When tested in accordance with IS.2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and filler for the particular mixture shall fall within the limits given in Table 38-2 for grading 2.

**Table 38-2 : Composition of Bituminous Concrete.**

<b>Grading</b>	<b>2</b>
<b>Nominal aggregate size*</b>	<b>13.2 mm</b>
<b>Layer Thickness</b>	<b>30 - 50 mm</b>
<b>IS Sieve1 (mm)</b>	<b>Cumulative % by weight of total aggregate passing</b>
19	100
13.2	90 - 100
9	70 - 88
4.75	53 - 71
2.36	42 - 58
1.18	34 - 48
0.6	26 - 38
0.3	18 - 28
0.15	12 - 20
0.075	4 - 10
Bitumen content % by mass of total mix	Min 5.4**

\* The nominal maximum particle size is the largest specified sieve size upon which any of the aggregate is retained.

\*\* Corresponds to specific gravity of aggregates being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 30°C or lower and lowest daily air temperature is - 10°C or lower, the bitumen content may be increased by 0.5 percent.

Bitumen content indicated in above Table is the minimum quantity. The quantity shall be determined in accordance with Clause of Mix Design.

**Mix Design****Requirements for the Mix**

Clause of Dense Bituminous Macadam (DBM) shall apply.

#### **Binder Content**

The binder content shall be optimized to achieve the requirements of the mix set out in Table 14-2.

Clause of Dense Bituminous Macadam (DBM) shall apply.

#### **Job Mix Formula**

Clause of Dense Bituminous Macadam (DBM) shall apply.

#### **Permissible variation from job mix formula:**

It shall be the responsibility of the Contractor to produce a uniform mix conforming to the approved job mix formula subject to the permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used within the limits as specified in below Table.

**Table 38-3 : Permissible Variations in the Actual Mix from the Job Mix Formula**

<b>Description</b>	<b>Base/binder Course</b>
Aggregate passing 19 mm sieve or larger	±7%
Aggregate passing 13.2 mm, 9.5 mm	±6%
Aggregate passing 4.75 mm	± 5%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	±4%
Aggregate passing 0.3 mm, 0.15 mm	±3%
Aggregate passing 0.075 mm	±1.5%
Binder content	± 0.3%

#### **Construction Operations**

##### **Preparation of Base**

The base on which Bituminous Concrete is to be laid shall be prepared, shaped and conditioned to the specified lines, grades and cross sections as directed by the Engineer. The surface shall be thoroughly swept clean free from dust and foreign matter using mechanical broom and dust removed or blown off by compressed air. In portions where mechanical means cannot reach, other approved method shall be used as per instruction of engineer in charge.

##### **Tack Coat**

Where the material on which the Bituminous Concrete is to be laid, tack coat shall be applied, as specified in the tender specification or as directed by the Engineer.

##### **Mixing and Transportation of the Mix**

Clause of Dense Bituminous Macadam (DBM) shall apply.

##### **Spreading**

Clause of Dense Bituminous Macadam (DBM) shall apply.

**Rolling**

Clause of Dense Bituminous Macadam (DBM) shall apply.

**Opening to Traffic**

It shall be ensured that the traffic is not allowed on the surface until the bituminous concrete layer has cooled to the ambient temperature.

**Surface Finish and Quality Control of Work****Surface evenness:**

The surface finish of construction shall conform to the requirements of Clause in Item No. 9.

**Quality control:**

Control on the quality of materials and works shall be exercised by the Engineer as per Table 38-7 in DBM clause.

**Arrangement for Traffic**

Clause of Dense Bituminous Macadam (DBM) shall apply.

**Measurements for Payment**

The rate shall be for a unit of one MT.

In addition to above, the contract unit rate of bituminous work shall also include:

1. Finding of buried man hole during resurfacing activity if any
2. Cleaning of bitumen from all catch pits.
3. Submission of coloured photographs of cleaned catch pits
4. Removal of all debris from site.

**Note:** - All aggregates used in the Hot mix material should be confirmed to the relevant standards and it should be procured from the approved source/region specifically from the **Sayla** area only. After completion of Bituminous concrete work, 90% amount of Bituminous concrete work will be released. Remaining 10% amount will be released after satisfactorily completion of raising of all Manholes & Catchpits of individual road included in the scope of work or tender.

**Item No. 39**

**Providing and laying hot applied thermoplastic compound of 2.5 mm thick including reflectorising glass beads @ 250 gm per sqm area. Thickness of 2.5mm is exclusive of surface applied glass beads as per IRC 35. The finished surface to be level uniform and free from streaks and holes etc. complete.**

1. The relevant specifications given in Clause 803 of MORT&H fifth revision specification shall apply to this item.
2. The measurement shall be in Sq.mt basis.
3. The rate includes of reflectorising glass beads at 250 gm/smt area. Thickness of 2.5 mm is exclusive of surface applied glass beads as per IRC 35. The finished surface to be level uniform free from streaks and holes and as per direction of engineer in charge.

**Item No. 40**

**Supply & Fixing cat eye (Stimsonite) made out from Acrilo beaultile sterine injection high compressed molding with reflector made of MMC (Prismatic type of size 12 cm x 6 cm x 2.5cm). Provided with bituminous adhesive 100g with each unit for fixing (High intensity Grade).**

1. The relevant specifications given in Section – 800 of MORT&H fifth revision specification shall apply to this item.
2. The measurement shall be in Nos. basis
3. The mode of payment shall be in Nos basis.

**Item No. 41**

**Paver Block Laying Colored/ Grey 80 mm thk, M-40 Grade for Car Parking. Providing and laying Shot blasted Non- interlocking, Grey/ Colored brick type paver blocks of 80 mm thick M-40 grade machine made and blasting by automatic machine and high density of as per approved sample of Vyara, Alcock, Super, Nishu as mentioned in the drawing. Including providing and laying 30 to 50 mm thick average bedding layer of coarse sand below paver block as per required grading and specification. Laid paver block shall be mechanically compacted. The work of the paving blocks shall be executed in line and level by skilled mason of flooring work only. It should be laid in such a way that the no cutting of the paver block to be necessary. If cutting of paver block shall be required, than cut by machine only and laying to be done by skilled flooring mason. The Finished surface of the Paver Block shall have Coarse Sand Texture Finish. Paver blocks shall be compacted and shall be re-laid if necessary. Actual laid area shall be measured and paid without any wastage.**

1. The item shall be executed as per relevant specification of IRC SP 63 & IS 15658.
2. The item shall be measured in Sq.mt in plan area. No separate measurement for sand for bedding and jointing.

**Item No. 42**

**Paver Block Laying Colored/ Grey 60 mm thk, M-40 Grade for pathway. Providing and laying Shot blasted Non- interlocking, Grey/ Colored brick type paver blocks of 60 mm thick M-40 grade machine made and blasting by automatic machine and high density of as per approved sample of Vyara, Alcock, Super, Nishu as mentioned in the drawing. Including providing and laying 30 to 50 mm thick average bedding layer of coarse sand below paver block as per required grading and specification. Laid paver block shall be mechanically compacted. The work of the paving blocks shall be executed in line and level by skilled mason of flooring work only. It should be laid in such a way that the no cutting of the paver block to be necessary. If cutting of paver block shall be required, than cut by machine only and laying to be done by skilled flooring mason. The Finished surface of the Paver Block shall have Coarse Sand Texture Finish. Paver blocks shall be compacted and shall be re-laid if necessary. Actual laid area shall be measured and paid without any wastage.**

1. The item shall be executed as per relevant specification of IRC SP 63 & IS 15658.

2. The item shall be measured in Sq.mt in plan area. No separate measurement for sand for bedding and jointing.

**Item No. 43**

**Providing and laying in positions machine mixed Plain Cement Concrete M10 grade for leveling course for kerb etc. as directed by Engineer-in-charge with graded broken stone aggregate from 6 mm to 20 mm including tamping, vibrating, leveling and curing complete with all formwork, dewatering wherever required including all materials, labours, plants, machineries & tools, all leads and lifts, etc. complete as per specification.**

1. The relevant specifications given for machine mixed plain cement concrete M10 grade as per Section -1500 & 1700 of MORT&H fifth revision specification.
2. The Item shall be measured in Cum.
3. The rate includes tamping, vibrating, leveling and curing complete with all formwork, dewatering wherever required including all materials, labours, plants, machineries & tools, all leads and lifts, etc. complete as per specification.

**Item No. 44**

**Providing & fixing M25 grade of concrete precast exposed finish kerb stones (manufactured on vaccume wet press machine with hydraulic pressing of wet concrete mixture to a minimum of 400 tons with simultaneous vacuuming, using ECO filters and developing texture finish) of Vyara and as per sample approved of following sizes. Kerbs shall be fixed on the foundation prepared of M10 grade concrete . The rate shall also include for erecting and fixing the pieces in position for complete Kerb systems with Chamfered type of kerbs including necessary accessories of kerb like Radius Kerbs, Angles and Quadrant Kerbs etc complete as per drawing. The rate shall also include the flush pointing in CM (1:2) for all joints of the kerbstones. (Sample must be approved). Protective coat of Hydrophobic silane-siloxane (silicon )to be applied on all exposed surface The contractor rate shall also include the cost of excavation and finish good, curing etc complete as directed by engineer in charge.**

**(a) 600 mm (L) x 300 mm (H) x 150 (W) mm Half better (HB) type Kerb stone**

The relevant specification for item description shall apply to this item.

The mode of payment shall be in per Rmt basis.

**Item No. 45**

**Providing & fixing M25 grade of concrete precast exposed finish kerb stones (manufactured on vaccume wet press machine with hydraulic pressing of wet concrete mixture to a minimum of 400 tons with simultaneous vacuuming, using ECO filters and developing texture finish) of Vyara and as per sample approved of following sizes. Kerbs shall be fixed on the foundation prepared of M10 grade concrete complete. The rate shall also include for erecting and fixing the pieces in position for complete Kerb systems with Chamfered type of kerbs including necessary**



accessories of kerb like Radius Kerbs, Angles and Quadrant Kerbs etc complete as per drawing. The rate shall also include the flush pointing in CM (1:2) for all joints of the kerbstones. (Sample must be approved). Protective coat of Hydrophobic silane-siloxane (silicon) to be applied on all exposed surface. The contractor rate shall also include the cost of excavation and finish good, curing etc complete as directed by engineer in charge.

**(a) 300 mm (H) x 150 (W) mm Half batter 90 degree angular corner kerb stones**

The relevant specification for item description shall apply to this item.

The mode of payment shall be in per Rmt basis.

#### **Item No. 46**

**Providing & fixing M25 grade of concrete precast exposed finish kerb stones (manufactured on vacuum wet press machine with hydraulic pressing of wet concrete mixture to a minimum of 400 tons with simultaneous vacuuming, using ECO filters and developing texture finish) of Vyara and as per sample approved of following sizes. Kerbs shall be fixed on the foundation prepared of M10 grade concrete. The rate shall also include for erecting and fixing the pieces in position for complete Kerb systems with Chamfered type of kerbs including necessary accessories of kerb like Radius Kerbs, Angles and Quadrant Kerbs etc complete as per drawing. The rate shall also include the flush pointing in CM (1:2) for all joints of the kerbstones. (Sample must be approved). Protective coat of Hydrophobic silane-siloxane (silicon) to be applied on all exposed surface. The contractor rate shall also include the cost of excavation and finish good, curing etc complete as directed by engineer in charge.**

**(a) 1000 (L) x 300 mm (H) x 150 (W) mm Bull nose type Kerb stone**

The relevant specification for item description shall apply to this item.

The mode of payment shall be in per Rmt basis.

#### **Item No. 47**

**Providing & fixing M25 grade of concrete precast exposed finish kerb stones (manufactured on vacuum wet press machine with hydraulic pressing of wet concrete mixture to a minimum of 400 tons with simultaneous vacuuming, using ECO filters and developing texture finish) of Vyara and as per sample approved of following sizes. Kerbs shall be fixed on the foundation prepared of M10 grade concrete. The rate shall also include for erecting and fixing the pieces in position for complete Kerb systems with Chamfered type of kerbs including necessary accessories of kerb like Radius Kerbs, Angles and Quadrant Kerbs etc complete as per drawing. The rate shall also include the flush pointing in CM (1:2) for all joints of the kerbstones. (Sample must be approved). Protective coat of Hydrophobic silane-siloxane (silicon) to be applied on all exposed surface. The contractor rate shall also include the cost of excavation and finish good, curing etc complete as directed by engineer in charge.**

**(a) 1000 (L) x 300 mm (H) x 150 (W) mm Dropper type Kerb stone**

The relevant specification for item description shall apply to this item.

The mode of payment shall be in per Rmt basis.

**Item No. 48**

**Providing and fixing 1.50 Metre high Galvanised Chain link fencing with 2.0 Metre long M.S. Angle for posts & horizontal 50mm x 50 mm x 6 mm and oil painting 3 coats fixed at 2.5 Mt. c/c. with Chain link 2 10 x 10 gauge, strained and fixed to posts including Excavation, fixing the posts in ground with 0.3m x 0.3m x 0.75m block in R.C.C. M20, backfilling and CRS reinforcement etc. complete.**

The relevant specification for item description shall apply to this item.

The mode of payment shall be in per Rmt basis.

**Item No. 49**

**Providing, laying & filling cement plum concrete in 1:3:6 with 40% plum stone including vibrating, ramming, labour for stone filling, curing etc. complete.**

1. The relevant specifications given for machine mixed plain cement concrete 1:3:6 grade as per Section -1500 & 1700 of MORT&H fifth revision specification..
2. The Item shall be measured in Cum.
3. The rate includes tamping, vibrating, leveling and curing complete with all formwork, dewatering wherever required including all materials, labours, plants, machineries & tools, all leads and lifts, etc. complete as per specification.

**Item No. 50**

**Providing and applying Synthetic Enamel Paint on Median & Footpath Kerb with one coat of white primer of cement paint and two or more coat of synthetic enamel paint including cleaning all dust, dirt and other foreign matters with all material labour equipments with all leads and lifts etc. complete and as directed by engineer in charge.**

1. Relevant specification shall be followed as per item description and as directed by engineer in charge
2. The measurement shall be in Sqm. basis.
3. The mode of payment shall be in per Sqm. basis.
4. The rate includes all material, paints, scaffolding, cleaning all dust, dirt and other foreign matters with all material labour equipments with all leads and lifts etc. complete

**Item No. 51**

**Providing and laying controlled cement concrete M30 with vibrating, curing etc. complete excluding the cost of form work & reinforcement for RCC work for Vehicle parking Canopy etc. complete at any height as directed.**

The relevant specification for item no. 59 shall apply to this item except the grading of concrete shall be controlled concrete M-30 grades for the works as specified in the item.

**Item No. 52**

**Providing and fixing Tensile structure for car parking including Supplying, cleaning, cutting, bending, welding, fabricating, erecting structural steel in position irrespective of locations and levels as per drawing with Fabric -700 gsm PVC with PVDF coated fabric - German make Sattler, transportation, installation, Paint on steel member as per drawing but excluding foundation.**

The relevant specification for item description shall apply to this item.

The mode of payment shall be in per Sqm basis.

**Item No. 53**

**Empty boring to the required depth (measured from bottom of pile cap to founding level) by means of hydraulic piling rig through all strata like soil, sand, clay, murrum, gravel, pebble, boulder, cobble, soft rock, etc. for pile of diameter as below, supported with the help of bentonite slurry including all required plant & machineries, disposal of excavated material with all leads & lifts, mobilisation demobilisation, remobilisation if required, transportation of required plant and machineries, etc. Method of boring shall be as per IS 2911-Part 1 - Section -II.**

- 1.) **Bore hole Drilling shall be done by use of hydraulic rig using temporary casing of required depth upto cut off level of pile, using bentonite slurry**
- 2.) **Reinforcement will be paid separately.**
- 3.) **Rate shall also include drilling and socketing in rock at required depth.**
- 4.) **Length of pile shall be measured from bottom of pile cap and upto the founding level.**
- 5.) **Rate is inclusive of empty boring through overburden (i.e. temporary working platform, etc.)**  
**600 mm dia. Pile**  
**750 mm dia. Pile**

1. MORT&H fifth revision specifications as in section 1100 shall be followed in connection with this item. All relevant provisions as have been included in the respective IRC and IS specifications are also applicable.
2. Measurement shall be in running meter.
3. The rate shall include all required plant & machineries, disposal of excavated material with all leads & lifts, mobilization demobilization, remobilization if required, transportation of required plant and machineries, etc. Method of boring shall be as per IS 2911-Part 1 - Section -II.

**Item No. 54**

**Boring holes of 6.0 m depth in ordinary soil (for cast in situ piles) and getting out the soil and disposal of the surplus excavated soil as directed, following diameter of piles including double under reaming inside the bore holes for under reamed.**  
**450 mm dia. Double under reamed pile**

The relevant specification for item no. 1 shall apply to this item.

**Item No. 55**

**Providing and placing with tremie reinforced cement concrete M40 grade in bored hole using 6 mm to 20 mm machine crushed well graded stone aggregate, natural or crushed sand of approved quality, Portland slag cement mixing in batch mix plant, transport, curing, casting of pile of any dia cut off level & chipping of pile up to cut off level, disposal of chipped material with all leads & lifts, etc. complete as per execution drawing & specification & as directed by engineer In charge. Including mobilization, demobilization, remobilization, transportation of required plant and machineries if required. as directed by engineer in charge.**

**1) Excluding reinforcement, pile load test and M.S. Liners.**

1. Relevant Specifications of MORT&H fifth revision Section – 1100, 1700 & 1900 shall apply to this item.
2. The measurement shall be in Cum basis.
3. The rate includes necessary , mixing in batch mix plant, transport, curing, casting of pile minimum 1 x dia. of pile above cut off level with all leads & lifts, etc. complete as per execution drawing & specification & as directed by engineer In charge. Including mobilization, demobilization, remobilization, transportation of required plant and machineries if required.
4. The rate is Excluding reinforcement, initial pile load test, routine load test and M.S. Liners but including temporary liners.
5. The Rate is inclusive of 10% additional cement to be added over & above the quantity of cement required for design mix M-40.

**Item No. 56**

**Providing and casting in-situ Reinforced Cement Concrete M40 grade controlled cement concrete in pile cap using 6 mm to 20 mm machine crushed well graded stone aggregate, sand of approved quality, Port land slag cement complete as per specification.**

**The rate is inclusive of all materials, including necessary dewatering, mixing in batch mix plant, transport, curing, vibrating, placing in position, shuttering, formworks, deshuttering carefully, making good the damages, fixing embedment, inserts, pockets, wherever necessary, with all lead and lift with labour, tools & plants, machineries, as directed by engineer in charge.**

1. The relevant specifications given for cement concrete M40 grade as per Section -1500, 1700, 2100 & 2200 of MORT&H fifth revision specification.
2. The measurement shall be per cum basis.
3. The rate is inclusive of all materials, including necessary dewatering, mixing in fully automatic batch mix plant, transport, curing, vibrating, placing in position, shuttering, formworks, de-shuttering carefully, making good the damages, fixing embedment, inserts, pockets, wherever necessary, with all lead and lift with contractor's labour, tools & plants, machineries, as required.

**Item No. 57**

**Applying general insecticide pest control treatment to floors, cupboards etc including labour material etc. complete. Using Heptachloride 20 EC. As Per 6113\_pests Concentration Weight 0.50 percent is recommended one litre chemical emulsion dillute with 39 liter of water will give. Total dillute concentration will be 40 litre inclusive of one litre chemical emulsion application 0.5 Litre chemical /Sqm of surface is recommended as per I.S**

It shall be completed as per the instruction and as directed by engineer in charge  
 The rate shall be for a unit of one square meter

**Item No. 58**

**Providing and laying controlled cement concrete M40 for Underground tank etc. with Portland slag cement, vibrating, curing etc. complete excluding the cost of form work & reinforcement for RCC work stated below etc. complete at any height as directed. For Base slab & RCC Wall**

The relevant specification for item no. 59 shall apply to this item.

**1. Cement :**

The cement shall be Portland Slag Cement confirming to IS:269

**Item No. 59**

**Providing and laying controlled cement concrete M40 with vibrating, curing etc. complete excluding the cost of form work & reinforcement for RCC work stated below etc. complete at any height as directed. For Column, Plinth beam, Grade slab, Slab, Wall, Floor beam, Stair case, Lintel, Chajja, Mullion, Coping etc.**

**1.1 REINFORCED CEMENT CONCRETE (RCC) MIX DESIGN (M40)**

The Contractor shall get the concrete mix designed confirming to various design parameters given in these specifications and latest revision of IS:10262 for each grade of concrete mentioned above by a Government approved laboratory. The cost / charge of the MIX DESIGN work shall be borne by the Contractor.

The MIX DESIGN shall be got approved from the Structural Consultant. No volume batching shall be allowed at site. The concrete mix at site shall be DIGITAL, 2 bin (or similar type of mixture machine as approved by Engineer Incharge), auto water control (with digital weigh batch mixture machine). The proportion of cement, sand and coarse aggregates, water and admixtures if any shall be determined by weight. The Contractor shall make arrangements to weigh water by an electronic device at the site.

The Contractor shall follow the following specifications for mix design reinforced cement concrete work.

**1.1.1 Proportioning Mix:**

The mix of fine and coarse aggregate, cement and water as per the DESIGN MIX shall give the most dense concrete confirming to minimum quantity of cement paste and maximum water cement ratio for binding the materials to give required strength, Water content and the water cement ratio shall give the specified strength with the materials proposed for use in actual work carried out before the work is started, adopting the consistency suitable for the work and method of compaction that will be actually used on site subject to the water cement Ratio as Tabulated separately.

**1.1.2 Test:**

Tests shall confirm to the specifications laid down in I.S. 456 – 2000. These tests shall be got done in an approved laboratory at the cost of Contractor.

**a) Preliminary tests:**

In preliminary test, three separate tests shall be carried out on samples collected from different stacks. Each test shall be carried out with six samples of 15 cm. (About 6”) cubes and 3 of these shall be tested at 7 days and 3 at 28 days. In preliminary tests the average crushing strength attained shall be 33 percent higher than that required on work tests.

**b) Work test:**

For each of the work test, 6 samples shall be prepared from the concrete being used on the site, 3 samples being tested at 7 days and the remaining 3 samples at 28 days. Work tests shall be carried out on each of the first six days and subsequently once in three working days or for every 60 cu.m. of concrete which ever is less and also whenever the quality or grading of the materials is changed. When a relation between the strengths at 7 days and 28 days is established, only 3 samples may be prepared and tested at 7 days only. This number of controlled specimen tests may be increased if the Engineer-in-charge considers it necessary.

**1.1.3 Field Mix:**

In the work tests, bulkage of sand due to moisture, if any, should be allowed for different batches according to the moisture actually present at the time of mixing. The moisture will be taken into account in controlling the mixing water also. The proportions once fixed by preliminary tests shall not be changed so long as the materials are the same, subject only to the quantities of fine aggregate and water being adjusted to compensate for bulkage due to the moisture in sand and free water in fine aggregate at the time of use.

No change of materials shall be allowed unless fresh tests with new materials show satisfactory results.

Water and cement content per batch or concrete as determined MIX DESIGN shall be maintained constant except for suitable allowances to be made for surface moisture of the aggregates at the time of actual use. Immediately upon the receipt of the award of the contract, the Contractor shall inform the Engineer-in-charge the exact location of the sources of the acceptable materials which he proposes to use and get approved materials to be used. The

CONCRETE MIX shall be got designed in an approved laboratory by the Contractor with minimum water cement ratio to give specified strength in the preliminary tests and the proportions got approved by the Engineer-in-charge in writing. These proportions shall be used so long as the materials contains to be of the same quality and from the same source subject only to slight changes in the relative quantities of fine and coarse aggregates for the purpose of promoting workability provided the works tests require the same. If during the progress of the work, the Contractor wishes to change the materials, the proportion shall be fixed on the basis of fresh MIX DESIGN to give the required strength after the Engineer-in-charge is satisfied that the materials satisfy the specifications. No adjustment of cost shall be made for change of proportions of cement fixed in the original preliminary tests.

#### 1.1.4 Maximum Water Cement Ratio :

Sr. No.	Types of concrete	Mix. Strength	Maximum water cement ratio
1	Reinforced concrete	M-40	0.40
		M-35	0.40
		M-30	0.45
		M-25	0.50
		M-20	0.55
		M-15	0.60

1.1.5 All structural members shall be kept continuously wet for a minimum period of 14 days by ponding and covering the surfaces by jute cloth and such other means.

## 1.2 DETAILED SPECIFICATIONS FOR CONCRETE:

### 1.2.1 INGREDIENTS

#### 1. Cement:

The cement shall be ordinary Portland Cement conforming to IS:269. Under special circumstances other cements may be used with prior approval of Engineer-in-charge. Cement shall conform to M-3

#### 2. Aggregate:

Aggregates shall comply with the requirements of IS:383. Generally aggregates having a nominal size of 20 mm shall be used. Coarse and Fine aggregate shall be weighed batched separately. Sand shall conform to M-6, Grit shall conform to M-8, Graded stone aggregate of design size shall conform to M-12

#### 3. Water:

Water shall conform to M-1. Water used for mixing and curing shall be as per Clause 5.4 of IS:456-2000.

1.2.2 Minimum cement content for different grades of concrete shall be as follows :

Grade	Minimum cement content in kg.
M-10	200



M-15	290
M-20	360
M-25	380
M-30	410
M-35	425
M-40	440

1.2.3 All reinforcement shall be free from loose mill scale, loose rust, and coats of paints, oil, mud or other coatings. The Contractor shall get the reinforcement cleaned by using wire brush, rubbing with gunny bags, light acid itching etc. as required.

1.2.4 Workability of concrete shall be as per Clause 6.0 of IS:456.

**1.2.5 Durability:**

In order to provide / produce durable concrete with low permeability, it must have an adequate cement content and a low water cement ratio. By using strong dense, aggregates, sufficient low water cement ratio, ensuring thorough compaction and sufficient hydration of cement through proper curing methods, a sufficient low permeability is achieved. Therefore cement content shall be sufficient to provide adequate workability with a low water cement ratio so that concrete can be completely compacted with the means available.

The permissible limits of chlorides and sulphate in concrete shall be as per Table 1 of IS-456 latest revision.

**1.3 CONCRETE MIX PROPORTIONING**

The Concrete mix should be so proportioned that when the concrete is hardened it shall be of the required strength, durability and surface finish. For this purpose the Contractor shall establish a well equipped concrete testing laboratory at site. The results of these shall be sent to consultant for their comments / approval / suggestion for modification of Design Mix.

**1.3.1 Strength Requirement of Concrete:**

Where ordinary Portland cement conforming to IS:269 or Portland blast furnace cement conforming to IS:455 is used, the compressive strength requirements for various grades of concrete, controlled as well as ordinary shall be as given in Table-1. Where rapid hardening Portland cement is used, the 28 days compressive strength requirement specified in Table-1 shall be met at 7 days. For controlled concrete, the mix shall be so designed as to attain in preliminary tests, a strength at least 33 percent higher than that required on work tests, for concrete mix upto and including M-25 and 25 percent higher for higher strengths. Preliminary tests need not be made in case of “ordinary concrete”.

Grade of Concrete	Minimum Compressive Strength (N/Sq.mm at 7 days)	Specified Compressive strength (N/Sq.mm at 28 days)
M 20	13.5	20.0

M 25	17.0	25.0
M 30	20.0	30.0
M 35	23.5	35.0
M 40	27.0	40.0

Note: In all cases, the 28 days compressive strength specified in Table-1 shall be the criterion for acceptance or rejection of the concrete.

When the strength of a concrete mix as indicated by test, lies in between the strength for any two grades specified in Table-1 such concrete shall be classified

for all purpose as concrete belonging to the lower of the two grades between which its strength lies.

Field Test cubes shall be taken as per IS 456 required / or directed by Engineer In Charge. The same shall be tested in approved laboratory & results shall comply with required strength of mix used. The cost of taking cubes and testing shall be included in rates quoted.

#### 1.3.2 Nominal Mix Concrete:

Under special circumstances nominal mix concrete for grades of M20 or lower may be used with prior approval of Engineer-in-charge. Nominal Mix concrete shall be as per Table 9 of IS

456 latest revision.

### **Item No. 60**

**Filling in foundation and plinth with local available sand including watering, ramming, consolidating and dressing etc. complete**

#### **Materials**

**1.1.** Sand shall conform to M 6

#### **2.0. Workmanship**

The relevant specifications of item No. 4.12 shall be followed except that sand shall be filled in under floors, including watering, ramming, consolidating and dressing etc , complete.

#### **3.0. Mode of Measurements & Payment**

**3.1.** The relevant specifications of item No. 4.12 shall be followed in R & B Specification Booklet.

**3.2.** The rate includes cost of collecting, carting sand with all lead and labour for filling the same in plinth under floors.

**3.3.** The rate shall be for a unit of one cubic meter.

**Item No. 61**

**Providing and fixing 25mm thick pre moulded asphalt filler joint as directed by engineer in charge.**

1. Premoulded asphalt joint filler shall conform to IS 1838 and shall be got approved from the Engineer in Charge.
2. Premoulded asphalt joint filler shall not get deformed or broken by twisting, bending or other handling when exposed to atmospheric condition. Pieces of joint filler that have been damaged shall be rejected.
3. The measurement shall be in cum basis. Thickness of filler joint as mentioned in item description and depth of joint shall be equal to full depth of the slab.
4. The rate shall include the cost of materials, labour, equipments and other incidental charges for fixing the joints complete in all respect as per these specifications and as shown on the drawings.

**Item No. 62**

**Providing and laying 50 mm thick heavy duty cement concrete flooring in 1:1.5:3 (1 cement : 1.5 coarse sand : 3 graded stone aggregate 20 mm nominal size) including water proofing compound finishing with a floating of neat cement slurry etc complete laid in one layer on grade slab for fire truck parking.**

**1.0. Materials**

Water shall conform to M-1. Cement shall conform to M-3. Sand shall conform to M-6. Stone aggregate 20 mm. nominal size shall conform to M-12. Cement concrete of 1:1.5:3 proportion measured by volume shall conform to relevant specifications of ordinary grade 1:1.5:3 concrete.

**2.0. Workmanship**

- 2.1. The cement concrete flooring of 50 mm thick (Average) is to be laid as per the site condition. The concrete shall be mixed in a mechanical mixer at the work and included water proofing compound. Hand mixing may however be allowed for smaller quantities of work and in case of failure of machineries or as permitted by the Engineer-in-charge. It shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. However in such cases 10% more cement than otherwise required shall have to be used without any extra cost. The mechanical mixing shall be done for period of 1.1/2 to 2 minutes. The quantity of water shall be just sufficient to produce a dense concrete of required workability for the purpose, Flooring or specified thickness shall be laid in accordance with approved pattern or as directed. Finishing operation shall depending upon the temperature and atmospheric conditions. The surface shall be left for some time till moisture disappears from it. Fresh quantity of cement shall be mixed with water to form a thick slurry and spread over the surface while the concrete is still green. Use of dry cement or cement and sand mixture sprinkled on this surface to stiffen the concrete or absorb excessive moisture shall not be permitted. The cement slurry shall then be properly pressed twice by means of iron floats, once when the slurry is applied and the second time when cement setting and finished floated smooth The surface shall be marked with string or B.R.C. fabric jali to make the

surface non-slippery as and when directed. The junction of floors with wall plaster, dado or skirting shall be rounded off where so required up to 25 mm. radius. Flooring in lavatories and bath rooms shall be laid after fixing of water closet and squatting pans and floor traps which shall be plugged while laying the floors and opened after the floors are completed. Any damage done to water supply or sanitary fittings during execution of work shall be made good.

- 2.2. After the final set, the concrete shall be kept continuously wet. if required by ponding for a period of not less than 7 days from the date of placement.
- 2.3. The form work shall be provided if necessary as directed by Engineer-in-charge. Concreting shall be done as per alternate bay method with necessary cantering either by mastic or cement mortar as directed

### 3.0. **Mode of measurements & payment**

- 3.1. The rate shall include the cost of all materials and labour involved in all the operations described above.  
No deduction shall be made or extra paid for any opening up to 0.1 sq. mt. In area in the floor, nothing extra shall be paid for laying the floor at different levels in the same room or the counter yard.
- 3.2. The rate shall be for a unit of one sq. meter.

#### **Item No. 63**

**Providing and laying 50 mm thick heavy duty cement concrete flooring in 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) including water proofing compound finishing with a floating of neat cement slurry etc. . complete laid in one layer on slab.**

### 1.0. **Materials**

Water shall conform to M-1. Cement shall conform to M-3. Sand shall conform to M-6. Stone aggregate 20 mm. nominal size shall conform to M-12. Cement concrete of 1:2:4 proportion measured by volume shall conform to relevant specifications of ordinary grade 1:2:4 concrete.

### 2.0. **Workmanship**

- 2.1. The cement concrete flooring of 50 mm thick (Average) is to be laid as per the site condition. The concrete shall be mixed in a mechanical mixer at the work. Hand mixing may however be allowed for smaller quantities of work and in case of failure of machineries or as permitted by the Engineer-in-charge. It shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. However in such cases 10% more cement than otherwise required shall have to be used without any extra cost. The mechanical mixing shall be done for period of 1.1/2 to 2 minutes. The quantity of water shall be just sufficient to produce a dense concrete of required workability for the purpose, Flooring or specified thickness shall be laid in

accordance with approved pattern or as directed. Finishing operation shall depending upon the temperature and atmospheric conditions. The surface shall be left for some time till moisture disappears from it. Fresh quantity of cement shall be mixed with water to form a thick slurry and spread over the surface while the concrete is still green. Use of dry cement or cement and sand mixture sprinkled on this surface to stiffen the concrete or absorb excessive moisture shall not be permitted. The cement slurry shall then be properly pressed twice by means of iron floats, once when the slurry is applied and the second time when cement setting and finished floated smooth. The surface shall be marked with string or B.R.C. fabric jali to make the surface non-slippery as and when directed. The junction of floors with wall plaster, dado or skirting shall be rounded off where so required up to 25 mm. radius. Flooring in lavatories and bath rooms shall be laid after fixing of water closet and squatting pans and floor traps which shall be plugged while laying the floors and opened after the floors are completed. Any damage done to water supply or sanitary fittings during execution of work shall be made good.

- 2.2. After the final set, the concrete shall be kept continuously wet. if required by ponding for a period of not less than 7 days from the date of placement.
- 2.3. The form work shall be provided if necessary as directed by Engineer-in-charge. Concreting shall be done as per alternate bay method with necessary cantering either by mastic or cement mortar as directed

### **3.0. Mode of measurements & payment**

- 3.1. The rate shall include the cost of all materials and labour involved in all the operations described above.  
No deduction shall be made or extra paid for any opening up to 0.1 sq. mt. In area in the floor, nothing extra shall be paid for laying the floor at different levels in the same room or the counter yard.
- 3.2. The rate shall be for a unit of one sq. meter.

#### **Item No. 64**

**Brick work using common burnt clay building bricks having crushing strength not less than 35kg / Sq. C. M. in ramp, steps and Foundation & Plinth in cement mortar 1:5 (1 cement : 5 coarse sand) including racking out joints, curing, scaffolding required if any etc. complete, as directed.**

### **1.0. Materials**

Water shall conform to M-1. Cement shall conform to M-3. Sand shall conform to M-6. Brick shall conform to M-15. Cement mortar shall conform to M-11.

### **2.0. Workmanship**

#### **2.1. Proportion:**

- 2.1.1. The proportion of the cement mortar shall be 1:5 (1 cement: 5 fine sand) by volume.

#### **2.2. Wetting of bricks:**

- 2.2.1.** The bricks required for masonry shall be thoroughly wetted with clean water for about two hours before use or as directed. The cessation of bubbles, when the bricks are wetted with water is as indication of through wetting of bricks.

**2.3. Laying:**

- 2.3.1.** Bricks shall be laid in English bond unless directed otherwise. Half or cut bricks shall not be used except when necessary to complete to bond; closures in such case shall be cut to required size and used near the ends of walls.
- 2.3.2.** A layer of mortar shall be spread on full width for suitable length of the lower course. Each brick shall first be property 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 brick is laid and pressed against it. On completion of course, the vertical joints shall be fully filled from the top with mortar.
- 2.3.3.** The walls shall be taken up truly in plumb. All courses shall be laid 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 brick course shall be kept uniform.
- 2.3.4.** The brick shall be laid with frog up wards. A set of tools comprising of wooden straight edges, man son's spirit level, square half meter rub, and pins, string and plumb shall be kept on the site of work for frequent checking during the progress of work.
- 2.3.5.** Both the faces of walls of thickness greater than 23 cms. shall be kept in proper place. All the connected brick work shall be kept not more than one meter over the rest of the work. Where this is not possible, the work shall be raked back according to bond (and not left toothed) at an angle not steeper than 45 degrees.
- 2.3.6.** All futures, pipes, outlets of water, hold fasts of doors and windows etc. which are required to be built in wall shall be embedded in cement mortar

**2.4. Joints:**

- 2.4.1.** 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 tools daily during the progress of work, when the mortar is still green so as to provide key for plaster or pointing to done.
- 2.4.2.** The face of brick shall be cleaned the very day on which the work is laid and all mortar dropping removed.

**2.5. Curing:**

- 2.5.1.** Green work shall be protected from rain suitably. Masonry work shall be kept moist on all the faces for a period of seven days. The top of masonry work shall be kept well wetted at the close of the day.

**2.6. Preparation of foundation bed:**

- 2.6.1.** If the foundation is to be laid directly on the excavated bed, the shall be leveled, cleared of all loose materials, cleaned and wetted before stating masonry, If masonry 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 masonry 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.

- 2.6.2** No deduction shall be made from the quantity of brick work, for any extra payment made for embedding in masonry or making holes in respect of following items:
- (1) Ends of joists, beams, posts, girders, purlins, trusses, corbel, steps etc. where cross sectional area does not exceed 500 Sq.Cm.
  - (2) Openings not exceeding 1000 Sq.Cm.
  - (3) Wall plates and bed plates, bearing of slabs, chajjas and the like whose thickness does not exceed 10 Cms. and the bearing does not extend to the full thickness of wall.
  - (4) Drainage holes, and recesses for cement concrete blocks to embed hold fasts for doors, windows etc.
  - (5) Iron fixtures, pipes up to 300 mm. dia hold fasts, and doors and windows built into masonry and pipes etc. for concealed wiring.
  - (6) Forming chases of section not exceeding 350 -Sq. Cm. in masonry.
- 2.6.3.** Apertures for fire places shall not be deducted nor shall be paid for separately.
- 2.6.4.** The rate shall be for a unit of one cubic meter.

**Item No. 65**

**Providing material and labour for Brick work using common burnt clay building bricks having crushing strength not less than 35 kg./Sq.Cm. in superstructure above plinth level upto floor two level (B) Cement Mortar 1:5. (1- Cement : 5 -fine sand) in any shape and thickness including finishing, racking of joints, curing, scaffolding for all height all level etc. complete as directed by engineer-in-charge.**

**1.0. Materials**

Bricks shall conform to M-15. Cement mortar shall conform to M-11.

**2.0. Workmanship**

- 2.1.** The relevant specification of item No. 6.12 (A) shall be followed except that the masonry work shall be carried out above plinth level to floor two level i.e. for ground floor.
- 2.2.** The frames of doors, windows, cupboards etc. shall be housed into the brick work at the correct location and level as directed. The heavy steel doors, window frames etc. shall be built in with work, but for ordinary steel doors and windows required opening for frames, hold-fasts, etc., shall be in the wall and frame embedded later on in order to avoid damage to the frames.
- 2.3.** 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 coarse only. Minimum number of holes be left in brick work for supporting horizontal scaffolding poles. The contractor is responsible for providing and maintaining sufficiently strong scaffolding so as to withstand all loads likely to come upon it.



- 2.4. For the face of brick work, where plastering is to be done, joints shall be racked out to a depth not less than thickness of joints. The face of brick work shall be cleaned and mortar dropping removed on very same day that brick work is laid.

**3.0. Mode of measurements & payment**

- 3.1. The masonry work of G.F. i.e. above plinth level to floor two level shall be measured and paid under this item.
- 3.2. Brick work in parapet shall be included in the corresponding masonry item of store immediately below the floor above which the parapet is built.
- 3.3. No deduction shall be made from quantity of brick work nor any extra payment made for embedding in masonry of marking holes in respect of following item.
- (1) Ends of joints, beams, posts, girders, rafters, purlins trusses corbel, steps, etc. where cross sectional area does not exceed 500 sq.cm.
  - (2) Opening not exceed in 1000 sq.cm.
  - (3) Wall plate sand bed plates bearing of slab, chhajjas, and like whose thickness does not exceed 10 cms. and the bearing does not extend the full thickness of wall.
  - (4) Drainage holes and recesses for cement concrete blocks to embed hold fasts for doors, window etc.
  - (5) Iron fixtures, pipes up to 300 mm. dia. hold fasts of doors, and window built into masonry and pipes etc. for concealed wiring.
  - (6) Forming charges of section not exceeding 350 sq.cm. in masonry.
  - (7) Apparatuses for fire places, shall not be deducted nor shall extra labour required to make splaying of jumps, throating and making trenches over the aperture be paid for separately.
- 3.4. The rate shall be for a unit of one cubic meter.

**Item No. 66**

**Providing cement vata (10cm. X 10cm. size) quarter round in cement mortar 1:1 including neat cement finishing, watering etc. complete.**

**1.0. Materials**

- 1.1. Water shall conform to M-1 .Cement mortar shall conform to M-11.

**2.0. Workmanship**

- 2.1. The work of cement vata of 10 cms x 10 cms. size shall be earned out at Functions of parapets and terraces as directed. The vata shall be finished in quarter round shape. The work shall be earned out in the nest workman like manner. The inter portion of rain water pipe shall be rounded off properly during constructing the vata. The work shall be cured for 7 days.

**3.0. Mode of measurements and payment**

- 3.1. The work shall be measured for finished item in running meter.
- 3.2. The rate shall be for a One running meter.

**Item No. 67**

**Providing and fixing plastic moulded reinforced steps with 25 mm TOR steel bar with plastic polyproclene (P.P.) material (vergin) etc. complete.**

The relevant specification for item description shall apply to this item.

The mode of payment shall be in per No. basis.

**Item No. 68**

**Providing and fixing D.I. frame and cover for underground / O.H. water tank, rate also including loading, unloading and fixing the frame in line and complete as per instruction by Eng. in charge.**

As per manufacture specification

Item shall be measured in per No.

The rate shall be inclusive of all material, labour, machinery, Supplying, Installation, testing, commissioning, etc required to execute above item as per specification and as directed by engineer in charge.

**Item No. 69**

**Providing and laying white glazed tiles 6mm thick in O.H. water tank base & wall on 10 mm thick water proofing cement plaster 1:3 (1-cement : 3-coarse sand) and jointed with white cement slurry.**

The relevant specifications of Item No. 14.29 in R & B Specification Booklet, shall be followed

**Item No. 70**

**Supplying, cleaning, cutting, bending, welding, fabricating, erecting structural steel in position irrespective of locations and levels as per drawing including handling and transport etc. complete including applying two coats of primer red oxide and two coats of approved quality of paint over it etc. complete as directed for Steel truss, stair, channel, beams, column, hollow pipe, solid pipe, plate, gusset plates, purlinn etc. as per drawings.**

**1.0. Materials**

**1.1. Water shall conform to M-22.**

It shall be completed as per the instruction and as directed by engineer in charge

Rate shall be for a unit of one MT.

**Item No. 71**

**Providing 10mm thick cement plaster in single coat on ceiling upto floor two level and finished even and finishing with a floating coat of neat cement slurry (i) Cement mortar 1:3 (1-cement:3-sand)**

The relevant specifications of , Item no 17.58 (I) in R & B Specification Booklet, shall be followed.

**Item No. 72**

**Providing 10mm thick cement plaster in single coat on ceiling Above floor two level and finished even and finishing with a floating coat of neat cement slurry (i) Cement mortar 1:3 (1-cement:3-sand). At Third floor**

Details specification same as per Item No.71 as directed by Engineer-in-charge.

**Item No. 73**

**Providing 10mm thick cement plaster in single coat on ceiling Above floor two level and finished even and finishing with a floating coat of neat cement slurry (i) Cement mortar 1:3 (1-cement:3-sand). At Forth floor**

Details specification same as per Item No.71 as directed by Engineer-in-charge.

**Item No. 74**

**Providing 10mm thick cement plaster in single coat on ceiling Above floor two level and finished even and finishing with a floating coat of neat cement slurry (i) Cement mortar 1:3 (1-cement:3-sand). At Fifth floor**

Details specification same as per Item No.71 as directed by Engineer-in-charge.

**Item No. 75**

**Providing 15 mm thick cement plaster (1:3) with floating coat of neat cement slurry in water tank wall & Soffit of tank at all levels including scaffolding, curing, etc. complete. This rate shall include moulding where specified. The rate shall include 2% approved quality water proofing compound (by weight) of cement.**

The relevant specification for item no. 14 shall apply to this item.

**Item No. 76**

**Applying two coats of Birla(white cement based) or Asian (acryclapy putty) or equivalent & two coats of primer of approved brand and manufacture on new wall surface to give an even shade including thoroughly brushing the surface free from mortar dropping and other foreign matte rand sand papered smooth.**

The relevant specification for item no. 22 shall apply to this item.

**Item No. 77**

**Distempering (two coats) with oil bound distemper of approved brand and manufacture and or required shade on undecorated wall surface to give an even shade, over and including a priming coat with distemper primer of approved brand and manufacturer after thoroughly brushing the surface free from mortar dropping**

**and other foreign matter also including preparing the surface even and sand papered smooth.**

**a) Wall      b) Ceiling**

**1.0. Materials**

- 1.1.** Oil bound washable distemper and primer shall be of approved brand and manufacture. The distemper shall be of required colour and shade and the same shall conform to I.S. : 428-1969.

**2.0. Workmanship**

**2.1. Scaffolding**

Where scaffolding is required, it shall be erected in such a way that as far as possible no pail of scaffolding shall rest against the surface to be distempered. A properly secured and well tied suspended platform (Joola) may be used for distempering. Where ladders are used, pieces of old gunny bags shall be tied at top and bottom to prevent scratches to the walls and floors. For distempering to ceiling, proper stage scaffolding shall be erected where necessary.

**2.2. Preparation of surface :**

- 2.2.1.** The undecorated surface to be distempered shall be thoroughly brushed from dust, dirt, grease, mortar dropping and other foreign matter and sand papered smooth. New plaster surface shall be allowed to dry for at least 2 months before applications of distemper.
- 2.2.2.** All unnecessary nails shall be removed. Pitting in plaster shall be made good with plaster again with a fine grade sand paper and made smooth. A coat of distemper shall be applied over the patches. The surface shall be allowed to dry thoroughly before the regular coat of distemper is allowed. The surface affected by moulds, moss, fungi, algae lichens, efflorescence etc. shall be treated in accordance with I.S; 2395 (Part 01) 1966. Before applying distempering, any unevenness shall be made good by applying putty made of plaster of paris mixed with water on entire surface including filling up the undulation and then sand papering the same after it is dry.

**2.3. Priming coat :**

- 2.3.1.** A priming coat of distemper primer of approved manufacture and shade shall be applied over the papered surface in case of new work on undecorated surface. If the distemper priming is done after the wall surface dries completely, the distemper primer shall be applied.
- 2.3.2.** Application of primer shall be done as under: The primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for at least 48 hours before oil bound distemper or paint is applied.
- 2.3.3.** Oil bound distemper is not recommended to be applied within six months of the completion of wall plaster.

**2.4. Preparation of oil bound distemper:**

- 2.4.1.** The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer only. Sufficient quantity of distemper required for a days work shall be prepared.

**2.5. Application of Distemper coat:**

- 2.5.1.** For undecorated surfaces, after the primer coat is dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out priming coat. All loose particles shall be dusted off after rubbing. Minimum two coats of distemper shall be applied with brushes in horizontal strokes followed immediately by vertical strokes which together shall constitute one coat. The subsequent coats shall be applied after a time interval of at least 24 hours between consecutive coats to permit proper drying of the proceeding coat. The finished surface shall be even and uniform without patches, brush marks, distemper drops etc.
- 2.5.2.** Sufficient quantity of distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be started in any room which cannot be completed on the same day.
- 2.5.3.** 15 cm. double bristled distemper brush shall be used. After day's work brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

- 2.6.** Protective measurements: The surfaces of doors, windows, floors, articles of furniture etc. and such other parts of the buildings as are not to be distempered shall be protected from being splashed upon. Such surfaces shall be cleaned of distemper splashes if any.

**3.0. Mode of measurements and payment**

- 3.1.** Priming coat of distemper primer, scraping of surface spoiled by struck roots, removal of oil and grease spots, treatment for infestation of efflorescences, mould moss, fungi, algae and lichen and patch repairs to plaster shall be included in this item for which nothing extra shall be paid.
- 3.2.** All the work shall be measured net in the decimal system as in place subject to the following limits unless otherwise stated hereinafter:
- (a) Dimensions shall be measured to the nearest 0.01 m.
  - (b) Area in individual items shall be worked out to the nearest 0.01 sq. m. All work shall be made for ends of joints, beams, posts etc., and openings, not exceeding 0.5 sq.mt. each and no addition shall be made for reveals, jambs, soffits, sills etc. of these openings not for finish around ends of joints, beams, posts etc.
- 3.3.** Deductions of opening exceeding 0.5 sq.m. but not exceeding 3 sq. m. each shall be made as follows and net addition shall be made for reveals, jambs, soffits etc. of these openings:
- (a) When both the faces of wall are provided with same finish, deductions shall be made for one face only.
  - (b) When each face of wall is provided with different finish, deduction shall be made for that side of frame for doors, windows etc. on which width of reveals is less than that of the other side but no deduction shall be made on the other side. Where the width of reveals on the both the faces of wall are equal, deduction of 50% of area of opening on each face shall be made from area of finish.

- (c) When only one face of wall is treated and the other face is not treated, full deductions shall be made if the width of the reveal on treated side is less than that on untreated side but if the width of the reveal is equal or more than that on untreated side neither deductions nor additions to be made for reveals, jambs, soffits, sills etc.
- 3.4. In case of opening of area exceeding 3 sq. m. each deduction shall be made for openings but jambs, sills and soffits shall be measured.
  - 3.5. No deductions shall be made for attachments such as casings, conduits, pipes, electric wiring and the like.
  - 3.6. Item includes removing nails, making good holes, patches with materials similar in composition of distemper.
  - 3.7. The rate includes cost of all materials, labours, scaffolding, protective measures etc. involved in all the operations described above. This shall also include conveyance, delivery, handling, unloading, storing work etc
  - 3.8. The rate shall be for a unit of one sq. meter

#### **Item No. 78**

**Providing and laying 24" x 24" vitrified 8 mm thick tile flooring over 20 mm (average) base of cement mortar 1:6 ( 1 cement: 6 coarse sand) on new surface or fixing on existing flooring by adhesive material including dismantling of existing flooring and jointed with colour cement slurry including finished with flush pointing & cleaning the surface etc. complete for light shade**

#### **1.0. Materials**

Water shall conform to M-1 Cement mortar shall conform to M-11 White glazed tiles shall conform to M-55

#### **2.0. Workmanship**

##### **2.1. Bedding:**

- 2.1.1. The sub grade shall be cleaned, wetted and mopped. The bedding shall then be laid evenly over the surface tamped and corrected to desired level and allowed to harden enough to offer a rigid cushion to tiles and to enable the monsoon to place wooden planks across and squat on it.
- 2.1.2. The white glazed tiles shall be laid on cement mortar bedding of 20 mm. thick in C.M. 1:6. The mortar shall have sufficient plasticity for laying and there shall be no hard lumps that would interfere with the evenness of bedding. The base shall be cleared and well wetted. The mortar shall then be spread in thickness not less than 10 mm. at any place and average 12 mm. thickness. The proportion of the cement mortar shall be as specified in the item.

##### **2.2. Fixing tiles :**

- 2.2.1. The tiles before laying shall be soaked in water for at least two hours. Neat gray cement grout at 33 kg/Cement/Sq. mt. of honey like consistency shall be spread over the mortar bedding as directed. The edges of the tiles shall be smeared with neat cement slurry. The tiles shall be well pressed and gently tapped with a wooden mallet till they are properly

bedded and in level with the adjoining tiles. There shall be. no hollows in bed or joints. The joints between the tiles shall be as thin as possible in straight line or as per pattern.

- 2.2.2.** The tiles shall not have staggered joints. The joints shall be true to centre line both ways. The Nahni trap coming in the flooring shall be so positioned that its grating shall replace only one tile as far as possible. Where full size tiles cannot be fixed they shall be cut (Swan) to the required size and the edges rubbed smooth to ensure straight and true joints. The joints shall be filled with grey cement grout with wire brush or trowel to a depth of 5 mm. and loose material removed. White cement shall be used for pointing the joints. After fixing the tiles finally in an even plane the flooring shall be kept wet and allowed to nature undisturbed for 7 days.

**2.3. Cleaning:**

- 2.3.1.** The surplus cement grout that may have come out of the joints shall be cleaned off before it sets. Once the floor has set, it shall be carefully washed, cleared by dilute acid and dried. Proper precautions and measures shall be taken to ensure that the tiles are not damaged in any way till the completion of the .construction.

**3.0. Mode of measurements & payment**

- 3.1.** The work done shall be measured in sq. mt. for visible area of work done. The length and width of the flooring shall be measured not between the faces of skirting or dedos or plastered face of wall as the case may be. The paving under dedo or skirting shall not be measured. No deduction shall be made not extra paid for any opening in the floor of area-up to 0.1 sq.mt. Nothing extra shall be paid for laying the floors at different levels in the same rooms.
- 3.2.** The rate shall be for a unit of one sq. meter.

**Item No. 79**

**Providing and laying Vitrified tiles 8 to 10mm thick, 24"x24" in dedo on 10mm thick cement plaster 1:3 (1-cement:3-coarsesand) and jointed with white cement slurry**

Details specification based on Item no 14.44 in R & B Specification Booklet, shall be followed

**Item No. 80**

**Providing and laying Vitrified tiles 8to10mm thick, 24"x24" in skirting on 10mm thick cement plaster 1:3 (1-cement: 3-coarse sand) and jointed with white cement slurry**

Details specification based on Item no 14.44 in R & B Specification Booklet, shall be followed



**Item No. 81**

**Providing and laying polished Kota stone slab flooring over 20 mm (average) thick base of cement mortar 1:6 (1 cement : 6 coarse sand) laid over and jointed with grey cement slurry including rubbing and polishing etc. 30 mm thick**

**1.0. Materials**

- 1.1.** Water shall conform to M-1. Lime mortar shall conform to M-10. Cement mortar shall conform to M-11 Polished kota stone shall conform to M-49,

**2.0. Workmanship**

- 2.1.** Each slab shall be cut to the required size and shape and fine chisel dressed at all the edges. The sides must be dressed shall have a full contract if a straight edge is laid along. The sides shall be table rubbed with coarse sand before paving. All angles and edges of the slabs shall be true square and free from chippings and giving a plane surface. The thickness shall be 30 mm. (Average) as specified in the item.
- 2.2.** Bedding for the Kota stone slabs shall be of cement mortar 1:6 (1 cement : 6 coarse sand) or L.M. 1:1.5 of average thickness 20 mm given in the description of the item. Sub grade shall be cleaned, wetted and mopped Mortar of the specified mix and thickness shall then be spread on an area sufficient to receive one kota stone slab. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped gently to bring it in level with the other slabs. It shall then be lifted and laid aside. Top surface of the mortar shall then be corrected by adding fresh mortar at hollows or depressions. The mortar shall then be allowed to harden bit. Over this surface, cement slurry of honey-like consistency shall be applied. The slab shall then be gently placed in position and tapped with wooden mallet till it is properly padded in level with and close to the adjoining slab. The joint shall be as fine as possible. The slabs fixed in the floor adjoining, the walls shall enter not less than 10 mm. under the plaster, skirting or dado. The junction between the wall and floor shall be finished neatly. The finished surface shall be true to levels and slopes as directed
- 2.3.** The floor shall be kept wet for a minimum period of 7 days so that bedding and joints set properly
- 2.4.** Polishing shall be normally commenced after 14 days of laying the stone slab. First polishing shall be done with carborundum stones of 120 grade grit fitted in the heavy machine and then second polishing shall be done with carborundum stone of 220 to 350 grade grit fitted in heavy machine. Water shall be properly used during polishing. The stone shall then be washed clean with water When directed by the Engineer-in-charge, wax polish of approved quality shall be applied on the surface with the help of soft cloth over a clean and dry surface. Then the polishing machine fitted with bobs shall be run over it.
- 2.5.** The holes required for Nahni traps, pipes and any other fittings shall be made, without any extra cost.

**3.0. Measurement & payment**

- 3.1.** The rate shall include the cost of all materials and labour involved in all the operations described above. The kota stone flooring shall be measured in square meters correct to two places decimal, length and breadth shall be measured correct to a centimeter and between

- the finished face of skirting dedo plaster and no deduction shall be made nor extra paid for any opening in floor of areas up to 0.1 sqm
- 3.2. The rate shall be for a unit of one sq. meter

**Item No. 82**

**Providing and laying marble stone slab flooring over 20mm (average) base of cement mortar 1:6 (1-cement:6 coarse sand) or L.M. 1:1.5 (1-lime putty:1.5-coarse sand) laid and jointed with gray cement slurry including rubbing and polishing complete.(A) Marble slab 25mm thick for flooring**

**1.0. Materials**

Water shall conform to M-1. Lime mortar shall conform to M-10. Cement mortar shall conform to M-1). Marble stone slab 25 mm. thick shall conform to M-51.

**2.0. Workmanship**

**2.1. Dressing of slabs :**

Every stone shall be cut to required size and fine chisel dressed to give a smooth and even surface on all sides to full depth. A straight edge laid along the sides of the stone shall be fully in contact with it Chisel dressing shall also be done on top surface to remove any waviness. The sides and top surface of marble slabs shall be machine rubbed or table rubbed with coarse sand before using. All angles and edges of slabs shall be true, square and free from chipping.

- 2.2 The thickness of stone shall be 25 mm. The allowable tolerance shall be 2 mm. allowable. The 'tolerance shall + 5 mm. in length and breadth.

**2.3. Bedding:**

Bedding of marble slabs shall either be lime mortar 1:1.5 (1 lime putty : 1.5 coarse sand) or cement mortar 1:6 (1 cement : 6 coarse sand) of average thickness 20 mm. thick as given in description of item. Minimum thickness at any place shall not be less than 10 mm.

**2.4. Laying**

The surface of sub-grade shall be cleared, wetted and mopped. Mortar of specified mix and thickness shall then be spread on an area sufficient to receive one marble slab. The slab be washed clean before laying. It is laid on top pressed and tapped gently to bring it in level with other slabs. It shall then be lifted and a side. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows, or depressions. The mortar shall then be allowed to harden it over this surface cement slurry or honey like consistency at 4.4 Kg. of cement per sq. meter. The edges of slabs already paved shall be buttered with gray cement. The slab shall then be gently placed in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slab. The joints shall be as fine as possible. Surplus cement on the surface of the slab shall be removed. The slab fixed in the floor adjoining the walls shall enter not less than 10 mm. under the plaster skirting or dedo. The junction between the walls and floors shall be finished neatly. The finished surface shall be true to level and slopes as directed.

**2.5. Curing:** The floor shall be cured for a minimum period of seven days.

**2.6. Polishing and finishing:**

Unevenness at the meeting edges of slab shall be removed by fine chiseling. Finishing etc. shall be done as per relevant specifications of item No. 14.21 (A) or terrazzo tiles flooring except that cement slurry with/or without pigments shall not be applied on the surface before each polishing.

**3.0. Mode of measurements and payment**

**3.1.** Marbles stone flooring with various kinds of marble shall be measured in sq. meter. The length and breadth shall be measured between-the finished face of skirting or dado or wall plaster. No deduction shall be made nor extra shall be paid for any opening in the floor or area up to 0.05 sq. mt. Nothing extra shall be paid for laying stone at different levels in the same room. Treads and steps of stairs paved with marble stone slabs shall be also be measured under flooring.

**3.2.** The rate shall be for a unit of one sq. meter.

**Item No. 83**

**Providing and laying marble stone slab flooring over 20mm (average) base of cement mortar 1:6 (1-cement:6 coarse sand) or L.M. 1:1.5 (1-lime putty:1.5-coarse sand) laid and jointed with gray cement slurry including rubbing and polishing complete.(A) Marble slab 25mm thick for Skirting**

The relevant specification for item no. 82 shall apply to this item.

**Item No. 84**

**Providing and laying polished Kota stone slab 25 mm thick in riser of steps, dado & pillars, skirting, laid on 10 mm thick cement mortar 1:3 (1 cement : 3 coarse sand) and jointed with grey cement slurry including rubbing and polishing etc. complete.**

The relevant specifications of item no. 81 shall be followed except that the thickness of stone shall be 25 mm.

**Item No. 85**

**Design supply & installation of suspended Spider Glazing system designed to withstand the wind pressure as per IS 875 (Part-III). The Suspended System held with Spider Fittings of SS-316 Grade Steel of approved manufacturer with glass panel having 12 mm thick clear toughened glass held together with SS- 316 Grade Stainless steel Spider & bolt assembly with laminated glass fins 21 mm thick. The Glass fins and glass panel assembly shall be connected to Slab/beams by means of SS- 316 Grade stainless steel brackets & Anchor bolts and at the bottom using SS channel of 50x25x2 mm using fastener & anchor bolts, non staining weather sealants of approved make, Teflon/ nylon bushes and separators to prevent bi-metallic contacts, all complete to perform as per specification and approved drawings. The complete system to be designed to accommodate thermal expansion & seismic movements etc. The joints**

between glass panels (6 to 8 mm) and gaps at the perimeter & in U channel of the assembly to be filled with non staining weather sealant, so as to make the entire system fully water proof & dust proof.

The rate shall include all design, Engineering and shop drawing including approval from structural designer, labour, T&P, scaffolding, other incidental charges including wastage, enabling temporary services all fitting fixers nut bolts, washer, Buffer plates, fastener, anchors, SS channel laminated glass etc. all complete. For the purpose of payment, actual elevation area of Glazing including thickness of joints and the portion of Glass panel inside the SS channel shall be measured.

Details specification as item Item Specification and as per engineer in charge and architecture suggestion and drawing.

#### **Item No. 86**

**Providing and fixing flush door shutters, solid core construction with frame of first class hardwood with cross board and face veneer or plywood face panels, including anodised aluminum butt hinges with necessary screws. (B) Non-decorative type and block board core anodised aluminum butt hinges in flush door shutters (2) 35 mm thick.**

#### **1.0 Materials**

Flush door shall conform to M-30. Plywood shall conform to M-37. Anodised aluminum butt hinges shall conform to M- 43.

#### **2.0 Workmanship**

The relevant specifications of item No. 10.23 shall be followed except that the shutters be non-decorative type and block board core with face veneer or plywood with 35 mm. thickness.

The relevant specifications of item No. 10.23 shall be followed except that the shutters be non-decorative type and block board core with face veneer or plywood with 35 mm. thickness.

#### **Mode of measurement and payment**

The relevant specifications of item No. 10.12 (A) (I) in R & B Specification Booklet , shall be followed.

The rate shall be for a unit of one sq. meter

#### **Item No. 87**

**Providing and fixing 35mm thick shutters for Doors, windows and clear story windows including blackenamelled M.S. butt hinges with necessary screws.(A) Indian teak wood. (i) Fully Panelled.**

Details specification same as per Item No.86 as directed by Engineer-in-charge.

**Item No. 88****Providing and fixing pvc paneled aluminum shutter with aluminum frame door.**

It shall be completed as per the instruction and as directed by engineer in charge

The rate shall be for a unit of per Square meter.

**Item No. 89**

**Providing and fixing window having extruded aluminum Colour anodized section frame main outer size 95mm x 24mm x 1.17 mm (of Jindal Section no : 2459 @ wt. of 0.738 Kg/mt), horizontal Three track member size 92mm x 31.75 mm x 1.30 mm (of Jindal Section no. 8688, @ Wt. 1.07 Kg/mt), vertical member of size 92mm x 31.75mm x 1.50 mm (of Jindal Section no. 8933, @ Wt. 1.06 Kg/mt.) with sliding shutters of horizontal member size 40mm x 18mm x .29 mm (of Jindal section no. 8947 @ wt. 0.456 Kg/mt.) vertical member of size 40mm x 18mm x 1.29mm (of Jindal Section no. 8949 @ wt. of 0.456 Kg/mt with 5 mm thick transparent bronze colour tinted float glass with powder coated aluminum fittings and fixtures and transparent silicon sealant glass fixing to frame as per details etc.**

**1.0 Materials:**

- 1 Aluminum alloy used in the manufacture of extruded sections for the fabrication of doors, windows, ventilators shall conform to designation HE9-WP of IS:733.
- 2 Transparent sheet glass shall conform to the requirements of IS:2835. Wired and figured glass shall be as per IS:5437.
- 3 Builder's hardware of fittings & fixtures shall be of the best quality from approved manufacturers.

**2.0 Workmanship:**

- 1 All aluminum doors, windows, ventilators and partitions shall be of the type and size as specified. The doors, windows, ventilators shall conform to the requirements of IS:1948. Aluminium windows shall conform to IS:1949, if so specified.
- 2 All aluminum units shall be supplied with anodized finish. The minimum anodic film thickness shall be 0.015 mm. Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the units shall be with the extruded sections, cut to correct lengths, metered and welded at the corners to a true right angle conforming to the requirements of IS:1948. Tolerance in overall dimensions shall be within  $\pm 1.5$ mm. The frames and shutters shall be free from warp or buckle and shall be square and truly plane. Punching of holes, slots and other provisions to install fittings or fixtures later shall be made at the correct locations, as per the requirements. Aluminum swing type doors, aluminum sliding windows, partitions shall be as specified.
- 3 IS:1948 and IS:1949 referred to incorporates the sizes, shapes, thicknesses and weight per running meter of extruded sections for the various components of the units. However, new sizes, shapes, thicknesses with modifications to suit snap-fit glazing clips etc. are being continuously being added by various leading manufacturers of extruded sections, which are available in the market. As such, the sections of the various components of the unit proposed

- by the Contractor will be reviewed by the Engineer in charge and will be accepted only if they are equal to or marginally more than that given in the codes/as specified.
- 4 The framework of the partitions with mullions and transom shall be with anodized aluminum box sections. Anodized aluminum box sections shall be in-filled with timber of class 3 (silver oak or any other equivalent) as per IS:4021. Panels of double/single glazing/plywood shall be fixed as per details indicated in the Drawings to be prepared by the Contractor. Partitions shall be fixed rigidly between the floor and the structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction Drawings to be prepared by the Contractor.
  - 5 Specific provisions as stipulated for steel doors, windows, ventilators under clause 7.9.2 shall also be applicable for this item work. Glazing beads shall be of the snap-fit type suitable for the thickness of glazing proposed as indicated in the items of works prepared by the Contractor. A layer of clear transparent lacquer shall be applied on aluminum sections to protect them from damage during installation. This lacquer coating shall be removed after the installation is completed.

#### **Item No. 90**

**Providing and fixing M.S. round or square bars with M.S. flats at required spacing in frames of windows and clerestory windows.**

##### **1.0 Materials**

M.S. bars and flats shall conform M-18 and M-22 respectively.

##### **2.0 Workmanship**

The M.S. bars shall be fabricated as shown in the drawing or as directed. It shall conform to I.S. 226-(latest Revision) and I.S. 96 and I.S. 1977 (latest Revision). The M.S. bars shall be fixed at the required spacing in mild steel flats, after drilling holes in the latter. The diameter and spacing of these bars shall be as mentioned in the drawing or as directed. The bars shall be passed through drill holes drilled into the mild steel flats, fixed in the recess in frames. The flats shall be fixed with iron screws.

#### **Mode of measurements & payment**

The rate shall be for the M.S. round or square bars with M.S. flats provided and fixed in position as per the specifications for the completed item.

The rate shall be for a unit of one Kg

#### **Item No. 91**

**Providing and fixing standard extruded of aluminum section of size 63mm x 38.10mm x 1.2mm (Jindal Section : 2434, @ Wt. 0.643 Kg/mt.) with color powder coated aluminum frame for ventilation with 5 mm thick frosted glass as details etc. complete for Ventilation**

Details specification same as per Item No.86 as directed by Engineer-in-charge and as per item description.

**Item No. 92**

**Providing and fixing 20 mm thick Granite gang saw cut, mirror polished, premoulded and prepolished, machine cut for wall cladding, platforms, vanity counters, window sills, facades, in linear as well as curvilinear surfaces and similar locations of required size, approved shade, colour and texture laid over 20 mm thick base cement mortar 1:4 (1 cement : 4 coarse sand), joints treated with epoxy matching pigment, epoxy touch ups, including rubbing, curing, molding and polishing to edges to give high gloss finish etc. complete at all levels. Including fixing granite stone, over and above corresponding basic item, in facia, wall cladding, Skirting and drops with chemical adhesive, including cleaning etc. complete. For all wall Cladding and Copping work also as per drawing including all colour and texture. (Brand for Adhesive: MYK Laticrete, Weber, Kerakoll)**

Specification for this item shall conform to item no. 14.44, of General Technical Specifications for building work. Except that the whole work is to be carried out by fixing polished granite stone 18mm thick For Door sill & jams in Single Piece only instead of polished kota stone dado. Rate including half round molding of edges as directed by engineer in charge Rate shall be for a unit of one Square meter.

**Item No. 93**

**water proofing on Terrace:**

**Providing and applying 1.5 mm thick SBS based self-adhesive waterproofing membrane SuperTene of STP Limited topped with hdpe cross laminated film with the following technical properties: Compound Elongation (ASTM D-638) > 200 %; Puncture Resistance 260 N as per ASTM E 154, Moisture Vapour Transmission (ASTM E-96) < 0.3 gm/m<sup>2</sup>/hr; including cleaning the surface, priming the surface with cold applied bituminous primer ShaliTex Primer @ 0.15-0.3 kg/sqm, properly sealing the joints & maintaining 75 mm overlap over longitudinal selva & 100 mm overlap on the transverse joints of the membrane over the slab.**

It shall be completed as per the instruction and as directed by engineer in charge

The rate shall be for a unit of per Square meter

**Item No. 94**

**P & L 24" x 24" vitrified 8 mm thick tile flooring over 20 mm (average) base of cement mortar 1:6 ( 1 cement: 6 coarse sand) on new surface or fixing on existing flooring by adhesive material including dismantling of existing flooring and jointed with color cement slurry including finished with flush pointing & cleaning the surface etc. complete for antiskit– Terrace**

Providing and laying vitrified tiles at all floors levels laid on a bed of 20 mm thick CM 1:6



( 1 Cement : 6 coarse sand) finished with flush pointing in white cement.

The item provides for flooring of vitrified tiles of approved standard brand and of color.

Vitrified tiles shall be of general purpose type and shall conform to relevant I.S in respect of constituent materials, shape, dimension, tolerance, wearing layer, color, general, appearance, general quality of tiles, strength, and resistance to wear, water absorption and tests etc. The size of a tile shall be 600mm x 600mm and shall be as approved by the Executive Engineer.

If there is any doubt about the quality of tiles, they shall be tested and the cost of the test shall be borne by the contractor, samples of the tiles shall be got approved by the Executive Engineer who shall keep them in office for reference. The supply shall conform to the sample

Cement mortar for the bedding shall be of the proportion 1:6. The bedding shall conform to I.S 1443 and work shall be carried out as per the direction of the engineer-in-charge. The joints of the tiles after laying them shall be filed with color cement slurry. Cleaning of the whole floor shall be done according to the provision in relevant. I.S flooring shall be kept wet as directed by the Engineer.

The item includes-

1. Cleaning the base and laying the bedding mortar of average thickness of 20 mm in cm 1: 3 and levelling it in level or required slope.
2. P/F the tiles in neat cement float on the bedding mortar.
3. Filling the joints of tiles with color cement slurry as directed.

Mode of Measurements & Payment:-All labour, materials and tools required for carrying out item in a satisfactory manner. The payment shall be made per sq. mt of the floor area covered by the flooring of the tiles. All work shall be measured net. The length and width of flooring shall be measured net between the faces of skirting or plastered faces of the walls as the case may be. Paving under the dado, skirting or plaster shall not be measured and shall not be paid.

#### **Item No. 95**

**Providing composite water proofing treatment to floor and walls of water tank, w.c.bath area, through approved agencies preparing floor and wall for water proofing work by chasing/cutting as per the companies requirement. First by providing and applying cementitious crystalline based waterproofing for concrete rafts, walls, water tanks, slabs, concrete floors etc. with Krystol T2 or equivalent system. Cementitious based dry Krystol T2 Crystalline powder capable of creating Crystals to seal the pores, intercrises and micro cracks in the concrete. The application to be done from positive side on a wet open pore concrete surface with brush @ to 1 kg/ sqm as per mfg.'s specification. After testing with ponding after 7 days, a layer of plaster with**

**waterproofing compound/ admixture about 25 mm thick in the floor / depression and about 18 mm on the sidewalls / depression upto the floor level shall be provided over the surface treated with crystalline powder. The waterproof plaster about 18 mm thick to be continued on the walls above the floor level for a height of 600 mm with surface suitable to receive further finishing treatment all complete as per companies specifications and instructions and as directed for all heights and floors. The round vata shall be included in this in sq.mt. and shall be taken upto top of round on wall It shall be completed as per the instruction and as directed by engineer in charge**

Mode of measurement & payment

The rate shall be for a unit of one square meter.

**Item No. 96**

**Providing & fixing Locks Godrej Mortice lock cover (with 3 sets of key) with all required tools and tackles, gaskets, screws in line and level at the height mentioned in the drawing, cutting and core the doors in exact dimensions, without damaging the shutter or frames up to the satisfaction of engineer in charge with Standard warranty of 1 year**

Mode of measurement & payment

The rate shall be for a unit of one nos.

**Item No. 97**

**Providing & fixing S.S. Pipe Handle of 30 Cm size of ASIS 316 Grade with all required tools and tackles, gaskets, screws in line and level at the height mentioned in the drawing up to the satisfaction of engineer in charge. (Brands KICH, OZONE AND ENOX)**

Mode of measurement & payment

The rate shall be for a unit of one nos.

**Item No. 98**

**Providing and fixing aluminium extruded section body tubular type universal hydraulic door closer (having brand logo with ISi, IS : 3564, embossed on the body, door weight upto 36 kg to 80 kg and door width from 701 mm to 1000 mm), with double speed adjustment with necessary accessories and screws etc. complete. (Brand Ozone, Kich, Enox)**

Mode of measurement & payment

The rate shall be for a unit of one nos.

**Item No. 99**

**Waterproofing over PCC for Horizontal Area (External) below Raft slab of Watertank:**

**Supplying and installing 1.2 mm thick HDPE membrane ShaliHDPE SA of STP Limited (sand finish or self adhesive type), having puncture resistance of 1000N as per ASTM E 154, Tensile strength of min 23 MPa as per ASTM D412, Elongation of 700% as per ASTM D 412, Resistance to hydrostatic head > 60M as per ASTM D 5385, Peel adhesion to concrete 900 N/m as per ASTM D 1000 and water absorption <0.30% as per ASTM D-570 and suitable for the requirements of UG waterproofing of structures, as per manufacturer's recommendation, including surface preparation.**

It shall be completed as per the instruction and as directed by engineer in charge

The rate shall be for a unit of per Square meter.

#### **Item No. 100**

##### **Waterproofing over Vertical Area (External) Walls of UG Watertank**

**Providing and applying 1.5 mm thick SBS based self-adhesive waterproofing membrane SuperTene of STP Limited topped with hdpe cross laminated film with the following technical properties: Compound Elongation (ASTM D-638) > 200 %; Puncture Resistance 260 N as per ASTM E 154, Moisture Vapour Transmission (ASTM E-96) < 0.3 gm/m<sup>2</sup>/hr; including cleaning the surface, priming the surface with cold applied bituminous primer ShaliTex Primer @ 0.15-0.3 kg/sqm, properly sealing the joints & maintaining 75 mm overlap over longitudinal selvage & 100 mm overlap on the transverse joints of the membrane over the slab.**

It shall be completed as per the instruction and as directed by engineer in charge

The rate shall be for a unit of per Square meter.

#### **Item No. 101**

##### **Protection of Membrane on Vertical Areas before backfill:**

**Installation of protection cum drain board on the retaining wall to avoid mechanical damage or puncture during back filling by ShaliDrain Board, a 500 microns HDPE dimple board having 8 mm height with dimple side facing the soil over the membrane on the entire retaining wall for protection and easy drainage of sub-soil water during top-down percolation or bottom-up rise.**

It shall be completed as per the instruction and as directed by engineer in charge

The rate shall be for a unit of per Square meter

#### **Item No. 102**

**Preparing of angle fillets all around the periphery of the wall with polymer modified mortar with ShaliSBR Latex also applied as a bonding coat.**

It shall be completed as per the instruction and as directed by engineer in charge

The rate shall be for a unit of per Square meter

**Item No. 103**

**Providing and fixing water tight construction or expansion joints. 180 mm dia dum belled type as shown in drawing.**

It shall be completed as per the instruction and as directed by engineer in charge

The rate shall be for a unit of per Running meter

**Item No. 104**

**Providing throating or plaster drip and moulding to R.C.C. Chhajja.**

**1.0. Materials**

Water shall conform to M-1. Cement shall conform to M-3. Sand shall conform to M-6  
Cement mortar shall conform to M-11

**2.0. Workmanship**

- 2.1.** The work shall be carried out as directed. The proportion of mix for finishing shall be in C.M. 1:2 by volume. Curing shall be done for not less than 7 days. The work shall be carried out in best workman like manner. The throating or plaster drip and moulding shall be one centimeter in thickness.

**Item No. 105**

**Dismantling of flexible pavements (Bituminous surface and Crust) and disposal of dismantled materials with all lead and lift, stacking serviceable and unserviceable materials separately as directed by engineer in charge.**

1. Relevant Specifications of MORT&H fifth revision Section – 202 except 202.6 (i) (iii) (iv) (v) & (vi) shall apply to this item.
2. The Item shall be measured in Cum.
3. The contract unit rates for the various items of dismantling shall be paid in full for carrying out the required operations including full compensation for all labour, material, tools, equipment, safeguards and incidentals necessary to complete the work. The rate will include excavation and value disposing of dismantled materials with all lifts and leads.

**Item No. 106**

**Dismantling of the existing structure including removing and stacking the dismantled materials as and where directed (b) R.C.C Work**

1. Relevant Specifications of MORT&H fifth revision Section – 202 except 202.6 (i) (iii) (iv) (v) & (vi) shall apply to this item.
2. The Item shall be measured in Cum.
3. The contract unit rates for the various items of dismantling shall be paid in full for carrying out the required operations including full compensation for all labour, material, tools,

equipment, safeguards and incidentals necessary to complete the work. The rate will include excavation and value disposing of dismantled materials with all lifts and leads.

**Item No. 107**

**Providing and supplying ISI Standard R.C.C. pipes (of SRC Pipe) in standard lengths of following class and diameter suitable for rubber ring joints including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete. (IS - 458/ 1989) RCC NP3 300dia Pipe & RCC NP3 450dia Pipe**

Refer Specification for Plumbing work.

**Item No. 108**

**Lowering, laying and jointing R. C. C. pipes of following diameters in proper position, grade and alignment at all level as directed by Engineer-in-charge including conveyance from stores to site of work, labour, giving hydraulic testing as per ISI code. 450dia Pipe**

Refer Specification for Plumbing work.

**Item No. 109**

**Providing bedding incl. ramming, watering, levelling consolidating etc. complete as per standard and instruction of engineer in charge as above with required quality sand brought from outside including all lead.**

Refer Specification for Plumbing work.

**Item No. 110**

**Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20 cm. in depth consolidation each deposited layer by ramming and watering as directed by engineer in charge.**

**1.0. Workmanship**

- 1.1.** The earth to be used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken.
- 1.2.** 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 etc., and filled with earth in layers not exceeding 20 cms. Each layer 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 but ends of crow-bars, where rammer cannot be used.
- 1.3.** The plinth shall be similarly filled with earth in layers not exceeding 20 cms. adequately watered and consolidated by ramming with iron or wooden rammers. When filling reaches

finished level the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.

- 1.4. The finished level of filling shall be kept to shape intended to be given to floor.
- 1.5. In case off large heavy duty flooring like factory flooring, the consolidation may be done by power rollers, where so specified. The extent of consolidation required, shall also be as specified.
- 1.6. The excavated stuff of the selected type shall be allowed to be used in filling the trenches and plinth. Under no circumstances black cotton soil be used for filling the plinth.
- 2.0. **Mode of Measurements & Payment**
- 2.1. The payment shall be made for filling in plinth and trenches. No deduction shall be made for shrinkage or voids, if consolidated as instructed above.
- 2.2. The rate shall be for a unit of one cubic meter.

**Item No. 111**

**Constructing curb inlet with catch basin of size 0.75 x 0.75 m depth upto 1.0 m including excavation, refilling, 23 cms thick in RCC M20, including perforated precast concrete heavy duty type frame & cover in M20 Grade, plastic moulded reinforced steps with 10 mm TOR steel bar with plastic polyproclene (P.P.) material etc. complete.**

- 1.0 **Materials :**  
Water shall conform to M-1. Cement shall conform to M-3. Sand shall confirm to M-6. Brick shall conform to M-15, Stone aggregate shall conform to M-12.
- 2.0. **Workmanship**
- 2.1. The catch basin shall be of size 750 mm. x 750 mm. internal clear dimensions between the masonry wall faces. The height of 1000 mm. shall be measured from the top of the bed concrete to the top of the frame.
- 2.2. The rate includes necessary required materails, mixing, transport, plaster, curing, etc. complete as per execution drawing & specification & as directed by engineer In charge.

The measurement shall be in No. basis.

**Item No. 112**

**Making connection of drain or sewer line with existing manhole including breaking into and making good the walls, floors with cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) cement plastered on both sides with cement mortar 1:3 (1 cement : 3 coarse sand), finished with a floating coat of neat cement and making necessary channels for the drain etc. complete : For 300 dia& For 450 dia**

It shall be completed as per the instruction and as directed by engineer in charge.  
Rate shall be for a unit of one No..

**Item No. 113**

**Reinstatement of Bituminous road including with 50 mm thick bituminous concrete with 2.5 kg/10 Sqm , 7.5 sqm/10 smt Filling in foundation , 150 mm thick WMM, 200 mm thick CTSB with necessary excavation / loosening and recompacting ground as per respective MoRTH specification and as directed by engineer in charge**

**1.0 General**

The scope includes the reinstatement of asphalt / paver block/ cement concrete / WBM / murrum / earth surfaces of design thickness crossing the sewerage/Storm pipelines.

**2.0 Reinstatement**

After the work of laying and jointing of pipeline is completed, the earthwork, murrum surface and asphalt surface will be reconstructed as per the designed thickness as directed and/or using with old soling and metalling material. Any extra spoul or metal required shall be brought to contractor at own cost. The prepared surface shall be grouted with asphalt. The surface will be maintained till the work is completed. The measurement will be paid on square meter basis for all the types of surfaces constructed including earthwork.

**3.0** The payment for reinstatement of asphalt road payment will be made on sq.mt. basis of the work carried out as per the design and direction of engineer –in-charge

**Item No. 114**

**Reinstatement of 60 mm thick with 35 mm sand bedding on 200 mm thick WMM & 150 mm GSB with necessary excavation/ loosening and recompacting ground as per respective MoRTH specification and as directed by engineer in charge.**

**1.0 Reinstatement**

After the work of laying and jointing of pipeline is completed, the earthwork, murrum surface and paving will be reconstructed as per the designed thickness as directed and/or using with old soling and metalling material. Any extra spoul or metal required shall be brought to contractor at own cost. The prepared surface shall be grouted with asphalt. The surface will be maintained till the work is completed. The measurement will be paid on square meter basis for all the types of surfaces constructed including earthwork.

**2.0** The payment for reinstatement of paver block will be made on sq.mt. basis of the work carried out as per the design and direction of engineer –in-charge



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Part C

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**Electrical Works**

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**19     Make of Materials**

Use Makes mentioned in Vol-I technical specifications only and if any make not covered then as per approved by Consultant.

**20     SAMPLE, SUBMISSION AND APPROVAL**

After award of work, the contractor shall submit following samples/ names of makes for approval from the EMPLOYER/Architect/Consultant before using it .Subsequently it shall be his responsibility to get the samples/Makes approved in due course of time without in any way affecting the overall schedule of completion of works.

- a) All Substation LT Equipment
- b) Conduit and Accessories
- c) Wires & Cables
- d) Switches and Sockets
- e) Distribution Boards
- f) Light fixtures
- g) Containment & Accessories
- h) Any other Electrical accessories other than (a) to (g)
- i) Street Light Pole / Decorative Pole

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Part C

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**Electrical Specifications**

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**Part A – Electrical Specification**


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**E1. Internal Wiring**


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This section covers, definition of point wiring, system of wiring and supply, installation, connection, testing and commissioning of point wiring for light points, ceiling fan points, exhaust fan points, convenience socket outlet points, power socket outlet points etc. including fixing of light fixtures, ceiling fan, exhaust fan, wall fan etc.

**1.1 Standards**

The following standards and rules shall be applicable:

Standard no.	Particular
IS : 732	Code of practice for electrical wiring installation (System voltage not exceeding 650 V)
IS : 1646	Code of practice for fire safety of buildings (General) Electrical installation.
IS : 2509	Rigid non-metallic conduits for electrical wiring.
IS : 6946	Flexible (Pliable) non-metallic conduits for electrical wiring.
IS : 1293	3 pin plugs and sockets.
IS : 8130	Specifications of conduits for electrical installation.
IS : 3854	Switches for domestic purpose.
IS : 3415	Fittings for rigid non-metallic conduits.
IS : 4648	Guide for electrical layout in residential building Indian electricity act and rules.

Regulations for the electrical equipment in buildings issued by the Bombay Regional Council of Insurance Association of India.

All standards and codes mean the latest.

**1.2 Point Wiring**

A point shall consist of the a switch as required, including the ceiling rose or pendant holder or swan holder, or ceiling fan box or socket or suitable termination. A point shall include, in addition, the earth continuity conductor / wire from the Switch Board to the earth pin / stud of the outlet / switch box and to the outlet points.

The point wiring shall be carried out in the under mentioned manner

- 1.2.1. Supply, installation, fixing of conduits with necessary accessories, junction / pull / inspection / switch boxes and outlet boxes. ( Refer BOQ Item for Pipe Supply )
- 1.2.2. Supplying and drawing of wires of required size including earth continuity wire.
- 1.2.3. Supply, installation and connection of flush type switches, sockets, cover plates, switch plates, etc.
- 1.2.4. The point shall be complete with the branch wiring from the Switch board to the outlet point, Pre laid conduit with accessories, junction, pull, inspection boxes, control switch, socket, outlet boxes, ceiling roses, button / swan holder, connector etc.



## **1.4 System of Wiring**

Unless otherwise mentioned on the drawings, the system of point wiring shall be as follows:

The system of wiring shall consist of single core, PVC insulated, 650/1100 volt grade, copper conductor FRLS wires laid through exposed (surface mounted) PVC conduits as directed.

## **1.5 General**

The contractor shall submit for approval, the shop drawing of conduit layout indicating the route of the conduits, number and size of the conduits, location of junction / inspection / pull / outlet boxes, size, location of switch boxes and switch board detail (SBD), number and size of wires pulled through each conduit and all other necessary relevant details prior to laying of conduits. Only after the drawings are approved, the contractor shall proceed with the work of conduit laying.

Prior to laying and fixing of conduits, the contractor shall carefully examine the working drawings prepared by him and approved by the Consultant indicating the layout, satisfy himself about the sufficiency of number and sizes of conduits, location of junction boxes, sizes and location of switch boxes and switch board detail (SBD) other relevant details. Any discrepancy found in the drawings shall be brought to the notice of the EMPLOYER's site representative. Any modifications suggested by the contractor shall be gotten approved before the actual laying of conduits is commenced.

In laying of conduits it is important that not more than two right angle bends are provided for each circuit and as far as possible. No junction box shall be provided in the entire length of conduit run for drawing of wires. Only switch outlets, lighting fixture outlets, equipment power outlets and socket outlets shall be considered for drawing of wires.

## **1.6 Material**

### **1.6.1 PVC Conduits**

All non-metallic PVC conduits shall conform to IS: 9537. The conduit shall be plan and type as specified in IS: 9537 and shall be used with the corresponding accessories (Refer IS: 3419 specification for fittings for rigid non PVC metallic conduits). PVC conduits shall be rigid unplasticized, medium gauge having 1.6 – 1.8 mm. wall thickness up to 20 mm. diameter conduit and 1.8 - 2 mm. wall thickness for all sizes above 20 mm. diameter.

### **1.6.2 Boxes**

All the boxes for switches, sockets and other receptacles, junction boxes, pull boxes and outlet boxes shall be fabricated from 2.0 mm. thick mild sheets painted with two coats of red-oxide and then two coats of enamel paints as called for. Colour of the paints shall be as approved by the client. The boxes shall have smooth external and internal finished surface. Boxes in contact with earth or exposed to the weather shall be of 2 mm. mild steel and hot dip galvanized after fabrication. Separate screwed earth terminal shall be provided in the box for earthing purpose. All boxes shall have adequate no. of knock out holes of required diameter for conduit entry. Switch boxes to receive switches, socket outlets, power outlets, telephone outlets, fan regulators, etc. shall be fabricated to the

approved shape and size to accommodate all the devices without overcrowding. Outlet boxes to receive ceiling fan shall be fitted with adequately sized rod / hook to fix ceiling fan. The boxes shall be of

minimum depth of 65 mm.

### **1.6.3 Cover Plate**

The cover of the boxes to receive outlet points shall be of best anodized sheet cut to shape and size or plate of approved manufacturers of switches.

### **1.6.4 Wires**

The wires shall conform to IS: 694. For all internal wiring FRLS wires of 650 / 1100 volts grade, single core shall be used.

The conductors shall be plain annealed copper conductors complying with IS:

1554. The conductors shall be circular copper conductor.

The insulation shall be XLPE compound complying with the requirements of IS: 694. It shall be applied by an extrusion process and shall form a compact homogenous body.

The thickness of XLPE insulation shall be as set out in the relevant standards

The cores of all cables shall be identified by colours in accordance with the following

sequence. Single phase	-	Red
Three phase	-	Red, Yellow, Blue
Neutral	-	Black
Earth	-	Green or Green/Yellow

Means of identifying the manufacturer shall be provided throughout the length of cable.

Unless otherwise specified in the drawings the size of the cables used for internal wiring shall be as follows: In case of circuit wiring for lights, exhaust fans, convenience socket outlet points (P+N+E):

2 nos. of 2.5 mm<sup>2</sup> + 1 no. of 1.5 mm.<sup>2</sup> - From MCB at Panel/DB to switch

boards. 3 nos. of 1.5 mm.<sup>2</sup> - From switch boards to outlet points

2 nos. of 4.0 mm.<sup>2</sup> + 1 no. of 2.5 mm.<sup>2</sup> - From MCB at Panel/DB to 16/20 Amp socket.

### **1.6.5 Switches**

Switches shall conform to IS: 3854, IS: 1293 and IS: 4615. The switches shall be single pole, single or two way and shown on the drawings or as specified. They shall be of moulded type rated for 250 volt, and of full 5 / 15 A capacity. They shall be provided with insulated dollies and covers.

The switches shall be rocker operated with a quite operating mechanism with bounce free snap action mechanism enclosed in an arc resistant chamber. The switches shall have pure silver and silver cadmium contacts. The switches shall be flush modular type the make of the switches shall be as indicated in the drawings or BOQ or make of material or as suggested and approved by the client. The switches installed in outdoor area shall be industrial, metal clad type, and shall be provided in weather proof enclosures, complete with weather proof gasketed covers.

### **1.6.6 Sockets**

The sockets shall conform to IS: 1293. Each socket shall be provided with control switch of appropriate rating. The sockets shall be moulded type, rated for 250 volts, and either of full 5 A or 15 A capacity, as mentioned on the drawings.

Sockets shall be of three pin type, the third in being connected to earth continuity conductor. The socket shall be flush modular type. The sockets installed in machine room, plant room or wet / damp

area shall be metal clad

weather proof type. The finishing and make of all the sockets shall be same as light switch. The socket shall have fully sprung contacts and solid brass shrouded terminals to ensure positive electrical connections.

The sockets shall be provided with automatic shutters, which open only when earth pit of the plug inserts in the socket.

The socket shall be provided with three pin plug top suitable to the socket and of the same make as socket.

#### **1.6.7 Under Floor Raceways**

The under floor duct for “in screed” system shall be “galvanized sheet” steel of 1.6mm thick with top and bottom plates are double folded and spot welded together to give required rigidity and to prevent the seepage of concrete and screed water. The duct must have two or three compartments to accommodate cables of different voltage ratings (Power, Data & Communication). The standard length of the duct shall be of 2.5 mtrs with a width of 100 / 200 / 250 (or) 300 mm and with a height of 28 / 38 (or) 48mm.

Coupler have to be used to connect the standard sizes of the ducts in screed covered system. The end cap should lock in to the duct without additional accessories to protect against dust or other foreign particles inside the duct. The riser bends should be easily mounted as well for quick entry of cables in the under floor system.

#### **Under floor Junction & Service Outlet Access Boxes**

The floor boxes must be of high quality material and should withstand heavy load and should have corrosion protection.

The Under floor Junction and Service Outlet Boxes shall be robust in its construction with a base plate and side walls manufactured from minimum 1mm thick galvanized steel and main levelling frames from die-cast/extruded aluminium. Height of the Under floor Service outlet and Junction Boxes shall be adjustable from 70 to 125mm in line with the height of the screed level for higher screed structures. The Junction and Service outlet boxes shall have suitable dimensions to eliminate congestion and to provide ample working space within the box. Junction Box shall be supplied with crossover bridges for segregation of power, voice and data cables. The sides of the Underfloor boxes shall be pre punched on all the sides for quick and easy installation of Under floor Ducts at site.

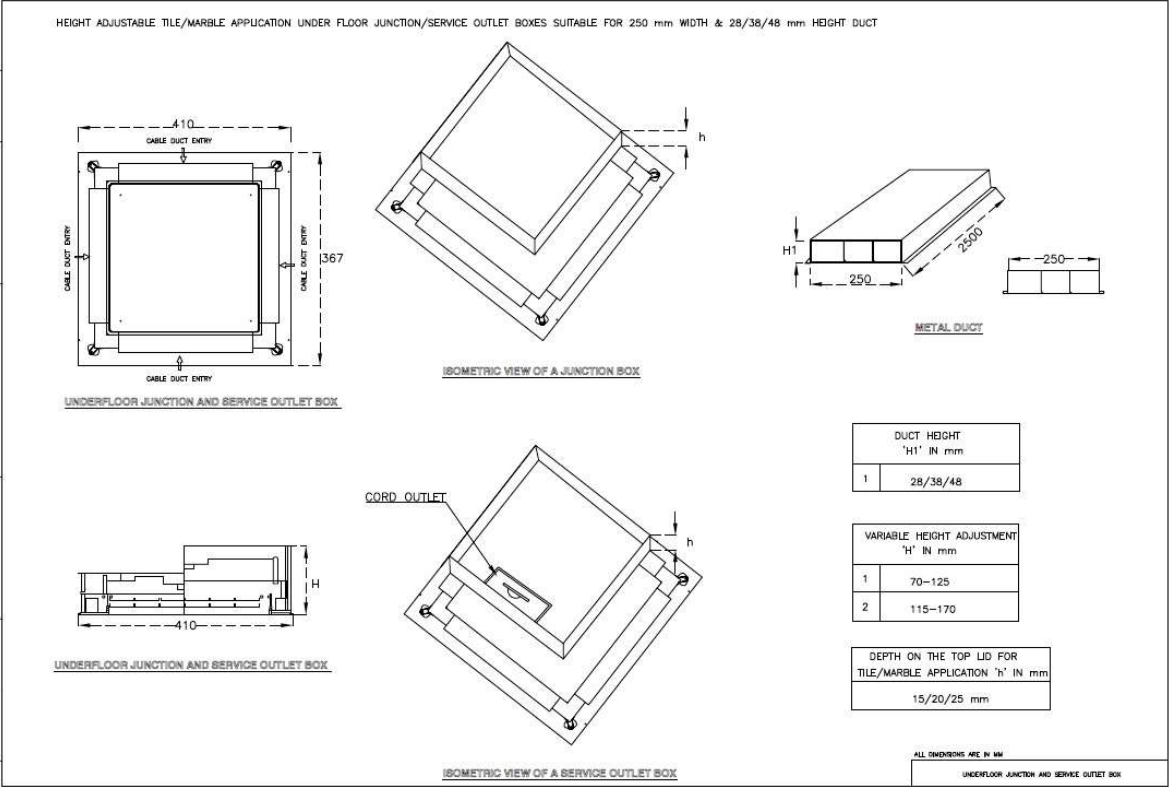
The Frame cassette for Stone finished application shall be manufactured from Stainless steel cassette with 10/15/20/25/30 & 40mm height options to support floor finishing stone of different heights. The cassettes shall also be fitted with a 4mm thick sheet steel plate for ensuring maximum rigidity and providing adequate load bearing capacity. The cassette shall be supported on the Under floor boxes with the help of four part cassette frame screwed on the under floor box firmly in place. The frame shall also house a square shaped gasket in single piece to prevent ingress of dirt and water through the gap between the cassette and frame.

#### **Installation:**

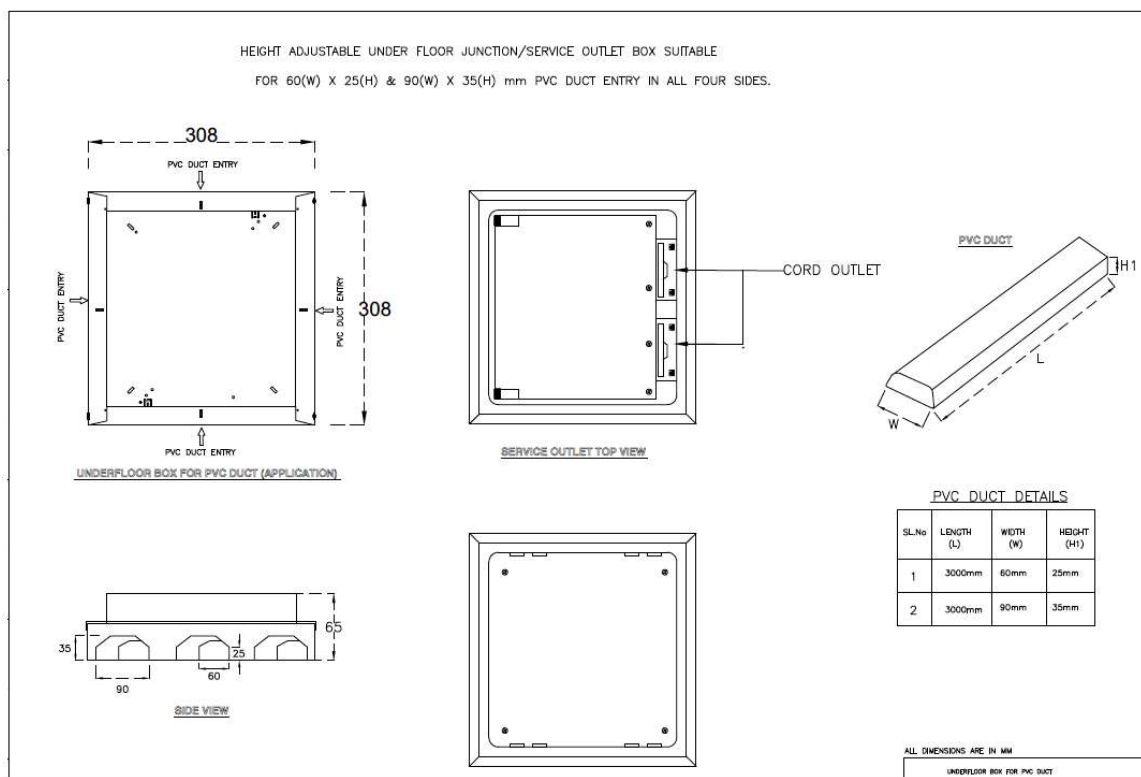
Under floor trucking system shall be installed strictly as per manufacturer's instructions and to a level of workmanship to ensure that all the under floor boxes are consistently in level with the screed level and any part of the boxes is not detected below and or above the floor slab. Failure to comply in this respect, the affected boxes shall be re-installed by the contractor, as required by the engineer.

Cross-over bridges shall be installed at the junctions as required, to ensure that adequate segregation of power, voice and data service cables is maintained.

Service outlets shall be installed within floor boxes after installation is completed and wiring is carried out, on to cover plates which are provided with suitable blanks for installation of service outlets.



### 1.6.8 Under Floor PVC Raceways



### 1.7 Drawing Of Conductors

The drawing and joining of copper conductor or wires shall be executed with due regard to the following precautions, while drawing insulated wires into the conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors. There shall be no sharp bends.

Insulation shall be shaved off for a length of 15 mm at the end of wire like sharpening of a pencil and it shall not be removed by cutting it square or ringing.

PVC insulated copper conductor wire ends before connection shall be properly soldered (at least 15 mm length) with soldering flux / copper solder, for copper conductor. Strands of wires shall not be cut for connecting to the terminals. The connecting brass-screws shall have flat ends. All looped joints shall be soldered and connected through terminals block / connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. Conductors having nominal cross section are exceeding 4 sq. mm shall always be provided with crimping type cable sockets. At all bolted terminals, brass flat washer of large area and approved steel spring washers shall be used. Brass nuts and bolts shall be used for all connections.

Only certified wire man and cable jointers shall be employed to do joining work.

For all internal wiring PVC insulated wires of 650 / 1100 volts grade shall be used. The sub-circuit wiring for point shall be carried out in looping system and no joint shall be allowed in the length of the conductors. No wire shall be drawn in to any conduit, until all work of any nature that may cause injury to wire is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the

wire. Before the wires are drawn into the conduits the conduits shall be thoroughly cleaned of moisture, dust, and dirt or any other obstruction by forcing compressed air through the conduits.

Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into rigid non metallic or PVC Conduits are given below:

Size of wires Nominal Cross Section Area (Sq. mm.)	Maximum number of wires within conduit size(mm)				
	20	25	32	40	50
1.5	5	10	14	--	--
2.5	5	8	12	--	--
4	3	7	10	--	--
6	2	5	8	--	--
10	--	3	5	6	--
16	--	2	3	--	6
25	--	--	2	4	6
35	--	--	--	3	5

## 1.8 Joints

The wiring shall be by looping back system, and hence all joints shall be made at main switches, distribution boards, socket outlets, lighting outlets and switch boxes only. **No joints shall be made inside conduits and junction boxes.** Joints where unavoidable, due to any specified reasons, prior permission in writing shall be obtained from the client before making such connections. Joints by twisting conductors are prohibited.

## 1.9 Load Balancing

Balancing of circuit in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

## 1.10 Earthing

All earthing systems shall be in accordance with IS: 3043 - 1985 code of practice for earthing.

## 1.11 Testing Of Installation

Before a completed installation is put into service, the following tests shall be complied with

### 1.11.1 Insulation Resistance

The insulation resistance shall be measured by applying 500 volt megger with all fuses in places, circuit breaker and all switches closed.

The insulation resistance in mega ohms of an installation, measured shall not be less than 50 mega ohms divided by the number of points on the circuit.

The insulation resistance shall be measured between

EARTH TO PHASE

EARTH TO NEUTRAL

## PHASE TO NEURAL

## PHASE TO PHASE

### 1.11.2 Earth Continuity Path

The earth continuity conductors shall be tested for electrical continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance or earth leakage circuit-breaker measured from the connection, with the earth electrode to any point in the earth continuity conductor in the completed installation and shall not exceed one ohm.

### 1.11.3 Polarity Of Single Pole Switches

A test shall be made to verify that every no-linked, single pole switch is connected to one of the phase of the supply system.

### 1.11.4 Test Reports

All the above tests shall be carried out in presence of client and the results shall be recorded in prescribed forms. Any default during the testing shall be immediately rectified and that section of the installation shall be re tested. The completed test result from shall be submitted to the client for approval.

On completion of an electric installation a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electric supply authority.

## E2. Distribution Boards

---

Distribution Boards (DB's) shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, neutral grounded at transformer. The DB shall be minimum di-electric strength of 2.5 KV / Sec. All Distribution Boards shall manufactured by a manufacturer listed in Appendix-I.

DB's shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

### 1.1 Construction Features

DB's shall be **IP 43/65** & made out of 1.6 mm thick high quality CRCA sheet steel and shall be pre-treated and powder coated sheet steel used in the construction of DB shall be folded and braced as necessary to provide a rigid support for all component. DB shall be suitable for indoor / outdoor installation, wall mounting free standing type, in double door construction. The Distribution Boards shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket, padlocking arrangement. All removable/ hinged doors and covers shall be grounded by 4.0 sqmm tinned stranded copper connectors. Distribution Boards shall be suitable for the climatic conditions. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage up to and including 1100 V AC.

### IP 65 DB :



DB shall be made up of high quality polycarbonate thermoplastic, shock proof, anti-corrosive, acid & chemical resistant, fire retardant, self extinguishing, highly impact resistant, halogen free, silicon free, recyclable, having internally embedded gasket. DB shall have provision for future expansion & shall be modular in construction. The bus bars shall be connected with C type clamps without any drilling on the bus bars. The panel shall be in accordance with IEC 60 439 – 1 (Fully TTA). The Degree of Ingress Protection shall be in accordance with IEC 60 529. DB has to be thermoplastic polycarbonate or of the material which has equivalent or exceeds the inherent features of thermoplastic polycarbonate. Said enclosures, in addition to containing the devices and components that constitute the electrical panel, must have certain properties and characteristics that are specific for their practical use; for e.g. they must provide a suitable degree of electrical insulation, have sufficient structural strength, be easy to handle, ensure adequate resistance to the aggression of chemical and atmospheric agents, be self extinguishing, etc. It should be clean and aesthetically appreciable.

**Degree of Protection IP 65, in accordance with IEC 60 529, type tested in accordance with IEC 60 439 – 1.**

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of DBs.

Three phase boards shall have phase barriers and a wire channel on three sides. Neutral bars shall be solid tinned copper insulated bars with tapped holes and chase headed screws. For 3 phase DB's, 3. Independent neutral insulated bars shall be provided. All DB's shall be internally pre-wired using copper insulated PVC wires brought to a terminal strip of appropriate rating for outgoing feeders.

Knockout holes of appropriate size and number shall be provided in the DB's in conformity with the location of cable/conduit connections. Detachable sheet steel gland plates shall be provided at the top / bottom to make holes for additional cable entry at site if required.

Distribution Boards shall comprise of the following:

- 1.1.1. A panel for mounting where appropriate incoming supply circuit breaker & other auxiliaries for Control & distribution as required.
- 1.1.2. Installation accessories shall be part of the DB for fixing conductor and rails for mounting MCB's and RCCB's etc... Neutral bus bars & earthing bus bars required in the circuit. All bus bars in the FDB shall be insulated type.
- 1.1.3. Service cable /interconnection shall be part of the Distribution Boards.
- 1.1.4. The board shall be installed at a height such that the operating is within reach of the normal human height i.e.  
1.2 to 1.8 meters from finish floor level.
- 1.1.5. Degree of protection shall be IP-52 for indoor application, IP-54 for kitchen & laundry and IP-55 for outdoor application.
- 1.1.6. All three phase distribution boards shall have 4 rows and single phase distribution boards shall have single rows for housing of MCB's and RCCB's unless noted otherwise.
- 1.1.7. Phase segregation to be maintained in all three phase distribution boards.
- 1.1.8. Earthing shall be provided in each FDB's.

## **1.2 Miniature Circuit Breaker (MCB)**

Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over

current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCB's shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B, C, D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values. MCB shall ensure complete electrical isolation & downstream circuit or equipment when the MCB is switched OFF.

The housing shall be heat resistant and having high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers shall have a common trip bar independent to the external operating handle.

MCB should be having an integrated label holder with dual side din rail locking facility. Incoming & Outgoing should have facility for termination of Busbar & Cable separately.

Cable termination facility should be up to 35 sq. mm.

### **1.3 Residual Current Circuit Breaker Current Operated Type (RCCB)**

#### **I. System Of Operation**

Residual Current Circuit Breaker shall conform to IEC 61008. RCCB shall work on the principle of core balance transformer. The incoming shall pass through the torrodial core transformer. As long as the currents in the phase and neutral shall be the same, no electro motive force shall be generated in the secondary winding of the transformer. In the event of a leakage to earth, an unbalance shall be created which shall cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive miniature relay, which shall trip the circuit if the earth leakage current exceeds a predetermined critical value. RCCB shall be current operated independent of the line voltage; current sensitivity shall be of 30 / 100 mA at 240/415 volts AC and shall have a minimum of 20,000 electrical operations.

It should provide full protection as envisaged by IE rules – 61-A, 71 – ee, 73 – ee, 1985 and also rule 50 of IE rule 1956.

#### **ii. Mechanical Operation**

The moving contacts of the phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism. Hence, the closing /opening of all the three phases shall occur simultaneously. This also shall ensure simultaneous opening of all the contacts under tripping conditions.

### **Iii. Neutral Advance Feature**

The neutral moving contact shall be so mounted on the common bridge that, at the time of closing, the neutral shall make contact first before the phases; and at the time of opening, the neutral shall break last after allowing the phases to open first. This is an important safety feature which is also required by regulations.

MCB should be having an integrated label holder with dual side din rail locking facility. Incoming & Outgoing should have facility for termination of Bus bar & Cable separately.

Cable termination facility should be up to 35 sq. mm.

### **Iv. Testing Provision**

A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB / RCCB and the operating handle shall move to the "OFF" position.

#### **1.4 Earthing**

Earthing shall be provided as per IS: 3043-1987.

#### **1.5 Painting**

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be of Siemens gray paint shade no. RAL-7032 of IS Code No.5.

#### **1.6 Labels**

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

#### **1.7 Testing**

Testing of panels shall be as per following codes:

IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages up to and including 1000 VAC. IS: 13947: 1993 Degree of protection

#### **1.8 Wiring**

In wiring a distribution panel it shall be insured that total load of various distribution panel and/or consuming devices is divided evenly between the phases and number of ways as per Consultants drawing.

### **E3. Cable Trench**

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Not Applicable

## E4. Cable Trays

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### General Requirement:-

Cable Tray and Cable Ladder systems are intended for the support and accommodation of cables and possibly other Electrical equipment in Electrical/Instrumentation/Communication systems.

### Design and Fabrication of Cable Trays / Ladders:-

The cable trays / ladders shall be fabricated according to the design specified by IEC 61537 and should be tested for Safe Working Load (SWL). The relevant details of SWL and the load chart with respect to SWL, supporting distance and the deflection should be according to the following chart.

Safe Working Load (SWL) with a span length up to 3 meters						
Description	Side Height (in	Width (in mm)	Span length (in meters)			
			1.5m	2m	2.5m	3m
			Permitted Load (in kg/meter)			
Perforated Cable Tray	35	50 - 300	125	90	50	-
	60	50 - 600	150	100	50	-
	85	100 - 600	175	110	50	-
	100 / 110	100 - 550	185	130	75	60
Cable Ladder	45	200 - 600	180	140	100	55
	60	200 - 600	-	225	150	100
	100 / 110	200 - 600	-	310	200	140

Safe Working Load (SWL) with a span length up to 10 meters									
Description	Side Height (in mm)	Width (in mm)	Span length (in meters)						
			4m	5m	6m	7m	8m	9m	10m
			Permitted Load (in kg/meter)						
Perforated Cable Tray for long span distance	100 / 110	200 - 300	160	110	75	-	20	-	-
		400 - 600	200	150	100	-	40	-	-
	160	200 - 300	230	180	140	100	70	-	-
		400 - 600	250	200	160	130	100	-	-
Cable Ladder for long span distance	100 / 110	200 - 300	160	110	80	40	-	-	-
		400 - 600	210	150	100	70	-	-	-
	160	200 - 300	230	180	140	100	70	-	-
		400 - 600	250	200	160	130	100	-	-
	200	200 - 600	-	-	300	250	200	140	100

Fabrication of Tray / Ladder and accessories at site and welding is not permitted. In unavoidable circumstances, If any cut or holes are made in the trays/Ladder/accessories, zinc spray need to be applied over the surface. The metal edge has to be protected by edge protection sleeves to avoid cable damage. Edge of the supports has to be protected with plastic END caps. Screwed connections and internal fixing Devices should not create any damage to the cable when correctly fixed. Sudden or jerky motions shall not be used to tighten reusable screw connections.

Cables shall run in cable tray/ladder mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures using mounting accessories

#### **Cable Tray:-**

The cable tray and all accessories shall be fabricated from sheet steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications

& should have a Base Perforation Class B according to IEC 61537. The cable trays shall be supplied in standard lengths of 3000mm and the width of the tray shall be as follows.

Width: 50, 100, 150, 200, 300, 400, 500, 600, 750&1000 mm.

All the cable tray accessories like Bend's, TEES's, Cross over's etc should be designed in accordance with IEC 61537 and shall be factory fabricated. The accessories shall be from the same material as of the tray and modular

type, it should be connected with the trays by using fasteners. Typical details of trays, fittings and accessories etc are shown in the enclosed drawings.

For Cable trays designed, tested and confirming to IEC 61537, thickness of cable tray should be according to the manufacturers catalogue. For locally fabricated and non tested tray, thickness should be 2 mm up to span length of

1.5 meter, 2.5 mm for span length between 2 to 3 meter and 3 to 4 mm for span length between 4 and 10 meter

#### **Cable ladder:-**

The cable Ladder and all accessories shall be fabricated from sheet steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications & should have a Free Base Area classification Y according to IEC61537. The cable ladders shall be supplied in standard lengths of 3000/6000 mm and the width of the tray shall be as follows.

Width: 200 to 1200 mm in multiples of 100 mm

Maximum rung spacing in the ladder shall be 300mm. The rung's should be made of C profiles suitable to fix cables by special metal clamps according to the drawing. The ladder shall be of riveted and foldable type for easy transportation and to avoid damage during transportation and storage. All the ladder accessories like Bend's , TEES's, Cross over's etc should be designed in accordance with IEC 61537 and shall be factory fabricated . The accessories shall be made from the same material as of the ladder and modular type, it should be connected with the ladder by using fasteners. The details of ladders, fittings and accessories .etc are shown in the enclosed drawing.

For Cable Ladders designed, tested and confirming to IEC 61537, thickness of cable Ladder should be according to the manufacturer's catalogue.

#### **Cover for Cable Trays / Ladders:-**

Cover for trays/ladders to protect the cable insulation from falling objects, water droplets, harmful effects of ultraviolet rays and accumulation of dust. The cover shall be made either from Hot Dip Galvanized sheet steel or superior quality Double Dip Galvanized Sheets. For Outdoor application, Double dip Galvanized material shall be used. The covers should be fitted properly to the Ladder / Tray by using pre fixed and tested locks which ensure that covers are fitted rigidly to Tray / Ladder. For outdoor application in high wind areas, additional cross over beadings to be used for fixing the cover on tray / ladder of width more than 500 mm.

#### **Mounting Accessories (supports and Brackets):-**

The mounting accessories shall be fabricated from steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications and should be of completely modular type.

All supports and Brackets should be factory made, hot dip galvanized after completing welding, cutting, drilling, other machining operations and tested according to IEC 61537 according to the arrangements



in the enclosed drawing. The system shall be designed such that it allows easy assembly at site by using Bolts and Nuts. The main support and brackets shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hard ware etc to form various arrangements required to support the cable trays. Welding of the components at the site shall not be allowed.

### **Corrosion Protection:-**

The cable tray / ladder/accessories shall be of HOT DIP Galvanized (ISO 1461-1999) for installations in corrosive atmospheres both indoor and outdoor application. Sample tray / ladder / accessories / mounting accessories and supports should be salt spray tested according to ISO 9227 for > 500 hours. (\*550 hours according to class 6 for Hot dip Galvanized surface as per ISO)

### **Testing and Certification:-**

Cable tray / Ladder, bend, T Bend, cross, and all supports are to be tested for Safe Working Load (SWL), deflections, Impact resistance, Salt Spray & Electrical continuity test according to IEC 61537. The cable tray/ladder should not deflect more than  $1/100^{\text{th}}$  of the span length at SWL in Mid span and the transverse deflection of all mounting accessories at SWL shall not exceed  $1/20^{\text{th}}$  of the length. The cable tray / cable ladder should be tested up to 1.7 times SWL at minimum and maximum room temperature. The temperature classification of cable tray system should be - 5 to + 150°C.

### **Marking, Documentation, Compliance and Inspection:-**

Each system component shall be durably and legibly marked with:

- the manufacturer's or responsible vendor's name or trade mark or identification mark;
- a product identification mark which may be, for example, a catalogue number, a symbol, or the like.

When system components other than cable tray lengths and cable ladder lengths are supplied in a package, the product identification mark may be, as an alternative, marked on the smallest package unit.

Marking shall be applied, by molding, pressing, engraving, printing, adhesive labels, or water slide transfers. Compliance is checked by inspection and, for marking on the product, by rubbing by hand for 15 s with a piece of cotton cloth soaked with water and again for 15 s with a piece of cotton cloth soaked with petroleum spirit. Marking made by molding, pressing, or engraving is not subjected to the rubbing test. After the test, the marking shall be legible.

If a system component is stored and transported at a temperature outside the declared minimum and maximum temperatures, the manufacturer or responsible vendor shall declare the precautions and the alternative temperature limits. Compliance is checked by inspection.

The manufacturer or responsible vendor shall provide in his literature all information necessary for the proper and safe installation and use of the cable tray system and cable ladder system. The SWL and impact resistance is valid for the whole temperature classification declared. The information shall include

- a. Instructions for the assembly and installation of system components and for the precautions required to avoid excessive transverse deflection, which could cause damage to the cables.
- b. Thermal Expansion properties and precautions to be taken, if necessary,
- c. Material, Surface Treatment and Salt Spray Test certificate
- d. Relative humidity if it affects the material and Surface Treatment
- e. Information on holes or devices provided for equipotential bonding or to run Earth Bonding Bar
- f. Precautions for transport and storage outside the declared temperature classification, where

applicable

- g. Product dimensions
- h. Torque setting in Nm for screwed connections and internal fixing Devices. These devices should not create any damage to the cable when correctly fixed. Sudden or jerky motions shall not be used to tighten reusable screw connections. To test the screwed connections, it shall be tightened and removed.
- i. End Span Distance
- j. Position and type of coupling along the span
- k. SWL in kg/m for the fittings when not directly supported
- l. Fixing method for installing cable tray or cable ladder to the supports

- m. SWL in kg/m for the cable tray lengths or the cable ladder lengths including joints for various Span Distances. SWL information can be given in the form of a diagram, table or similar. Compliance is checked by inspection
- n. SWL in kg for cantilever brackets
- o. SWL for pendants as a bending moment in kg and /or as a force in N
- p. The appropriate material specification and environmental conditions, chemical environments or aggressive agents for which the product is suitable

## **1.2 General Requirements**

### **I. Quality Of Zinc**

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS: 209-1992.

#### **ii Coating Requirement**

Minimum weight of zinc coating for mild steel flats with thickness up to 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.

The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters.

Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing.

## **E5. Medium Voltage Cables**

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### **1.1 Scope**

This section shall cover supply of medium voltage cables.

### **1.2 Standards**

The following standards and rules shall be applicable:

IS: 1554 PVC insulated electric cables (heavy duty). IS: 1753 Aluminium conductors for insulated cables. IS: 3961 Recommended current ratings for cables.

IS: 8130 Aluminium conductors for insulated cables Indian Electricity Act and Rules.

### **1.4 General**

The medium voltage cables shall be supplied, laid, connected, tested and commissioned in accordance with the drawings, specifications, relevant Indian Standards specifications, manufacturer's instructions. The cables shall be delivered at site in original drums with manufacturer's name, size, and type, clearly written on the drums.

### **1.5 Material**

The MV cables shall be cross linked polyethylene (XLPE) insulated PVC sheathed of 1100 volts grade aluminium or copper conductor, armoured and unarmoured heavy duty, conforming to IS : 7098 Part I IS : 1988 Part I. as asked for in the schedule of quantities.

1.5.1. All XLPE Aluminium/Copper Power cables shall be 1100 Volts grade, multi core constructed as per IS : 7098 Part-I of 1988 as follows :

- a. Stranded Aluminium /Copper conductor of high conductivity up to 4 mm.<sup>2</sup> size, the conductor shall be solid and above 4 mm.<sup>2</sup>, conductors shall be concentrically stranded as per IEC: 228.
- b. Cores laid up
- c. The inner sheath should be bonded over with thermo-plastic material for protection against mechanical and electrical damage.
- d. Armoring should be provided over the inner sheath to guard against mechanical damage. Armouring should be Galvanized steel wires or galvanized steel strips. (In single core cables used in A.C. system armouring should be non-magnetic hard aluminium Wires/Strips. Round steel wires should be used where diameter over the inner sheath does not exceed 13 mm; above 13 mm flat steel armour should be used. Round wire of different sizes should be provided against specific request.)
- e. The outer sheath should be specially formulated heat resistant black PVC compound conforming to the requirement of type ST2 of IS: 5831-1984 extruded to form the outer sheath.

- 1.5.2. Conductor shall be of electrolytic Aluminium/Copper conforming to IS : 8130 and are compact circular or compact shaped.
- 1.5.3. Insulation shall be of XLPE type as per latest IS general purpose insulation for maximum rated conductor temperature 70 degree centigrade.
- 1.5.4. In Inner sheath laid up cores shall be bonded over with thermoplastic material for protection against mechanical and electrical damage.
- 1.5.5. Insulation, inner sheath and outer sheath shall be applied by extrusion and lapping up process only.
- 1.5.6. Armouring shall be of galvanized steel wire/flat.  
Galvanized steel flat strip / round wires applied helically in single layers complete with covering the assembly of cores.  
For cable size up to 25 Sq. mm: Armour of 1.4 mm dia. G.I. round wire  
For cable size above 25 Sq. mm: Armour of 4 mm wide 0.8 mm thick G.I. strip
- 1.5.7. Repaired cables shall not be used.
- 1.5.8. Current ratings of the cables shall be as per IS: 3961.
- 1.5.9. The XLPE insulated cables shall conform to latest revision IS read along with this specifications. The Conductor shall be stranded Aluminium/Copper circular/ sector shaped and compacted. In multi core cables the core shall be identified by red, yellow, blue and black coloring of insulation as following.

**Core identification:**

Two cores	:	Red and Black
Three cores	:	Red, Yellow and Blue
Four core	:	Red, Yellow, Blue and Black
Single core	:	Green, Yellow for earthing Black

shall always be used for neutral.

- 1.5.10. The XLPE insulated 1100 Volts grade power cables shall conform to latest IS and shall be suitable for a steady conductor temperature of 70 degree centigrade. The conductor shall be stranded Aluminium/Copper as called for in the Schedule of quantities. The outer sheath shall be as per the requirement of type ST-2 of IS: 5831 of 1984.
- 1.5.11. The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.
- 1.5.12. Progressive automatic in line sequential marking of the length of cables in

meters at every one meter shall be provided on the outer sheath of all cables.

1.5.13. Cables shall be supplied in non returnable wooden drums as per IS: 10418.

Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation, storage and erection.

1.5.14. The product should be coded as per IS: - 7098 Part-I as follows:-

Aluminium	A
Conductor XLPE	2
Steel round wire armour	W
Steel strip armour	F
Steel Double round wire armour	WW
Steel Double strip armour	FF
Non-magnetic (Al.) round wire	Wa
Non-magnetic (Al.) strip armour	Fa
PVC outer sheath	Y

## **1.6 General**

All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of handling during transportation, loading, unloading etc.

The cable shall be supplied in single length i.e. without any intermediate joint or cut unless specifically approved by the client.

The cable ends shall be suitably sealed against entry of moisture, dust, water etc. with cable compound as per standard practice.

## **1.7 Testing**

### **1.1.1 Finished Cable Tests At Manufacturer's Works**

The finished cables shall be tested at manufacturer's works. Following routine tests for each and every length of cable and copy of test results shall be furnished for each length of cable along with supply. If specified, the cables shall be tested in presence of clients' representative.

#### **a. Voltage test**

Each core of cable shall be tested at room temperature at 3 KV A.C. R.M.S. for duration of 5 minutes.

#### **b. Conductor resistance test**

The D.C. Resistance of each conductor shall be measured at room temperature and the results shall be corrected to 20° c. to check the compliance with the values specified in IS 8130 - 1976. Prior to dispatching cables and at the time of delivering the cables at stores, following tests shall be carried out:- Insulation Resistance test between phases and phase to Neutral and phase to earth Continuity test of all the phases, neutral and earth

continuity conductor Sheathing continuity test Earth resistance test of all the phases and neutral

All tests shall be carried out in accordance with relevant Indian Standard Code of practice and Indian Electricity Rules. The Vendor shall provide necessary instruments, equipments and labour for conducting the above test and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the client and results shall be recorded in the prescribed forms.

### **1.8 Cable Marking**

#### **Embossing On Outer Sheath**

The outer sheath shall be legibly embossed with  
following legend: ELECTRIC CABLE: 1100 V,  
SIZE: 3.5 C x ----- mm<sup>2</sup>.

Manufacturer's Name & year of manufacturing.

### **1.9 Sealing, Drumming & Packing**

After tests at the manufacturer's works, both ends of the cable shall be sealed to prevent the ingress of moisture during transportation and storage.

Cable shall supply in length of  $500 \pm 10\%$  meters on packed non-returnable drums of sufficiently sturdy construction.

Cables of length more than 250 meters shall also be supplied on non-returnable drums. The spindle hole shall be 110 mm minimum diameter.

Each drum shall bear on the outside flange, legibly and indelibly in the English literature, a distinguishing number, the manufacturer's name and particulars of the cable i.e. voltage grade, length, conductor size, cable type, insulation type and gross weight shall also be clearly visible. The direction for rolling shall be indicated by an arrow. The drum flange shall also be marked with manufacturer's name and year of manufacturing etc.

### **E6. Cable Termination**

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Not Applicable



## **E7. Medium Voltage Panel Board / MV Switch Gear**

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### **1.1 Scope**

This scope shall cover design, manufacture, check test, and supply, installation, testing (Scope to assist the Ele. Contractor for installation, all the sections of panels & Internal Control wiring should be done by panel vendor on site ), testing and commissioning of various medium voltage Panel Board as described in Bills of quantities and drawings. The Panel manufacturer should have a design validated by CPRI / ERDA for breaking capacity of at least 100 KA for 1 Sec.**All Panel Shall have tested assembly as per IEC61439.**

Medium voltage Panel Board will be installed indoor and is connected through the cables.

### **1.2 Service Conditions at Site**

Ambient Temperature :	Max. / Min. = 45° C. / 6° C.
Design temperature :	50 Degree C.
Relative humidity :	95% max.
Voltage :	415+/- 10%, TPN
Frequency :	50 Hz. + 3% to -6%
Neutral :	Solidly / earthed neutral.
Fault level :	35KA, Symmetrical at 415V solidly earthed.

### **1.3 Documentation**

#### **1.3.1. Vendor shall furnish drawings**

- General arrangement drawing indicating accessories and dimensions.
- Foundation plan and loading.
- Termination arrangement with dimensions.
- Three phase wiring diagrams
- SLD's and control schemes
- Terminal plans
- Bill of quantity for each panel.
- Panel assembly Test Certificate as per IEC61439

#### **1.3.2. Documents to be submitted after placement of order, before starting of the Fabrication of the Panels**

- As per above for comments and approval for manufacture.
- Schematic and sectional drawing.

#### **1.3.3. Final documents - data and manuals in six sets along with equipment supplied.**

- As built drawings with RTP (Reproducible Tracing Paper).

- Instruction and maintenance manual - Six copies.
- Test certificates - Six copies.

#### **1.4 General Specifications**

All the Panels shall be metal clad, totally enclosed, rigid, floor / wall mounting, air insulated, cubicle type suitable for operation on three phase / single phase, 415 V / 230 V / 240 V, 50 Hz., neutral effectively grounded at transformer and short circuit level as mentioned in the drawings.

Degree of protection for following type of distribution panel enclosure shall be as per IS: 13947-1993.

- a. IP 52 for indoor panels.
- b. IP 54 for kitchen and laundry panels.
- c. IP 65 for outdoor panels.

The painting of all the metal part shall be with seven tank process followed by powder coating as per the standard.

The Panels shall be designed to withstand the heaviest condition at site, with maximum expected ambient temperature of 50° c., 95% humidity.

#### **1.5 Standards And Codes:**

The Panels shall comply with the latest edition of relevant Indian Standards and Indian Electricity Rules and Regulations. The following Indian standards shall be complied with:

Standard no.	Particular
IS : 4237	General requirements for switchgear and control gear for voltages not exceeding 1000 V A.C. or 1200 V D.C.
IS : 5578	Guide for marking of insulated conductors.
IS : 11353	Guide for uniform system of marking and identification of conductors and apparatus Terminals.
IS : 13947	Low voltage switchgear and control gear.
IS : 8197	Terminal marking for electrical measuring instrument and their accessories.
IS : 2551	Danger notice plates
IS : 10118	Code of Practice for selection, installation and maintenance of switchgear and control gear.

IS : 8623	Specification for factory built assemblies of switchgear and control gear for voltage up to and including 1000 V A.C. and 1200 V D.C.
IS : 8828	Miniature circuit breakers.
IS : 9224	HRC fuse links
IS : 2705	Current transformer
IS : 3156	Voltage transformer
IS : 3231	Electrical relay for protection
IS : 1248	Indicating instrument

Standard no.	Particular
IS : 722	Integrating instrument
IS : 6875	Control switches and push buttons
IS : 1822	A.C. motor starters of voltage not exceeding 1000 V

Indian Electricity Act and Rules (as amended up to date) and approval of FIA of India.

The Panels also require approval of the consultant at various stage of their manufacture such as design, selection, construction, testing, shipping etc.

## 1.6 Panels

### A. Structure

**The Panels shall be of compartmentalized design so that circuit arc / flash products do not create secondary faults and be fabricated out of high quality CRCA sheet, suitable for indoor installation having dead front operated and floor / wall mounting type. The type of construction shall be 4b. The panel shall be in accordance with IEC 61439 (Fully TTA).**

All CRCA sheet steel used in the construction of Panels shall be 2 mm. thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet steel shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal.

The Panels shall be totally enclosed, completely dust and vermin proof and degree of protection being not less than IP: 51 to IS: 2147. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. All doors and covers shall be fully gasketed with foam rubber and /or rubber strips and shall be lockable.

All panels and covers shall be properly fitted and screwed with the frame and holds in the panel correctly positioned. Fixing screws shall enter into holes, taped into an adequate thickness of metal or provided with bolts and nuts. Self threading screws shall not be used in the construction of Panels.

A base channel of 75 mm. x 40 mm. x 6 mm. thick shall be provided at the bottom. A clearance of 300 mm. between the floor of the Panels and the bottom of the lower most units shall be provided.

Panels shall be preferably arranged in multi-tier formation. The Panels shall be of adequate size with a provision of 20% spare space to accommodate possible future additional switchgear. The size of the Panels shall be designed in such a way that the internal space is sufficient for hot air movement and the electrical component does not attain temperature more than 50°C. If necessary, openings shall be provided for natural ventilation, but the said openings shall be screened with fine weld mesh. The entire electrical component shall be derated for 50°C.

Knock out holes of appropriate size and number shall be provided in the Panels in conformity with the number, and the size of incoming and outgoing conduits / cables.

Alternately, the Panels shall be provided with removable sheet steel plates at top and bottom to drill holes for cable / conduit entry at site.

The Panels shall be designed to facilitate easy inspection, maintenance and repair.

The Panels shall be sufficiently rigid to support the equipment without distortion under normal and under short circuit condition. They shall be suitably braced for short circuit duty.

#### **A1. Structure & Construction for IP 65 Panel / Feeder Pillar**

Feeder Panels shall be lockable IP65 3 mm thick sheet steel with FRP / GRP Lining cabinet for Outdoor installation, dead front, floor mounting type and shall be form 3b construction. The Distribution panels shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket, padlocking arrangement and bolted back. All removable/ hinged doors and covers shall be grounded by flexible standard connectors. Distribution panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of Distribution panels shall be 3 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall conform to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage up to and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Distribution panels. A base channels of 75 mm x 40 mm x 5 mm thick & Suitable Size Stand with the 3 mm Sheet Cover the bottom for floor mounted panels. Minimum clearance of 450 mm shall be provided between the floor of Distribution panels and the lowest unit.

The Internal electrical switchboard (panel) shall be made up of high quality polycarbonate thermoplastic, shock proof, anti-corrosive, acid & chemical resistant, fire

retardant, self extinguishing, highly impact resistant, halogen free, silicon free, recyclable, having internally embedded gasket. The switchboard (panel) shall have provision for future expansion & shall be modular in construction. The bus bars shall be connected with C type clamps without any drilling on the bus bars. The panel shall be in accordance with IEC 60 439 – 1 (Fully TTA). The Degree of Ingress Protection shall be in accordance with IEC 60 529. Panel Enclosure (Internal) has to be thermoplastic polycarbonate or of the material which has equivalent or exceeds the inherent features of thermoplastic polycarbonate. Said enclosures, in addition to containing the devices and components that constitute the electrical panel, must have certain properties and characteristics that are specific for their practical use; for e.g. they must provide a suitable degree of electrical insulation, have sufficient structural strength, be easy to handle, ensure adequate resistance to the aggression of chemical and atmospheric agents, be self extinguishing, etc. It should be clean and aesthetically appreciable.

Internal panel should be totally insulated FEEDER PILLAR PANEL made out of Modular Panel Box System, Degree of Protection IP 65, in accordance with IEC 60 529, type tested in accordance with IEC 60 439 – 1.

The manufacturer of board/panel shall submit a copy of CPRI test report of Degree of Ingress Protection IP 65 in accordance with IEC 60529. The gasket material shall be Polyurethane; while the gasket shall be internally embedded.

The manufacturer of board / panel shall submit a copy of type test report of a board made out of Polycarbonate thermoplastic panel in accordance with IEC 60439-1. The report shall have mention of following tests performed and passed out satisfactorily:

1. Temperature Rise.
2. Dielectric Properties.
3. Short circuit withstand current – Rated peak & short time withstand current and Rated Conditional Short Circuit Current.
4. Effectiveness of Protective Circuits.
5. Clearance & Creep age Distance.
6. Mechanical Operation

For better safety the Polycarbonate encl shall be fire retardant & self extinguishing in accordance with IEC 60 695- 2-11, DIN VDE 0304 Part 3, UL Subject 94 for Flammability V-2. It should be tested at Glow Wire test for 960 deg. Cent.

The impact strength of polycarbonate enclosures / boards i.e. the Degree of Protection against Mechanical load shall be in accordance with EN 50298-98 for IK 08.

The lid closing and opening shall be done by quick fastening spring mechanism latches.

Compactness of the boards is main criteria due to space constraints. The board / panel should be made compact meeting the technical requirements in accordance with relevant standards and also keeping adequate space for technicians to work. The MCB/ RCCB switching operations / accessing the MCB dolly should be preferably by opening of a window flap. Window flap must be integral part of body of the box. Window flap Additional screwing by cutting the front of the box for MCB or any accessories will not be acceptable.

Note: The board manufacturer must submit the copy of type test reports for Polycarbonate Thermoplastic Board only with final arrangements as per approved GA. Test Reports submitted of other material of construction like MS, SS will not be applicable. Each

Board shall have individual routine test report of the manufacturer.

Internal Insulated enclosures of protection class II shall be made out of environment friendly, recyclable polycarbonate thermoplastic, UV Resistant, halogen & silicon free, highly impact resistant, Anti Acid, Anti corrosive : Resistant against demands caused by rains, water and corrosive atmosphere, Degree of Protection against mechanical load IK 08 in acc. with DIN EN 50 102, Color Gray RAL 7032, fire retardant, Glow Wire Tested at 960 deg. cent in acc. with IEC 60 695-2-1, DIN VDE 0304 Part 3. UL Subject 94, V – 2, Flame Retardant, Self Extinguishing, with transparent / opaque lids having tool operated / sealable / hand operated / lockable quick fastening mechanism. Modular panel box doors especially for circuit breakers should be the integral part of the top cover, Additional flap mounted on the box shall not be allowed.

Incoming & Outgoing Cable from all the directions....

Mounting Type: Free Standing Type with Canopy of 3 mm thick CRCA Sheet. Protection

Measure: Totally Insulated

Degree of Protection: IP 65 in acc. with IEC 60 529 Rated Voltage: 690 / 1100 V

Bus Bar System: electrolytic grade square type copper bus bars as per description with insulated supports.

Interconnection between solid bus bars and equipment shall be connected by means of bus bar connectors to avoid tapings on solid bus bars...

Temperature Resistance: - 40 deg. cent to + 120 deg. cent.

Distribution panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Switches shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Distribution panels in conformity with the location of cable / conduit connections. Removable sheet steel plates shall be provided at the Bottom to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram engraved on PVC sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

<b>Sr. No.</b>	<b>Criteria / Parameter</b>	<b>SMC required specification</b>	<b>Vendor specification</b>
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1.	Material of Construction of Main Feeder Pillar	Polycarbonate	
2.	Degree of Ingress	IP 65 in accordance with IEC 60529	
3.	Gasket Material of enclosure	Polyurethane	
<b>Sr. No.</b>	<b>Criteria / Parameter</b>	<b>SMC required specification</b>	<b>Vendor specification</b>
4.	Test Report The Polycarbonate Panel manufacturer shall submit the test report	<p>The Polycarbonate Panel manufacturer shall submit the test report for following type tests.</p> <ol style="list-style-type: none"> <li>1. Temperature Rise.</li> <li>2. Dielectric Properties.</li> <li>3. Short circuit withstand current – Rated peak &amp; short time withstand current and Rated Conditional Short Circuit Current.</li> <li>4. Effectiveness of Protective Circuits.</li> <li>5. Clearance &amp; Creepage Distance.</li> <li>6. Mechanical Operation</li> </ol>	
5.	Fire Retardant & Self- Extinguishing Test	The PC Enclosures shall be tested for Glow Wire Test at 960 deg. cent. in accordance IOEC 60 695 – 2 – 11	
6.	Impact Test	The PC Enclosure shall be rated for IK 08 for mechanical impact test in accordance with EN 50298-98	

**B. Protection Class**

All the indoor Panels shall have protection class of IP : 54

**C. Painting**

The painting shall be seven tank process followed by powder coating.

**D. Circuit Compartments**

Each circuit breaker and switch fuse unit shall be housed in separate compartments and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly interlocked with the breaker in 'ON' and 'OFF' position.

The door shall not form an integral part of draw out position of the circuit breaker. All instruments and indicating lamp shall be mounted on the compartment door. Sheet steel barriers shall be provided between the tiers in a vertical section.

**E. Instrument Compartments**

Separate adequate compartment shall be provided for accommodating instruments, indicating lamps, control contactors / relays and control fuses etc. These components shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the switchgear / control gear, busbar and connections.

**F. Busbars**

The busbar shall be air insulated and made of high quality, high conductivity, and high strength Aluminium / Copper.

The busbar shall be of 3 phases and neutral system with separate neutral and earth bar. The size of neutral busbar in all main panels or lighting panels and feeders for LDB shall be equal to phase busbar. The busbar and interconnection between bus bars and various components shall be of high conductivity Aluminium / Copper. The busbar shall be of rectangular cross-section designed to withstand full load current for phase bus bars and half rated current for neutral bus bars in case of APFCR panels only and shall be extensible on either side. The busbar size shall be as per drawing. The busbar shall have uniform cross-section throughout the length.

The bus bars and interconnections shall be insulated with epoxy coated bus sleeves. The busbar shall be supported on bus insulators of SMC/DMC type at sufficiently close intervals to prevent bus bars sag and shall effectively withstand electromagnetic stresses in the event of short circuit capacity of 15 KA RMS symmetrical for 1 sec.

The busbar shall be housed in a separate compartment. The busbar shall be isolated with 3 mm. thick Bakelite sheet to avoid any accidental contact. The busbar shall be arranged such that minimum clearance between the busbar is maintained as below:

Between phases	:	27 mm. minimum
Between phases and neutral	:	27 mm.
Between phases and earth	:	27 mm.
Between neutral and earth	:	20 mm. minimum



All busbar connections shall be done by drilling holes in bus bars and connecting by chromium plated or tinned plated brass bolts and nuts. Additional cross-section of busbar shall be provided in all Panels to cover up the holes drilled in the busbar. Spring and flat washers shall be used for tightening the bolts.

All connections between bus bars and circuit breakers / switches and cable terminals shall be through aluminium / Copper strips of proper size to carry full rated current. These strips shall be insulated with insulating tapes.

Panel to panel entry of bus bar shall be effectively sealed by electrical and thermal insulation barriers so that products of flashover do not travel from one panel to another panel creating multiple faults.

Bus bar shall be calculated on 50 deg. C. ambient temp. and 85 deg. C. for continuous and short time rating. Bus bar surrounding air temp. shall be considered 70 deg. C. for busbar calculation

Bus bar capacity shall be considered minimum as

under: Copper : 1 sq. mm = 1 Amp.

Aluminium 1 Sq. mm. = 0.8 Amp.

All joint shall have non-flammable insulation shrouds for secondary insulation purpose

#### **G. Electrical Power And Control Wiring Connection:**

Terminal for both incoming and outgoing cable connections shall be suitable for 1100 V grade, aluminium / copper conductor PVC insulated and PVC sheathed, armoured cable and shall be suitable for connections of solder less sockets for the cable size as indicated on the appended drawings for the Panels.

Power connections for incoming feeders of the main Panels shall be suitable for 1100 V grade aluminium conductor (PVC) cables.

Both control and power wiring shall be brought out in cable alley for ease of external connections, operation and maintenance.

Both control and power terminals shall be properly shrouded.

Clip on type terminals shall be provided up to 10 sq.mm conductor and above 10 sq.mm bolt type terminals shall be used.

10% spare terminals shall be provided on each terminal block. Sufficient terminals shall be provided on each terminal block, so that not more than one outgoing wire is connected per terminal.

Terminal strips for power and control shall preferably be separated from each other by suitable barriers of enclosures.

Wiring inside the modules for power, control, protection and instruments etc. shall be done with use of 660 / 1100 V grade; PVC insulated copper conductor wires conforming to IS: 694 & 8130 Power wiring inside the starter module shall be rated for full current rating of respective contactor, but not less than 4.0 sq.mm. cross-section area. For current transformer circuits, 2.5 sq.mm. copper conductor wire shall be used. Other control wiring shall be done with 1.5 sq.mm. copper conductor wires. Wires for connections 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.

Control power supply to modules through the control transformer only. Control power wiring shall have MCB for circuit protection. All indicating lamps shall be protected by MCB.

Particular care shall be taken to ensure that the layout of wiring is neat and orderly. Identification ferrules shall be fitted to all the wire termination for ease of identification and to facilitate checking and testing.

Spring type washers shall be used for all copper and aluminium connections.

Final wiring diagram of the Panels power and control circuit with ferrules numbers shall be submitted along with the Panels as one of the documents against the contract.

#### **H. Terminals**

The outgoing terminals and neutral link shall be brought out to a cable alley suitably located and accessible from the panel front. The current transformers 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 and only one conductor may be connected in one terminal.

#### **I. Wireways**

A horizontal / vertical metal / Al. wire way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

## **J. Cable Compartments**

Cable compartments of minimum **300 mm** size shall be provided in the Panels for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate supports shall be provided in the cable compartments to support cables. All outgoing and incoming feeder terminals shall be brought out to terminal blocks in the cable compartment.

## **K. Earthing**

Copper earth bars of 25 mm  $\square$  6 mm shall be provided in the Panels for the entire length of the panel. The frame work of the Panels shall be connected to this earth bar. Provisions shall be made for connection from this earth bar to the main earthing bar coming from the earth pit on both sides of the Panels.

The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bar. The armour shall be properly connected with earthing clamp, and the clamp shall be made for connection from this earth pit on both sides of the Panels.

The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bar. The armour shall be properly connected with earthing clamp, and the clamp shall be ultimately bonded with the earth bar.

## **L. Labels**

Engraved PVC labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside the distribution board shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.

## **M. Name Plate**

A name plate with the Panel's designation in bold letters shall be fixed at top of the central panel. A separate name plate giving feeder details shall be provided for each feeder module door.

Inside the feeder compartments, the electrical components, equipments, accessories like switchgear, control gear, lamps, relays etc. shall suitably be identified by providing stickers.

Name plate shall be engraved in Gujarati language be of 3 ply, (Red-White-Red or Black-White-Black) lamicold sheet. However, black engraved perpex sheet name plates shall also be acceptable. Engraving shall be done with square groove cutters.

Name plate shall be fastened by counter send screws and not by adhesives.

## **N. Danger Notice Plates**

The danger notice plate shall be affixed in a permanent manner on operating side of the Panels.

The danger notice plate shall indicate danger notice both in Hindi and English and with a sign of skull and bones. The danger notice plate, in general, meets the requirements of local inspecting authorities.

Overall dimensions of the danger notice plate shall be 200 mm. wide x 150 mm. high.

The danger notice plate shall be made from minimum 1.6 mm. thick mild steel sheet and after due pre-treatment to the plate, the same shall be painted white with vitreous enamel paint on both front and rear surface of the plate.

The letters, the figures, the conventional skull and bones etc. shall be positioned on plate as per recommendation of IS: 2551-1982.

The said letters, the figures and the sign of skull and bones shall be painted in signal red colour as per IS: 5-1978.

The danger plate shall have rounded corners. Location of fixing holes for the plate shall be decided to suit design of the Panels.

The danger notice plate, if possible, is of ISI certification mark.

## **O. Internal Components:**

The Panels shall be equipped complete with all types of required number of MCCB's, contactors, relays, fuses, meters, instruments, indicating lamps, push buttons, fittings, bus bars, cable connectors etc. and all the necessary internal connections / wiring as required and as indicated on relevant drawings. Components necessary for the proper and complete functioning of the Panels but not indicated on the drawings shall be supplied and installed on the Panels.

All parts of the Panels carrying current including the components, connections, joints and instruments shall be capable of carrying their specified rated current continuously, without temperature rise exceeding the acceptable values of the relevant specifications at the part of the Panels.

All units of the same rating and specifications shall be fully interchangeable.

## **1.7 Component**

### **s 1.7.1 General**

The type, size and rating of the components shall be as indicated on the relevant drawings.

While selection of the capacity of the components resulting from the prevailing conditions like ambient temperature shall be allowed for the thermal and magnetic trip rating shall be compensated for the ambient temperature.

The rating indicated on the drawing is ratings anticipated at prevailing site conditions.

### **1.7.2 Air Circuit Breaker**

#### **A. Construction**

The ACBs shall have following features:

- Motorized with 230 V A.C. motor.
- 230 V A.C closing and shunt trip coil
- Draw out type with "service", "test", "isolated" and "maintenance" position.
- Safety shutter of Fibre glass / polycarbonate sheet of 2mm thickness shall be provided
- Mechanically trip free plus antipumping feature is to be provided.
- Electrical trip free plus anti pumping shall be provided with relay ONLY and not by contactors.
- Electrical/Mechanical operation counter shall be provided.
- Door interlock with defeat features to be provided.
- ACB shall be lockable in isolation position.

#### **B. Release**

- Microprocessor based release shall be direct acting type, tripping ACB mechanically.
- Short circuit, overload and earth fault protection shall be provided.
- Vendor to suggest release type for feeders of supply range characteristic and accuracy.

#### **C. ACB Performance**

- ACB performance inside panels at ambient 50 Degree.
- The Symmetrical breaking, 50KA
- Making capacity peak 87.5 KA
- Short time rating , 1sec. 50KA

#### **D. Incomer ACBs**

All **incomer** ACBs shall have following additional protections other than mentioned above.

- Under and over voltage
- Under and over frequency
- Restricted Earth Fault protection
- Trip Circuit supervision with PS class CT's.
- Undercurrent, ( DG set only)
- Reverse power ( DG set only)
- Phase sequence reversal ( DG set only)
- Load shedding and reconnection thru programmable contacts.
- Release should display the Contact wear indication.

The release should provide local indication of actual %age loading at any instant. The release should be able to communicate on MODBUS RTU protocol using inbuilt RS485 port and shall be integral part of supply with trip unit. Parameters of the Protection Release should be changeable from Release as well as thru communication network. Release should have graphical LCD for display of power parameters. The release should provide comprehensive metering with the following parameters

- Phase currents (running, avg & max) – All parameters in single window.
- Release should be able to capture short circuit current on which ACB has tripped. The last ten trips and alarms shall be stored in memory with the date & time stamping along with type of fault and alarm. The sensing CT Should be Rogowsky type with measurement precision of 1%.
- Release should be self powered .
- Release should have facility to select different type of IDMTL protection(DT,SIT,VIT,EIT,HVF) for better co-ordination with HT Breaker/Fuse.
- Phase voltages (running, avg & max)
- Energy & power parameters (active, reactive and apparent)
- PF
- Frequency
- Maximum Demand ( KVA & KW)
- Total Harmonics distortion

#### **E. O/G ACBs**

All **O/G** ACBs shall have following functions.

##### **Protection**

- The ACB control unit shall offer the following protection functions as standard:
- Long-time (LT) protection with an adjustable current setting and time delay;



- Short-time (ST) protection with an adjustable pick-up and time delay;
- Instantaneous (INST) protection with an adjustable pick-up and an OFF
- Position.
- Current and time delay setting shall be indicated in amperes and seconds respectively

- On a digital display.
- Earth-fault protection with an adjustable pick-up and time delay shall be provided if indicated on the appended single-line diagram.

### **Measurements**

- An ammeter with a digital display shall indicate the true rms values of the currents for each phase. Release shall acknowledge the current & time delay settings done by user on the LCD display.
- A LED bar graph shall simultaneously display the load level on the three phases.
- A maxi meter shall store in memory and display the maximum current value observed since the last reset. The data shall continue to be stored and displayed even after opening of the circuit breaker.

### **Safety Features**

- i. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.
- ii. It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.
- iii. There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.
- iv. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.
- v. It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.
- vi. Draw out breakers should not close unless in distinct Service/Test/Isolated positions.
- vii. The insulation material used shall conform to Glow wire test as per IEC60695.
- viii. The ACB shall provide in built electrical and mechanical anti-pumping.
- ix. All EDO ACB's Shall have Ready to Close Contact to ensure that the ACB gets a command only when it is ready to close for applications of Remote Control, AMF, Synchronization and Auto Source Change Over Systems.

### **1.7.3 Moulded Case Circuit Breaker**

The moulded case circuit breaker (MCCB) shall be air break type and having quick make - quick break with trip free operating mechanism.

Housing of the MCCB shall be of heat resistant and flame retardant insulating material.

Operating handle of the MCCB shall be in front and clearly indicate ON/OFF/TRIP positions.

The electrical contacts of the circuit breaker shall be of high conducting non deteriorating silver alloy contacts.

The MCCB shall be provided with thermal / magnetic type bi-metal overload release and electromagnetic short circuit protection device. All the releases shall operate on common trip busbar so that in case of operation of any one of the releases in any of the three phases, it will cut off all the three phases and thereby single phasing of the system is avoided.

The MCCB wherever called for in the appended drawings shall provide an earth fault relay.

The MCCB shall provide two sets of extra auxiliary contacts with connections for additional controls at future date. The electrical parameters of the MCCB shall be as per the description given in the appended drawings.

Draw out type MCCB shall be provided for the feeder indicated in the single line diagram. The MCCB shall be provided with 230 V A.C motor for closing and tripping / switching off for the feeders if indicated in single line diagram.

**MCCB should be with following:**

- i. Free Alarming for O/L, Healthiness check of the Breaker, Fault Differentiation on front of the MCB from Display / LED.
- ii. All MCCB should be Communicable & have all kind of communication accessories within built metering should support open / Modbus protocol.
- iii. MCCB should provide switch board display unit for panel cut-out.

**1.7.4 Fuse**

Fuses shall be of high rupturing capacity (HRC) fuse links and shall be in accordance with IS: 2000-1962 and having high rupturing capacity of not less than 15KA at 415 V. The back-up fuse rating for each motor / equipment shall be so chosen that the fuse does not operate on starting of motors / equipment. HRC fuses shall be of the make as specified in Make of Material.

**1.7.5 Miniature Circuit Breakers**

Miniature Circuit breakers shall be current limiting type conformed with British standard BS: 3871 (Part I) 1965 and IS: 8828. The housing of MCBs shall be heat resistant and having high impact strength. The fault current of MCBs shall not be less than 10KA at 230 V. The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical 'ON' and 'OFF' indications.

The circuit breaker dollies shall be of the trip free pattern to prevent closing the breaker on a faulty circuit.

The MCB contacts shall be silver nickel and silver graphite alloy and tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCBs shall be provided with magnetic fluid plunger release for over current and short circuit protection. The overload or short circuit device shall have a common trip bar in the case of DP and TPN miniature circuit breakers. All the MCBs shall be tested and certified as per Indian Standards, prior to installation.

**1.7.6 Contactors**

The contactors shall meet with the requirements of IS: 13947 and BS: 771.

The contactors shall have minimum making and breaking capacity in accordance with utilization category AC3 and shall be suitable for minimum Class II intermittent duty.

If the contactor forms part of a distribution board then a separate enclosure is not required, but the installation of the contactor shall be such that it is not possible to make an accidental contact with live parts.

**1.7.7 Voltmeter**

Voltmeter shall be digital. The dial of the meter shall be square in shape of 96 x 96 mm.

The voltmeter selector switch shall be arranged to provide line to line voltage reading and line neutral voltage.

**1.7.8 Ammeter**

Ammeter shall be digital. The dial of the ammeter shall be square in 96 x 96 mm. Separate current transformer

shall be provided for all ammeters.

#### **1.7.9 Current Transformer**

Where ammeters are called for C.T.s shall be provided for current measuring. Each phase shall be provided with separate current transformer of accuracy Class I and suitable VA burden for operation of associated metering and controls. Current transformer shall be in accordance with IS: 2705 - 1992 as amended up to date.



#### **1.7.10 Push Buttons**

The push button unit shall comprise of the contact element, a fixing holder, and a push button actuator. The push button shall be momentary contact type. The contacts shall be of silver alloy and rated at 10 Amps. Continuous current rating. The actuator shall of standard type and colour as per its usage for ON, OFF and TRIP. Wiring for Remote ON, OFF push button is to be required.

#### **1.7.11 Indicating Lamps**

Indicating lamps assembly shall be screw type with built in resistor having non fading color lens. **LED** type lamps are required. Wiring for Remote ON, OFF, TRIP indicating lamp is required.

Colour shade for the indicating lamps shall be

as below: ON indicating lamp :

Red

OFF indicating lamp : Green

TRIP indicating lamp : Amber

PHASE indicating lamp : Red, Yellow, and Blue

TRIP circuit healthy lamp : Milky

### **B. Power Factor Correction System With Detuned Filter**

#### **1.1 Scope**

Design, manufacture, supply, erection, testing and commissioning of Indoor type power correction capacitor banks for power factor improvement as per specification given below:

#### **1.2 Standard**

Unless otherwise stated below, the capacitor shall comply with the following standards (and their latest amendments): IS 13340-1993, IS 13341-1992, IEC 60831-1+2

#### **1.3 Rating**

50 KVAR (or less) capacitor units as specified in the BOQ shall be used to form a bank of capacitors of desired capacity.

#### **1.4 Enclosure**

The panel shall be indoor type, free standing, and floor mounting with IP42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure with angle supports as necessary and shall be finished with powder coating in the approved colour shade/s to match the colour of the other panels. The thickness of powder coating should be minimum 60-80 microns.

Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided as a necessary.

The front portion shall house the switchgear and the rear portion shall house capacitors and series reactors. The enclosure is to be suitably sized to accommodate all the components, providing necessary air clearance between live and non-live parts, providing necessary working clearance.

### 1.5 APFC Relay / Controller

Microprocessor based IPFC relay (Intelligent VAr controller) shall sense the PF in the system and automatically switch ON / OFF the capacitor unit or stage to achieve the preset target PF. The controller shall have the following features:

- Digital settings from all the 3 phases for parameters like PF, Switching time delay, Step limit etc.
- Indication of PF, preset parameters.
- Minimum threshold setting of 1% of CT current.
- No-volt release.
- Protective shut down in case of harmonic overload.
- Indication for Failure to achieve the target PF, Harmonic overloading, Step failure etc.

### 1.6 Construction

Each basic unit of mixed dielectric extra low loss / All Poly Propylene (APP) / GAS Filled capacitor shall be built with a number of elements. These elements shall be combination of capacitor tissue paper and biaxially oriented polypropylene film impregnated with non PCB bio-degradable impregnant or Film Foil capacitor manufactured using Poly propylene film placed between 2 layers of metal foil and winding. The elements shall be connected to the external bus bars through these leads in a series parallel connection to form a three phase unit.

The capacitor units shall be floor mounting type using minimum floor space. The container of capacitors shall be made out of 2 mm thick M S sheet steel of polyester paint coated finish. Each standard unit shall be provided with internal fuses (operation co-ordinate with case-rupture characteristics to avoid rusting).

Total Harmonic Distortion (THD) of up to 5% on voltage and current waveforms shall not affect the life of capacitors.  $660 \pm 10\%$  variation in line voltage shall not affect the life of the capacitors.

### 1.7 Capacitors

- General specifications: 3 phase, delta connected, 50 Hz.
- Voltage: Must be designed to withstand system over voltage, increased voltage due to series reactor and harmonics.
- Capacitor type: Super heavy duty with double side metalized capacitor tissue paper. Gas Filled and self-healing type with bi-axially oriented polypropylene film shall be fitted with pressure sensitive disconnect in each individual capacitor cell.
- □ Over voltage +10% (12h / 24h), + 15% (30m / 24h), + 20% (5m), +30% (1m) as per Clause 6.1 of IS 13340-1993.
- Over current :  $2.5 \times I_n$
- Peak Inrush current withstand :  $350 \times I_n$



- Total watt-losses including discharge resistors:  $\leq 0.45 \text{ W / k V Ar}$ .
- Temperature category: -25 deg. C to 70 deg. C.
- Capacitor shall be self-heating type and oil impregnated for longer life. The impregnant shall be non-PCB, biodegradable type, must be properly treated and de-gasified, so as not to have any degeneration properties and shall be non-oxidizing.
- The design shall be modular for simple mechanical assembly, no extra accessories / metal parts to be required. Unit must be free standing with an IP 41 protection level.

### **1.8 Discharge Resistance**

Capacitors shall be provided with permanently connected discharge resistors so that residual voltage of capacitors is reduced to 50 volts or less within one minute after the capacitors are disconnected from the source of supply.

### **1.9 Terminals**

Each capacitor bank shall be provided with a terminal chamber and cable glands suitable for PVC insulated aluminium conductor armoured cables as specified.

### **1.10 Earthing**

Two separate earthing terminals shall be provided for earth connection of each bank.

### **1.11 Low Voltage Filter Reactor**

Filter reactor shall be series type having a three phase, iron core construction suitable for indoor use. The reactor shall be air cooled and the layout shall be in accordance with IEC 76. The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin and shall be suitable for temperature class H operation. The reactor coils shall be wound with high grade aluminium / copper and termination shall be provided with suitably designed copper bars.

### **1.12 Testing**

The reactor shall be tested using a separate source voltage test of 3 KV (coil to core) for one minute as per IEC 76/3. The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuit in case of high operating temperature.

### **1.13 Series Reactor Application**

on

LV Harmonic Filters shall be used with harmonic filter duty power capacitors to mitigate harmonics, improve power factor and avoid electrical resonance in LV electrical networks.

### **Construction, Testing & Protection**

The low voltage filter reactor shall be series type having a three phase, iron core construction

suitable for indoor use (IP 00). The reactor shall be air cooled and the layout shall be in accordance with IEC 60076.

The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin and shall be suitable for temperature Class H (T60/H) operation.

The reactor shall be tested using a separate source voltage test of 3.0kV (coil to core) for 1 minute as per IEC 60076/3.

The permitted tolerance of inductance shall be + 3% of rated inductance value.

Reactor tuning factor shall be **13%** and the current rating of the reactor shall include the effects of harmonics and other possible over-currents.

The limit of linearity of inductance of the filter reactor shall be as follows  $1.2 \square \square \square \square \square$  with  $L = 0.95 L_N$

The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuits in case of high operating temperatures.

#### **1.14 Switchgear & Protection**

Incomer switchgear shall be TP&N breaker appropriate rating. Suitable contactor for each step shall be used and must be capable of capacitor switching duty at each step for short circuit protection.

Bus bars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cables used shall have superior mechanical, electrical and thermal properties, and shall have the capability to continuously operate at very high temperatures up to 125 deg.C.

Internal wiring between main bus-bars, breaker, contactor and capacitors shall be made with 1100 V grade, PVC insulated, copper conductor cable of appropriate size, by using suitable copper crimping terminal ends etc.

Suitable bus links for input supply cable termination shall be provided.

#### **1.15 Control Circuit & General Protection**

The control circuit shall be duly protected by using suitable rating MCB.

An emergency stop push button shall be provided to trip the entire system (22.5 mm dia., mushroom type, press to stop and turn to reset).

Wiring of the control circuit shall be done by using 1.5 sq.mm, 1100 V grade, PVC insulated, multi-stranded copper control wire.

Inspection terminal strip, number ferruling, labelling etc. shall be provided. 440 V caution board on the panel shall be provided.

#### **1.16 Testing**

The capacitor bank shall be subject to tests as specified in relevant Indian Standards at the factory and the test certificates shall be furnished.

### **1.17 Installation**

Capacitors banks shall be installed as per installation manual of supplier and shall conform to relevant Indian Standards.

All interconnections in the control panel shall be checked before commissioning.

Cable end boxes shall be sealed after cable connections to prevent absorption of moisture.

15 mm thick rubber matting of an approved make over a 100 mm high Timber platform shall be provided in front of the full length of the capacitor bank and control panel.

### **1.18 Testing And Commissioning**

- i. Insulation resistance shall be tested with a 1000 volts megger between phases and phase to earth.
- ii. Residual voltage shall be measured after switching of the capacitors and the same shall not be more than 50 volts after one minute.
- iii. Each discharge resistor shall be tested for its working.

## **C Lightning And Surge Voltage Protection**

### **1.1 Scope**

The work required under this section shall include all material, labour and auxiliaries required to furnish and install complete Surge Protection Devices at main LT Panel incoming feeders (Stage I / Class B) & Distribution Boards (Stage II / Class C) for the protection of Building electrical and Electronics system from the effect of Lightning discharges, line induced transient surge voltage or switching surges as per the details.

### **1.2 Codes & Standards**

The following standards & publications as referred in the various parts of this Specification shall apply.

- ☐ IEC-61643-11, IEC-61643-12
- ☐ IEC 60 364 – 5 – 5 53
- ☐ IEC 62 305 - 4

### **1.3 Product Specifications**

#### **1.3.1 Surge Protector At Stage I / Class B (L T Panel Protector)**

The Surge Protection Device (SPD) manufacturer shall offer a complete line of Surge Protection Devices to support the requirements for Main LT Panel Incoming feeders. The surge protector at this stage shall be provided to protect the downstream electrical and electronics against any lightning discharges surges that may enter into the system through Main panel.

The Protection unit shall be based on single arc spark gap technology and shall be able to withstand 10/350 microsecond surge currents associated with external lightning discharges.

#### **1.3.2 Protection Network Configuration**

The work required under this section consists of furnishing, installing and connecting SPD device as specified and as asked for in BOQ. The SPD device shall be installed in a NETWORK configuration, consisting of one set of SPD panel device at the service entrance of switchboard. All SPD devices in

this network configuration shall be of same manufacturer. All SPD devices shall be modular, mountable on 35 mm DIN rail.

Unit status indicator shall be provided to indicate the status of complete Protection unit.

Protection shall be manufactured for the specific type and voltage of the electrical Service and shall provide clamping for both normal (L-N) and common (N-G) mode operation.

Protection shall be manufactured to withstand a maximum continuous operating voltage of not less than 115% of normal RMS Line voltage of 240 V.

The Protection shall be provided with safety MCB's to be connected in series between Line/s to neutral & neutral to earth as per the TNS configuration of wiring. It shall be testable on line for routine maintenance, module failure and in order to prevent catastrophic failure modes.

Protection shall be a fail-safe type device, shall have a follow through current quenching capacity up to 25 KA r.m.s., shall have repeated surge capability state, shall be self restoring and be fully automatic in all mode of operation.

Protection shall comply with IEC 61643 and shall be approved for the location in which they are listed. Protection shall have an operating temperature ranges from -20°C to 60°C.

### 1.3.3 Protection Criteria

- The maximum continuous operating voltage (Rated Voltage) for SPD devices connected to phase-neutral shall not be less than the values shown in table:

Nominal Voltage Rating per phase	Maximum Continuous Operating Voltage
(Vrms)	(Vrms)
240	320

- The surge protective device and associated hardware must comply with IEC 61643-11.
- The Protection voltage of the complete rail mount surge protective device shall be type test to the figures as indicated in table below, which must not exceed the values shown.

Service Voltage / per phase	Protection Voltage @ In (Nominal discharge current) /
240 V	< 2.5 k V (between Line to Neutral) 1.5 kV (between Neutral to Earth)

- Surge protective device application at Low Voltage AC main LT Panel incoming feeder surge impulse current withstanding capacity as shown in table below.

Application Panel Location	Max. Single Withstand Surge Current (of 10/350 $\mu$ s Impulse)
----------------------------	--

Service Entrance (Main LT Panel)	$\geq 25$ KA, 10/350 $\mu$ s (between Line to Neutral) 100 KA, 10/350 (between neutral to Earth)
----------------------------------	---

- Compliance to this specification must be provided in the form of a certificate from an independent testing laboratory.
- Response time of stage-I class –B arrester should not be < 100 ns. Visual Indication of the flag in the surge arrester (Line to Neutral) Healthy condition : Green Colour  
Faulty condition : Red Colour

**Protection for Sensitive Equipments at the input of the end equipments like UPS, VFD's or at Important MCB DB's feeding power to Computer / Server etc**

#### **1.3.4 Surge Protector At Stage II / Class-C (Final Distribution Board Protector)**

- The surge Protection manufacturer shall offer a complete line of surge Protection product to support the requirements for the Distribution Board. The surge protector at this stage shall be provided to protect the downstream electrical and electronics against any induced switching surges that may be passed on to the downstream electrical & electronic system.
- The Protection unit shall be based on Single High Capacity Metal Oxide Varistors (MOV), capable of handling 8/20  $\mu$ s surges and shall be able to give an indication in the event module failure and be pluggable to facilitate the in-service replacement without distributing the lines. One extra set of replacement module shall be furnished to the job site.
- Protection Network Configuration - The work required under this section consists of furnishing, installing and connecting SPD device as specified and as shown in the drawings. The SPD device shall be installed in a NETWORK configuration, consist of one set of SPD panel device at the service entrance of switchboard. All SPD devices in this network configuration shall be of same manufacturer. All SPD devices shall be modular, mountable on 35 mm DIN rail and be field replaceable without interruption of electrical distribution circuit.
- Unit status indicator shall be provided to indicate the status of complete Protection unit on the product as well as provision for remote indication must be provided.
- Protection shall be manufactured for the specific type and voltage of the electrical Service and shall provide clamping for both normal (L-N) and common (N-G) mode operation.
- Protection shall be manufactured to withstand a maximum continuous operating voltage of

not less than 115% of normal RMS Line voltage of 240 VAC.

- The Protection shall be provided with internal safety fusing if required, to be connected in parallel between Line/s to neutral & neutral to earth as per the TNS configuration of wiring. It shall be testable on line for routine maintenance, module failure and in order to prevent catastrophic failure modes.
- Protection shall be a fail-safe type device, shall have no follow through current shall have repeated surge capability, shall be solid state, shall be self restoring and be fully automatic in all mode of operation. It shall have thermal disconnection and indication against overloading of the device.

Protection shall comply with IEC 61643 standards.

Protection shall have an operating temperature ranges from -20°C to + 60°C.

### Protection Criteria

The maximum continuous operating voltage (Rated voltage) for SPD devices connected to phase-neutral shall not be less than the values as shown in table below:

Nominal Voltage Rating per phase (Vrms)	Maximum Continuous Operating Voltage (Vrms)
120	150
240	320
350	440
480	600

The surge protective device and associated hardware must comply with IEC 61643-11.

The Protection voltage of the complete rail mount surge protective device shall be type test to the figures as indicated in table below, which must not exceed the values shown.

Service Voltage / per phase	Protection Voltage @ In (Nominal discharge current) /
240 V	1500 V

Nominal Withstand Surge Current.

Surge Protective device (including all fusing and over current protection) for application at sub-

Distribution Panels shall have a Nominal surge current withstand capacity as shown in table below. The failure or operation of any fuse / over – current device during the test is not permissible.

Application Panel Location	Max. Single Withstand Surge Current Of 8/20 $\mu$ s
Sub-Distribution Panel	10KA for 8 / 20 $\mu$ s (between Line to Neutral)
Final Distribution Board	$\geq 25$ KA for 10/350 $\mu$ s (between Neutral to Earth)

Compliance to this specification must be provided in the form of a certificate from an independent testing laboratory.

Response time of Class C arrestor should not be  $< 25$  ns.

Visual Indication of the flag in the surge arrester (Line

to Neutral) Healthy condition : Green Colour

Faulty condition : Red Colour

#### **Visual Indication of the earth healthiness in the surge arrestors (N-PE)**

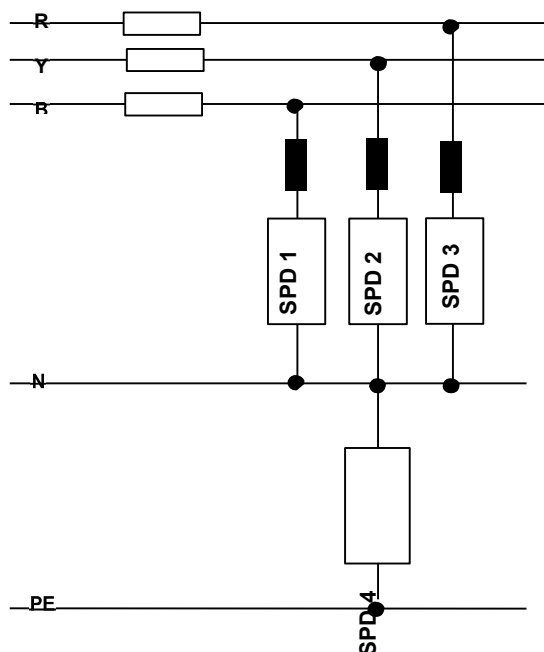
Healthy earth : Green color LED indication

No earth : Red color LED indication

Healthy earth: Green color LED indication

No earth: Red color LED indication\*\*

#### **Connection diagram for SPD for 3 phase 4 wire network**



F1, F2, F3 - : Incoming ACB/MCCB/SFU

F4, F5, F6        -: MPCB / MCB for Surge Arrester  
R, Y, B and N   -: RYB and N Bus bar or looping after  
the incomer PE    -: Earth Bus bar in the panel  
SPD1, 2, 3       -: Surge Arrester to connect between Line  
and Neutral SPD 4 -: SPD to connect between Neutral  
and Earth.

### **FIRE SEALANT AS PER NEC**

Fire sealants according to NEC – National Electrical Code 2011; SP 30 (by Bureau of Indian Standards) as per the following specification should be used to reduce the spread of fire through electrical installation.

All wiring system which passes through the building construction –viz- floor, walls, roof, Sceilings, partitions etc., the openings (after the passage of wiring systems and pipes) shall be sealed to avoid spreading of fire and smoke. All wiring system viz- conduits, cable ducting, cable trunking shall be internally sealed to maintain the degree of fire resistance as well as externally sealed to maintain required fire resistance. A non flame propagating wiring system having a maximum internal cross section of  $710\text{mm}^2$  need not be internally sealed. All wires/bunch of wires running in vertical cable shafts should be wrapped with fire-protected bandage as below. The manufacturers certificate as well as inspection report / label to be prepared during the installation and should be recorded. These papers are to be handed over to the appropriate authority to comply to the verification requirements according to National Electrical code – Bureau of Indian standards.

#	Description
1	<p>Fire resistant Mortar with fire resistance class S90 according to testing standard DIN 4102 Part 9 DIBT approval Z- 19.15 – 2046 suitable to seal the openings with all kinds of cables, pipes and cable support system in steel and , aluminium and plastic profiles ( Except hollow core conductors). The residual openings shall be closed with filler.</p> <p>The maximum size of the opening shall be 100 x 200 cm and the minimum insulation thickness shall be 15cm. Approved make – Pyromix of OBO Bettermann or equivalent</p>
2	<p>Fire Protection foam from with fire resistance class to EI120 according to testing standard EN 1366 PART 9 approval ETA -11/0527, VKF 22552,22553,22554,22555 suitable to seal the openings with a combination insulation cables, pipes and the cable trays ( Except hollow core conductors ). The maximum size of the opening shall be 45 x 45 cm and in case of hole the max diameter shall be 30 cm, and the minimum insulation thickness shall be 10 cm for massive wall and lightweight partition wall, 15 cm for solid ceiling.</p>



3	Fire resistant cable bandage for wrapping of cable with or without cable trays in vertical shafts with a fire resistance class of 90 minutes according to testing standard IEC 60332-3-22: 2000-10. The Outer side of the sheet shall be of grey and the inner side shall be of white in colour. The protection sheet shall behave material properties DIN 4102/2B1 with no restriction in cable types and diameters. The maximum fastening spacing shall be of 500mm.  Approved make – Cable Bandage FSB-BS of OBO Bettermann or equivalent
4	Fire resistant sleeves with metal housing with fire resistance class S90 suitable to seal plastic pipes passing through fire resistance areas, according to testing standard DIN 4102 Part 9 approval no Z-  resistant sleeves shall be used along with combination of other fire sealants. The residual openings shall be closed with filler.  Approved make - Pyrocomb pipe sleeve of OBO Bettermann or equivalent.

## 1.8 Shop Drawings

Prior to fabrication of the Panels the supplier / contractor shall submit for consultant's approval the shop / vendor drawing consisting of G.A. drawing, sectional elevation, single line diagram, bill of material etc. and design calculations indicating type, size, short circuiting rating of all the electrical components used, busbar size, internal wiring size, Panels dimension, colour, mounting details etc. in 6 sets.. The contractor shall also submit manufacturer's catalogues of the electrical components installed in the Panels along with the drawing.

The following shall be furnished as part of the Tender:

- a) General arrangement showing plan, elevation and typical sectional views.
- b) Technical literature on the various equipment.
- c) The following shall be furnished after award of contract for Purchaser's approval :
  - i. General arrangement showing plan, elevation and typical section views.
  - ii. Foundation plan showing location of fixing channels, floor opening etc.,
  - iii. Schematic wiring drawings for each feeder.

### 1.8.1 DOCUMENTATION :

1.8.1.1 Vendor shall furnish drawings, data and manuals in six sets along with equipment supplied.

- General arrangement drawing indicating accessories and dimensions.
- Foundation plan and loading.
- Termination arrangement with dimensions.
- Three phase wiring diagrams
- SLD's and control schemes
- Terminal plans
- Bill of quantity for each panel.

1.8.1.2 Documents to be submitted after placement of order.

- As per 2.1 above for comments and approval for manufacture.
- Schematic and sectional drawing.

### **1.9 Inspection**

At all reasonable times during production and prior to transport of the Panels to site, the supplier / contractor shall arrange and provide all the facilities at their plant for inspection.

### **1.10 Test Certificates**

Testing of Panels shall be carried out at factory and at site as specified in Indian standards in the presence of Employer.

## **E8. Lighting Fixtures & Accessories**

The lightfixtures and fittings shall be assembled and installed in position complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the Project Manager.

### **1.1 Scope**

Scope of work under this section shall include inspection at suppliers/manufacturer's premises at site, receiving at site, safe storage, transportation from point of storage to point of erection, erection and commissioning of light fittings, fixtures and accessories including all necessary supports, brackets, down rods and painting etc as required.

### **1.2 Codes & Standards**

(A) The equipment shall comply with all currently applicable electricity rules, approval of fire insurance, association, statutory regulations and safety codes in the locality where the equipment will be installed.

(B) Unless otherwise specified equipment shall conform to the following latest applicable IS Standards. Equivalent IEC /BS standards shall be used as applicable

#### **List of Codes and Standards :**

<b>Sr. No.</b>	<b>Codes and Standards</b>	<b>Year</b>	<b>Description</b>
1	IS:10322 Part5 /Sec3	2012 (Reaffirmed 2017)	Luminaires – Luminaires for road and street lighting.
2	IS: 16101	2012 (Reaffirmed 2017)	General Lighting - LEDs and LED modules- Terms & Definitions
3	IS:16102 (Part 1)	2012 (Reaffirmed 2017)	Self-Ballasted LED Lamps for General Lighting Services Part 1 Safety Requirements.
4	IS:16102 (Part 2)	2017	Self-Ballasted LED Lamps for General Lighting Services Part 2 Performance Requirements.
5	IS:16103 (Part 1)	2012 (Reaffirmed 2017)	LED Modules for General Lighting Part 1 Safety Requirements
6	IS:16103 (Part 2)	2012 (Reaffirmed 2017)	LED Modules for General Lighting Part 2 Performance Requirements
7	IS:15885 (Part2/Sec13)	2012 (Reaffirmed 2017)	Safety of Lamp Control Gear Part 2 Particular Requirements Section 13 dc or ac Supplied Electronic Control gear for LED Modules.
8	IS:16104	2012 (Reaffirmed 2017)	dc or ac Supplied Electronic Control gear for LED Modules- Performance Requirements.
9	IS:16105	2012 (Reaffirmed 2017)	Method of Measurement of Lumen Maintenance of Solid-State Light (LED) Sources.

10	IS:16106	2012 (Reaffirmed 2017)	Method of Electrical and Photometric Measurements of Solid-State Light (LED) Products.
11	IS:16107(Part 1)	2012 (Reaffirmed 2017)	Luminaires Performance Part 1 General Requirements.
12	IS:16107 (Part 2/Sec1)	2012 (Reaffirmed 2017)	Luminaires Performance Part 2 Particular Requirements Section 1 LED Luminaire.
13	IS:16108	2012 (Reaffirmed 2017)	Photobiological Safety of Lamps and Lamps Systems.
14	EN 55015	2016	Limits and methods of measurement of radio disturbance characteristic of electrical lighting & similar equipment.
15	IEC 60529	2013	Classification of degree of Protections provided by enclosures
16	IEC 62031	2018	LED modules for general Lighting-Safety requirements.
17	EN 61547	2009	Equipment for general lighting purposes. EMC immunity requirement
18	EN 60929	2011	Performance, AC supplied electronics ballast for tubular fluorescent lamps performance requirement.
19	IEC 60598-2-1	1979	Fixed general purpose luminaries
20	IEC 60598-1	2017	Luminaries - General requirement and tests
21	IEC 61000-3-2	2018	Electro Magnetic compatibility (EMC) - Limits for Harmonic current emission -. (Equipment input current. $\geq 16$ Amps. per phase
22	IEC 60068-2-38	2009	Environmental Testing: Test Z- AD: composite temperature/humidity cyclic test
23	IEC 61347-2-13	2016	Lamp control gear: Particular requirements for DC or AC supplied electronic control gear for LED modules.
24	LM 79		LED luminaire photometry measurements.
25	LM 80		Lumen Maintenance
26	IEC 62384	2011	DC or AC supplied electronic control gear for LED modules performance requirements
27	IEC 61347-1	2015	Lamp Control gear - General and safety requirement

### 1.3 Light Fittings-General Requirements:

a) Lighting fittings shall be heavy duty type and suitable for 240V  $\pm$  6%. Single phase, 50Hz,  $\pm$ 3%, AC. System for continuous operation.

(a) Lighting fittings shall be heavy duty type and suitable for 240V  $\pm$ 6%, single phase, 50Hz  $\pm$ 3%, A.C. system for continuous operation.

(b) The terminals shall be non-corrosive, easily accessible and clearly marked.

(c) The wiring and insulation inside fittings shall be non-hygroscopic.

(d) The variation in voltage and frequency in the system shall be + 6% and + 3% respectively.

(e) Electronic Ballast/Driver shall be provided for LED light fitting, Driver shall be high frequency, low maintenance and energy saving, conforming to following international standards. Total Harmonic Distortion (THD) shall be less than 10% with constant wattage output, at all voltages and without any stroboscopic effect. For LED Light fittings One (1) Driver shall control a group of LED's. Drivers shall be provided with internal Harmonics filters to reduce THVD to below 10%

i.	Safety	-	IEC 61347-1,2015
ii.	Performance	-	EN60929,2011
iii.	Mains Harmonicas	-	IEC 61000-3-2,2018
iv.	Immunity to interference	-	EN61547, 2009
v.	Immunity to Radio Frequency Interference (RFI)	-	EN55015, 2016

### 1.4. Light Fittings – Constructional Features

(a) The LED fitting shall be with Pressure die-cast aluminium for Floodlight, Streetlight, Highbay & Downlighter luminaire. /CRCA (Cold Rolled Close Annealed) powder coated enclosure for recess 2X2 and 1X4 luminaire.. The enclosure shall withstand or be treated against corrosion.

(b) Housing, if not used as a heat sink shall be made of at least 0.5 mm thick sheet Steel conforming to relevant standards CRCA, polyester powder coated of at least 40 microns and high U.V. & corrosion resistance. For mid flux LEDs the thickness shall be designed such that heat dissipation shall meet the relevant standards.

(c) Heat sink used should be aluminium extrusion/pressurized having high conductivity preferably to grade 6061 alloy or better having thermal conductivity of at least 170-180 W/mK or Aluminium die cast having high conductivity preferably ADC 12 or LM 24.

(d) Efforts shall be made to keep the overall outer dimensions as minimum as possible.

(e) All luminaries shall be provided with high efficiency (min. 87%) prismatic diffuser under the LED chamber to protect the LED and luminaries (thickness not less than .8mm for down light and 1.2 for linear diffusers)

(f) Fixture/light shall not show yellowness during luminaire life time.

(g) Suitable number of LED lamps shall be used in the luminaire to achieve the desired lux level or the purpose.

(h) Suitable reflector / lenses may also be provided to increase the illumination uniformity and distribution.

(i) Design of the thermal management shall be done in such a way that it shall not affect the properties of the diffuser.

(j) All sealing and mating surface shall be smooth and provided with continuous gasket made of suitable

material.

- (k) Wherever reflectors have to be used they shall be of high efficiency, low decay reflecting surfaces.
- (l) Wire guard shall be of M.S. wire, zinc plated and passivated or stove enamelled grey colour painted.
- (m) For street lighting and flood lighting fittings, housing shall be of cast aluminium LM6 grade, painted grey outside and white inside
- (n) Components used in all equipment shall be of approved make.
- (o) All outdoor lighting fitting shall have min IP 65 degree of protection.
- (p) Lumen output of each luminaire shall be as specified in Data sheet / Material take off (MTO).
- (q) Danger Caution Board shall be provided as per CEA regulations

## 1.5. Features of LED

- 1.5.1 High power and high lumen efficient LEDs suitable for following features shall be used:
  - a. The efficiency of the LED lamps at 85 Deg C junction temperatures shall be more than 90%.
  - b. The working life of the lamp at junction temperature of 85 Deg C at rated current shall be more than 50,000 working hours of accumulative operation and shall be suitable for continuous operation of 24 hours per day. These features shall be supported with datasheet.
  - c. Adequate heat sink with proper thermal management shall be provided.
  - d. Colour temperature of the proposed white colour LED shall be 6500k/5700k/3000k/4000k.
  - e. The output of LED shall be at least 100 lumens per watt at minimal operating current and shall ensure guaranteed operation life of 50,000 burning hours with controlled junction temperature of 85 deg. C.
  - f. Lumen maintenance report as per LM 80 guidelines shall be produced for the power LEDs used.
  - g. Power factor of complete fitting shall be more than 0.9 at full load 180-240V.
  - h. Thermal management shall be in such a way that LED soldering point temperature shall not go beyond 75 degree centigrade.
  - i. Input frequency range shall be between 50Hz $\pm$ 3%.
  - j. The LED luminaire shall be free of glare.
  - k. Colour rendering index CRI  $\geq$ 80 for indoor light fixtures

## 1.6. LED Driver Specification

- 1.6.1 LED driver shall have following features:
  - a. Input voltage Range within 140 to 270 VAC
  - b. No load power consumption  $\leq$  1.5W
  - c. Power factor 0.9
  - d. Full Load Efficiency  $\geq$  85%
  - e. Total Harmonic Distortion THD  $\leq$ 10%
  - f. Load regulation  $\pm$ 5%
  - g. Current waveform should meet EN 61000-3-2
  - h. Led Driver shall withstand, withstand voltage of 350V for 2 hours and restore normal working when normal voltage is applied as per IEC 629
  - i. Maximum Temperature rise  $\leq$  20°C @ 35°C Temp with safety margin of 10°C
  - j. The driver should comply to CISPR 15 for limits and methods of measurement of Radio Disturbance characteristics
  - k. The equipment should comply to IEC 61547 for EMC immunity requirements

- l. The control gear should be compliant to IEC 61347-2-13, IEC 62031 and IEC 62384 as per the requirements
- m. Driver shall have two stage surge protection with removable fuse for easy maintenance
- n. The equipment should be compliant to IEC 60598-1, IEC 62031 and IEC/PAS 62612 depending on the type of luminaire

### **1.7. Acceptance Criteria**

- (a) Low smoke materials shall be used inside the fixtures
- (b) The fixtures shall comply all the local requirement (Indian standards) for designing and manufacturing the system
- (c) The design of the fixture and the mounting arrangement shall be in line with the architectural concept of the project.
- (d) The colour of the fixture shall be as per approval of the Main contractor/Client//main contractor's representative.
- (e) The colour coding shall be as per new colour coding system. For phases Red, Yellow, Blue and for neutral Black colour and for Earth green with yellow shall be used.
- (f) The glare factor shall be reduced by using proper diffusers to maintain comfort working environment.
- (g) The Solder used shall be ROHS (Restriction of Hazardous Substances Directive) compatible for environment friendly.
- (h) Electronic driver shall be of Constant Current type,
- (i) There shall be over voltage, short circuit & over current protection

### **E9. Street Lighting Poles:**

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#### **Lighting Poles : Lighting Poles for street lights /flood lights shall be swaged type GI pole construction**

The lighting poles shall be fabricated from heavy duty cold-rolled steel tubes to IS:1239-1958 and hot dip galvanized or painted as specified. The pole shall have a base plate, a large access panel, and necessary fixture mounting bracket at top. The access panel shall provide easy access to a multi-way porcelain connector and fuse board, to be mounted inside the pole. The access shall be specially fabricated with adequate reinforcement and weather gasket to prevent ingress of moisture and vandal proof. Poles shall have large diameter entries for incoming and outgoing cable and two earth studs. The pole fabrication shall conform to the drawings and where such drawing is not available, the contractor shall make such drawing and have it approved before fabrication.

## E 10. Transformer 11/0.415 KV

### Scope

The specification covers design manufacture, testing packing and delivery of 3 phase 50 Hz 11/0.415 KV Dry type Cast resin distribution transformer up to 2.5 MVA.

The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such, components shall be deemed to be within the scope of the Contractor's supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

### Tolerances:

Tolerances on all the dimensions shall be in accordance with provisions made in the relevant IS/IEC standards/ and in these specifications.

### System Particulars

The transformers shall be suitable for indoor installation with following system particulars and should be suitable for service under fluctuations in supply voltage as permissible under Indian Electricity Act & Rules there under.

- |   |   |                                |
|---|---|--------------------------------|
| a) Nominal System Voltage               | : | 11kV                           |
| b) Corresponding Highest System Voltage | : | 12kV                           |
| c) Neutral earthing                     | : | Solidly earthed                |
| d) Frequency                            | : | 50 Hz with $\pm 3$ % Tolerance |

### Service Conditions

Equipment to be supplied against the specification shall be suitably designed to work satisfactorily under following tropical conditions:-

- |  |   |             |
|--|---|-------------|
| Maximum ambient temperature (Degree Celsius) | : | 50          |
| Minimum ambient temperature (Degree Celsius) | : | As per site |
| Relative humidity (% range)                  | : | up to 95%   |
| Altitude                                     | : | <1000metres |

### Standards

The materials shall conform in all respects to the relevant Indian / International Standards with latest amendments thereof and not limited to:

a.	IS: 5	Colours for ready mixed paints and enamels.
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b.	IS:1180	Three phase distribution transformers up to and including 100 kVA, 11KV
c.	IS 11171/IEC 60076-Part 11	Dry type transformer
d.	IS:2099	Bushing
e.	IS:3347	Dimensions for porcelain transformer bushing for use in normally and lightly polluted atmospheres

### **Technical Requirements**

Nominal voltage ratings

- i) Primary voltage - 11 kV
- ii) Secondary voltage - 0.415kV

The vector group shall be Dyn11.

Percentage Impedance: 6.25% at 75deg C (subject to IS tolerance)

Temperature Rise;

- i) Average winding temperature rise over an ambient temperature of 50 deg. C shall not exceed 90<sup>0</sup> C by resistance method. i.e. maximum temperature of winding shall not exceed 155<sup>0</sup> C.
- ii) Core, metallic parts and adjacent material shall in no case reach a value that may damage these materials or reduce their life expectancies.

### **Core**

The core shall be of Prime grade cold rolled grain oriented (C.R.G.O) annealed steel lamination, having low loss and good grain properties, coated with insulation, bolted together to the frames firmly to prevent vibration or noise. All core clamping bolts shall be effectively insulated. The complete design of core must ensure permanency of the core losses with continuous working of the transformers. To ensure efficient cooling, each core shall be provided with Air ducts.

Stage inspection of the core shall be done at manufacturer's premises & inspection call shall be given with following Documents

- a) Invoice of the supplier
- b) Mill's test certificate
- c) Packing list
- d) Bill of landing & Bill of Entry certificate by customs

### **Winding**

H. V. & L. V. Coils

- i) LV Winding: LV Winding shall be made from Copper Pre Impregnated with class F epoxy resin.

- ii) The LV winding is produced using copper; this foil will be insulated between each layer using a heat-reactivated class F pre-impregnated epoxy resin film.
- iii) The ends of the winding are protected and insulated using a class F insulating material. The whole winding assembly will be polymerized throughout by being autoclaved for 2 hours at 130<sup>0</sup> C.
- iv) HV coil should be casted with Class F epoxy resin & should be premixed with active filler which should make the coil self-extinguishing & should comply to fire behavior class F1 as per IEC 60076.
- v) The HV windings will be vacuum cast in a class F fireproof epoxy resin casting system composed of:
  - an epoxy resin
  - an anhydride hardener with a flexibility additive
  - a flame-retardant filled
- vi) The flame-retardant filler will be thoroughly mixed with the resin and hardener. It will be composed of trihydrated alumina powder (or aluminium hydroxide) or other flame-retardant products to be specified, either mixed with silica or not.
- vii) The casting system will be of class F. The interior and exterior of the windings will be reinforced with a combination of glass fiber to provide thermal shock withstand.
- viii) Manufacturer should comply to Climatic test category of C2 & Environmental category of E2 as per IEC 60076 so as to withstand changing climatic variations & should be able to withstand high degree of pollution & humidity up to 95%.
- ix) Transformer shall be self-extinguishing - F1 Certified as per ISEC60076-Part 111.

### **On Load Tap Changing Gear (OLTC)**

The tap changer shall be suitable for connection to tapping brought out from HT winding (delta connected) covering a range of from +5% to 10% in 7 steps of 2.5% each (-10, -7.5, -5, -2.5, 0, +2.5, +5) making a total of 7 positions (taps). Taps shall be rated for maximum continuous KVA rating of the transformer & shall be suitable for operation at sustained voltage of 110% of the rated tap voltage.

- (a) OLTC gear shall safely carry and withstand through fault current of the transformer and shall incorporate protections to prevent tap change operation during flow of such fault current.
- (b) Tap changing once initiated should be completed irrespective of status of the initiating devices or loss of control supply.
- (c) OLTC driving mechanism and its associated control equipment (operational through PLC also) shall be mounted in a weatherproof cabinet having degree of protection of at least IP65. The cabinet shall incorporate the following:

- (i) Driving motor with associated switch and fuse (or MCB) and raise and lower contactors with overload and single phasing protection
  - (ii) Remote / local selector switch
  - (iii) Control switch for raise / lower operations
  - (iv) Pressure relief device and pressure relay
  - (v) Over current blocking device
  - (vi) Parallel control device
  - (vii) Limit switches to prevent over travel and final mechanical stops
  - (viii) Manual operating device with interlocking switch
  - (ix) Tap position indicator
  - (x) Operation counters
  - (xi) Break or clutch to permit only one tap change at a time
- Auxiliaries such as terminal block, space heaters, interior lighting, etc.
- (d) Voltage sensing and regulating device for automatic control including a time delay relay for delaying the indication of tap changing shall be provided. Settings shall be adjustable at site.
  - (e) A remote control panel (communicable to PLC ) shall be provided in the electrical room and shall include, but not to be limited to following:
    - (i) Voltage regulator (solid state)
    - (ii) Control switches for raise / lower
    - (iii) Tap position indicator
    - (v) Alarm annunciator with 'Acknowledge', 'Sound Cancel', 'Reset' and 'Lamp test' push buttons
    - (vi) Audio signal for 'Tap Change in progress'
    - (vii) Winding temperature indicator
    - (viii) Indicating lamps for upper and lower limit of taps and for 'Tap Change in Progress'
    - (ix) Auxiliary relays as required for remote annunciation, control
    - (x) Auxiliaries such as terminals, fuses, space heaters, interior lighting, etc.

## **Clearances**

Clearances provided shall be strictly as per IS 11171 / IEC 60076-Part 11.

## **H. T. & L. T. Bushing**

For 11KV Bushing will be used and for 415 volts, 1 kV Bushing shall be used. Bushing of the same voltage class shall be interchangeable. Bushing with same plain shades as per IS 3347 amended up to date shall be mounted on the side of the enclosure and not on the top cover. Only sheet metal pocket shall be provided for mounting of HV bushing and the same shall not be fixed on pipes. Sheet metal pocket shall be designed in such a way that all HT bushing shall remain parallel and equidistant throughout. Bushing having type tested as per IS 3347 amended up to date shall only be acceptable.

## **Earthing & Neutral Grounding Resistor**

- Each transformer shall have 2 independent maintenance free earthing pits for body earthing.
- The neutral of each transformer shall be connected to 2 independent maintenance free earthing pits.
- Each transformer shall have independent neutral grounding resistor of required rating.
- The NGR shall be used for medium resistance grounding of LV (415 V) system.
- NGR shall be connected between earth pit and neutral point of applicable transformer.
- The NGR shall be suitable for limiting the desired value of earth fault current and duty as arrived in detail design and approved by Employer's Engineer.
- The resistor unit shall be natural air-cooled type suitable for installation at outdoor/ indoor locations.
- All equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.
- Each Neutral Grounding Resistor shall be formed of non-aging (grade ASTM-A240/AISI-304 or better) corrosion resistant punched stainless steel elements for high value (say 300A/400/500A) of earth fault current and of FECRAL material for low value (say 1A) of earth fault current.
- Resistance material mentioned above shall have high electrical resistivity and low temperature coefficient of resistance.
- Resistor bank shall be provided in series and parallel combination to achieve the overall resistance value. Minimum two banks in parallel shall be provided in the system, unless specified otherwise by Employer's Engineer.
- The resistor unit shall consist of suitable no. of elements. All the elements shall be mounted inside the cubicle so as to ensure ease of inspection and replacement of individual element. For Low value of earth fault current edge wound configuration of resistance material would be acceptable after approval of Employer's Engineer.
- All elements connection shall be bolted type to ensure stable resistance value throughout the working life of the unit.
- Wet process type brown glass porcelain insulators shall be used for supporting resistor elements and used to insulate the resistor element from enclosure. Porcelain insulators shall have high Creepage value (not less than 25 mm/per unit system phase to phase voltage) suitable for heavily polluted atmosphere charged with dust particles.
- The NGR shall be provided with suitable taps for cable/strip connection.
- Each neutral grounding resistor shall be housed in weather-proof enclosure having DOP of IP: 65. Enclosure shall be cold rolled sheet steel having a minimum thickness of 2 mm.
- The terminals for neutral and earthing connections shall be housed in separate vermin-proof, weather-proof terminal box with min. IP-55 degree of ingress protection.

- The enclosure shall be supported on insulators placed on mounting structure in such a fashion that it is not easily accessible for man standing on ground level. Any part of insulator shall be at a height 2500 mm above ground/plinth.
- All cubicle door hinges shall be concealed type. Each cubicle shall be complete with suitably mounted cable box fitted with removable gland plate of Aluminium of suitable thickness for fixing cable gland. Double compression brass Cable glands and cable lugs of tinned copper shall be used.
- The enclosure shall not be earthed to prevent bypassing of resistor in case of any inadvertent shorting of resistor from inside.
- Panel space heater arrangement along with thermostat, suitable for connection to 240V AC single supply, shall be provided at the bottom of the panel. The illumination arrangement and switch socket shall also be provided in the panel.
- For connection of other end of NGR to ground, 2 nos. earthing terminal/pad tapped holes and bolts for connection of 50X6 or 75X10 mm copper strip/aluminium strip or copper ground wire shall be provided.

### **Inspection & Tests**

All acceptance and routine tests as per relevant standards shall be carried out by the manufacturer.

### **Terminal Marking Plates and Rating Plates**

Terminals shall be provided with terminal marking plates. The transformer shall provide with riveted rating plate of minimum 8 SWG aluminum anodized material sheet in a visible position. The entries of the rating plate shall be indelibly marked (for example by etching, engraving or stamping).

The marking as 'DSIR' and 'Sr. No...' of Transformer will be engraved on Transformer enclosure, below L.T. Bushings.

The name of the company, order No., capacity, month and year of manufacturing shall be engraved on the enclosure of transformer just below the nameplate clearly visible. The engraving can be done on separate plate which shall be firmly welded to enclosure and shall form integral part of the enclosure.

C2/E2/F1 shall be engraved in the rating plate

### **Other Parameters**

a)	Cooling	AN
b)	Rated System Voltage	11kV/415V
c)	Phases	Three
d)	Impedance	6.25% at 75deg C (subject to IS tolerance) for 2000KVA 5% at 75deg C (subject to IS tolerance) for 1000KVA
e)	Overload Capacity	As per IS2026
f)	Vector Group (Three Phase)	Dyn11
g)	Climatic Class	C2
h)	Environmental class	E2
i)	Fire Class	F1
j)	No load & Full Load losses as per ECBC	As per ECBC[Energy conservation building code] guidelines

### Test And Inspection

**Routine Tests: Manufacturer's Lab should have NABL accreditation so as to ensure transformer's genuinity on various design parameters**

i) All transformers shall be subjected to the following routine tests at the manufacturer's works.

The tests are to be carried out in accordance with the details specified in IS 2026

1. Measurement of winding resistance.
2. Ratio, polarity and phase relationship.
3. Impedance voltage.
4. Load losses.
5. No-load losses and No-load current.
6. Insulation resistance.
7. Induced over voltage withstand.
8. Separate source voltages withstand.

ii) All the routine tests shall be conducted in the suppliers' laboratory at their cost.

iii) Heat run test shall be arranged free of cost on the unit selected from the 1st lot by Employer's Engineer. The test should be done at NABL accredited lab only.

iv) The calculations to confirm the thermal ability as per Clause no. 9.1 of latest IS: 2026 Part-I or equivalent International Standard shall be submitted to Inspecting Engineer.

v) Partial discharge test shall be carried out on one transformer & value shall be less than 10%.

## **E11. U.P.S.**

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### **1.0 Uninterruptable Power Supply**

#### **2.1 General Requirements**

2.1.1. The scope of work for supply and installation of UPS system shall include design manufacture, supply, installation, testing and commissioning of all related equipment together with all accessories and auxiliaries as per specifications.

The system shall be fully operational and shall comply with the specified codes and standards.

The contractor shall be responsible for providing all materials, equipments and engineering services specified or which are required to fulfil the intent of ensuring reliability of the total work covered under these specifications within his quoted price.

2.1.2. Supply and installation of the UPS system covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable Standards.

- a) IEEE Standard 446-1987 : Emergency and standby power systems.
- b) IEEE Standard 450-1975 :
- c) IEEE Paper 4-177 : Some discharge characteristics of lead acid batteries.
- d) IEC 60140-3 : UPS Performance
- e) IEC 60140-2 :Electro Magnetic Compatibility
- f) IEC 60140-1 :Safety
- e) ANSI C 37.90a, IEEE Standard 472 : Surge withstand capability test.
- f) ANSI C 34.2 : Practices and requirements for semiconductor power rectifiers.
- g) ANSI C 37.90 : Relays and relay system associated with electrical power apparatus.
- h) NEMA PE-1-1983 : Uninterrupted Power System Standard
- i) IS 2208 & IS 9224 : Cartridge fuses for voltages up to and including 650 V  
(Part 1 & Part 2) (I.E.C. 269)
- j) IS 9224 (Part - 4) : Fuses for protection of semiconductors.
- k) BS 2709 (I.E.C 119) : The Electrical Performance of Semiconductor Rectifiers.  
Rectifiers) (Metal
- l) BS 4417 (I.E.C 146) : Semi-conductor Rectifier Equipments.

- m) IS 13947: 1993 : Specification for Low voltage Switchgear & Control gear
- n) IS 3961(Part 2):1967 : Recommended current rating for PVC insulated Cables
- o) IS 1652 & IS 1652 : Lead-acid stationary cells and batteries.
- p) BD 9720 : Custom-built transformers and inductors of assessed quality.
- q) IP20 : Degree of protection.
- r) IEC : Semi Conductor Convertor Standards.
- s) JEC : Standard of the Japanese Electro technical committee
- t) JIS : Japanese Industrial Standard.
- u) JEM : The standard of the Japan Electrical Manufactures
- v) ISO 9001 approved

2.1.3. The vendor shall submit his offer for UPS systems as indicated in the tender document.

2.1.4. All components of the UPS equipment shall have Surge Withstand Capability (SWC) to meet the requirements of ANSI C62.41-1980, ANSI C 37.90a, IEEE Standard 472-1974.

2.1.5. All components of UPS system shall withstand short circuit current without any damage.

2.1.6. Following general requirements shall be met for ensuring proper circuit protection.

- a. Fuses shall not be larger than 125% of the transformer primary circuit current where the secondary circuit fuse protection has not been provided.
- b. Where the secondary fuses are sized not larger than 125% of the secondary current of the transformer, fuses shall not be required in the primary circuit, provided the primary feeder fuses are not larger than 250% of the transformer primary current.
- c. All the neutral conductors in three phase UPS systems shall be sized equal to at least 150% of the maximum phase current. In addition, all the isolators and circuit breakers used in three phase UPS system shall also to be rated such that the neutral poles shall take at least 150% of the maximum phase current.
- d. All control shall be designed and positioned such that possibility of inadvertent or accidental operations is eliminated.
- e. All UPS system cabinets, frames and power equipment shall be double earthed.

2.1.7. The UPS design shall ensure that a single component/ device failure shall not result in failure of the entire UPS system. The design of UPS System shall be modular to permit easy maintenance.

2.1.8. The various overload capacities of inverters, static switch, and step down transformer/voltage stabilizer as specified herein are the minimum requirements. However, if the Contractor's offered system has better overload capacities for the above devices, the same shall be highlighted by the Bidder in his bid.

2.1.9. The UPS system offered by the contractor shall be suitable for operating continuously at the rated capacity indicated in tender with in ambient temperature 0-40 deg.C and relative humidity of



0 to 95%. Also the UPS system shall be suitable for operation as per full rating up to 1000 meters above sea level without derating. The Contractor shall furnish a certificate towards compliance on ambient conditions permissible.

2.1.10. The UPS system to be supplied by the contractor shall have maximum humming noise level of 65 DB one meter away from the UPS cabinets. Shall not exceed 69 dBA measured 5 feet from surface of the UPS.

2.1.11. Suppression of Radio Interference shall be provided to meet statutory requirements.

2.1.12. Detailed literature should be provided showing Quality Assurance Procedure adhered to.

2.1.13. The contractor shall submit detailed item by item compliance statement along with the tender.

## **2.2 Functional Requirements**

2.2.1. Contractor shall furnish On-Line Uninterruptible Power Supply (UPS) system of continuous duty of the ratings mentioned in Bill of Quantities. Each UPS shall give regulated filtered & uninterruptible power supply as described in the specifications.

2.2.2. Contractor shall note that the KVA ratings of the UPS systems shall be guaranteed at 40 deg.C ambient temperature. In case contractor's standard UPS KVA rating are based at a lower temperature, the contractor must consider a derating factor of at least 1.5% per deg.C for arriving at the specified UPS capacity at 40 deg.C ambient temperature.

2.2.3. In case the calculated /specified UPS capacity is not the same as one of the standard KVA ratings of the UPS manufacturer, the next higher standard KVA rating shall be selected. UPS of non standard rating shall not be acceptable.

2.2.4. UPS system supplied by the contractor shall be the latest state of the art technology system fully digitalized using microprocessor controlled full wave rectification and IGBT inverter.

2.2.5. Batteries shall be valve regulated lead acid specially ment for UPS application.

2.2.6. Monitoring and control system shall also be state of the art technology LCD touch panel type providing all relevant data described in this document.

2.2.7. The monitoring and control system shall be capable of RS485 with MODBUS protocol input software for connecting to customer's computer system for data display and monitoring.

2.2.8. All necessary components required for protecting UPS equipment and connected inputs and outputs shall be furnished by the Contractor as an integral part of the UPS system.

2.2.9. The control logic power supply shall have redundant power supply AC input and the system battery as power sources.

2.2.10. The UPS systems shall include but not be limited to the following equipment:

- a. UPS system including 100% capacity float-cum-boost charger with 100% sealed valve regulated lead acid batteries with guaranteed battery life of 5 years.
- b. Suitable factory built battery cabinet for housing the batteries, including terminal isolator / breaker and power disconnect device. The enclosure shall conform to IP 20 as minimum.
- c. All cables, connectors, accessories like turning, cable trays, conduits etc. required for connection between battery and the UPS unit.

## **3. Static Convert**

### **er 3.1 General**

The static converter (rectifier) shall be a multi-functional converter providing functions of power conversion, battery charging and shall have the additional functions of input power factor improvement and current harmonics reduction. The converter equipment shall include all necessary control circuitry and device to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

The converter shall be a solid state static PWM converter utilizing Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) transistors and shall include intelligent features like the drive circuitry, over current protection, over temperature protection, control power failure protection and short circuit protection.

The IGBT / IPM transistors shall enable high speed switching at 6 KHz thus reducing the heat dissipation in the UPS and thereby providing high efficiency.

The PWM converter shall utilize the above and achieve unity power factor and reduce input current harmonics as given earlier and thus improve the overall power factor of the converter achieving input KVA savings.

During any step inverter load change (0-100%) the converter shall only supply 100% current to the inverter. The battery shall not be cycled at any time during this step load changes.

## **2.2 Input Current Limit**

The converter logic shall provide input current limiting by limiting the DC output current. Two (2) line-side current transformers shall be employed as a means of sensing the current amplitude. The converter logic shall also be capable of providing auxiliary current limited when the logic is signalled to do so via an external dry contact closure (e.g. UPS fed from generator). The converter shall be capable of supplying overload current in excess to the full load rating. It shall also have sufficient capacity to provide power to a fully loaded inverter while simultaneously recharging the system battery to 95% of full capacity within 10 times the discharge time. The DC output current limit values shall be as follows:

- Rectifier output current (maximum) 100%.
- Rectifier output current (aux.) 25% - 100%

variable. Note: 100% current shall be under the battery

recharging mode. **3.3 Battery Charge Current Limited**

The converter logic shall provide current limiting function of battery charging to prevent the battery from damage. The following battery current limit and protection shall be provided.

- Battery charge current limit 10% of battery Ah rate.
- Over-current protection at 120% of above item.

## **3.4 Voltage Regulation**

The rectifier / charger output voltage including variation effects of input voltage does not deviate by more than +/- 1% of the nominal output voltage, due to the following conditions:

- From 0 to 100% loading.

- Rectifier input variations of voltage and frequency within the limitations set in Section 3.10.
- Environmental condition variations within the limitations set in Section 3.10.

### **3.5 Automatic Input Current Walk-In**

The converter logic shall employ circuitry to allow a delayed and timed ramping of input current. Subsequent to energizing the converter input, the ramping of current shall be delayed by a maximum of 3 seconds. Upon starting the walk-in process, the ramping of current is timed to assume the load gradually within 1 through 60 seconds (every 1 second selectable).

### **3.6 Input Overload Protection**

The A/C input fuses shall be provided at the converter input as a means of overload protection. The AC maximum current shall be controlled by the Converter.

### **3.7 Equalizing Charge Timer**

The UPS logic shall provide an electronic automatic equalize charge timer which shall be selectable 24 hours for Lead Acid type or 8 hour for alkaline type batteries. The timer circuit, once activated shall provide a high rate equalizing charge voltage to the system battery for the selected time. The circuit shall also be capable of manual activation via the LCD touch panel mounted on the front door. The level of equalizing voltage shall be equal to that stated by the battery manufacturer. Upon completion of the timer count, the converter output voltage shall automatically return to the specified float voltage.

### **3.8 Step Load Change**

During any step inverter load change (0-100%), only the converter shall supply 100% current to the inverter. The batteries SHALL NOT be cycled at any time during these step load changes.

### **3.9 Input Voltage**

The converter shall be fed from the Normal Power Supply source.

The converter shall meet the following specifications in addition to other requirements stated herein:

Nominal Voltage	: 415V, 3 Phase, 3 Wire
Voltage Range.	: + 15% / - 30% AC
Normal Frequency	: 50 Hz $\pm$ 8 %
Frequency Range	: $\pm$ 8% ( $\pm$ 4 Hz)
Input Power Factor	: 0.9 lagging or more at full load (PF improvement)
Input Harmonic Current THD	: 3% typical at 100% load 6% maximum at 50% load
Duty	: Continuous at 40 deg.C
Cooling	: Forced cooling using fans with thermal relays using a latched cut out for re- setting as protection for cooling fans. Each individual fan shall have its own thermal

Ambient operating temperature range	: Operating - 0 to 40 deg.C maximum. Storage & Transport -
Operating Relative Humidity	: 0-95% non-condensing.
Operating Altitude	: Altitude Operating: to 3,000 ft. (1,000 meters) above Mean Sea Level. Derated for higher altitude applications.  Storage/Transport: to 40,000 ft. (12 200 meters) above Mean Sea Level
Magnetized sub-cycle in rush current	: Typically 8 times normal full load current
Converter Walk-in time	: 1 through 60 seconds (every 1 second selectable, (0 to 100% rated load)
Input	: Suitable terminals shall be provided for termination of cables from the AC distribution board.

#### **4. Static Invert**

##### **er 4.1 General**

The static inverter shall be of solid state type using proven Pulse Width Modulation (PWM) technique. The inverter equipment shall include all necessary control circuitry and devices to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

The inverter shall utilize Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) Transistors which shall provide intelligent features like the drive circuitry, over-current protection, over temperature protection, control power failure protection and short circuit protection.

The IGBT / IPM transistors shall enable high speed switching of 6 KHz thus reducing the heat dissipation in the UPS and thereby providing high efficiency.

The UPS shall utilize both Voltage and Current feedback control circuits so that the inverter shall act not only as a constant voltage source but also as a load required current source. This shall enable the inverter to quickly adapt to the changing load current value and wave shape.

##### **4.2 Voltage Regulation**

The inverter output voltage shall not deviate by more than + 1% RMS due to the following steady state conditions:

- From 0 to 100% loading
- Inverter DC input voltage varies from maximum to minimum.
- Environmental conditions variations within the limitations set in the section 4.8.

##### **4.3 Frequency Control**

The inverter output frequency shall be controlled by an oscillator internal to the UPS module logic. It shall be capable of synchronizing to an external reference (e.g. the bypass source or another UPS module) or operating asynchronously. The oscillator shall maintain synchronization with the external reference within the limitations set hereunder. The inverter shall operate on self run mode without synchronism if the bypass frequency exceeds the set value. The oscillator, while running asynchronously, shall maintain the frequency as  $50 \text{ Hz} \pm 0.01\%$  (or  $+ 0.005 \text{ Hz}$ ). Automatic adjustment of phase relationship between inverter output and standby bypass source shall be gradual at a controlled slew rate which shall be adjustable at the rate of 0.5, 1.0, 2.0, 3.0 Hz / second. (Default 2.0 Hz / second).

The inverter output frequency shall not vary during steady state or transient operation due to the following conditions:

- a. From 0 to 100% loading.
- b. Inverter DC input varies from maximum to minimum.
- c. Environmental condition variations within the limitations set in section 4.8.

#### **4.4 Output Voltage Harmonic Distortion**

The inverter output shall limit the amount of harmonic content to the values stated in section 4.9. The use of excessive or additional filtering shall not be required to limit the harmonic content thus maintaining a high level of efficiency, reliability and original equipment footprint.

#### **4.5 Output Overload Capability**

The inverter output shall be capable of providing an overload current while maintaining rated output voltage to the values stated in section 4.8. An LED indicator shall be located on the control panel to identify this condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current amplitude, the load shall be transferred to the bypass source without interruption.

#### **4.6 Inverter Current Limit**

The inverter output shall be limited to 150% of rated load current. The two sensing locations shall operate separately and independently thus providing redundancy and, in the event of a failure, preventing unnecessary damage to power transistor components / fuses. Load current above 150% shall cause an immediate transfer of the load to the bypass source for fault clearing.

#### **4.7 Inverter Overload Protection**

The AC output from the inverter shall utilize fuses for overload protection. The inverter shall utilize a contactor to isolate the inverter output from the critical bus.

The inverter fuses shall be the fast acting semiconductor type.

The inverter output isolation contactor shall be located in the UPS module and shall be controlled by the internal UPS module system logic.

#### **4.8 Inverter Specifications**

The inverter shall meet the following specifications in addition to other requirements stated herein:

Voltage Input	: Three Phase UPS : Nominal 360 V DC (Range 290 V to 414 V DC to maximum DC bus voltage during charging the batteries).
Nominal Voltage Output	: 415 V $\pm$ 1% AC 3 Phase, 4 Wire

Inverter Capacity	:	
Voltage Regulation	:	
a. For 0 to 100% loading	:	$< \pm 1\%$
b. Inverter DC input voltage vary from maximum to minimum	:	$< \pm 1\%$
d. Environmental conditions given below	:	$< \pm 1\%$
Transient Voltage Regulation	:	
a. AT 100% step load change	:	$< \pm 3\%$
b. At loss or return of AC input	:	$< \pm 1\%$
c. At load transfer from bypass to inverter	:	$< \pm 3\%$
Time to recover from transient to normal voltage	:	20 milli seconds
Wave form		
a. Normal frequency	:	50 Hz
b. Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination (automatically	:	$\pm 0.01\%$
c. Synchronization limits for synchronism between the inverter and	:	49 Hz to 51 Hz.
d. Field adjustment range for above	:	$50 \pm 0.25$ Hz to $50 \pm 1.5$ Hz

<b>4.9</b>	<b>Total voltage harmonic distortion</b>	:	< 2% THD for 100% linear load < 4% THD for 100% non-linear load
	Duty	:	Continuous
	Cooling	:	Forced cooling using fans.
	Ambient operating temperature range	:	0 to 40deg.C maximum continuous.
	Operating relative humidity	:	0-95% non-condensing.
	Operating altitude.	:	Sea level to 1000 meters.
	Output	:	Suitable terminals are provided for termination of cables for connecting inverter output to AC distribution

#### **4.10 Built-In Isolation Transformer**

This shall provide neutral separation which shall mean that output neutral will be independent of incoming neutral, hence critical load shall be isolated from the problems like incoming neutral open or, short or, variations in neutral to earth voltage due to sudden loading in neighbouring installation.

#### **4.11 Reverse Phase Sequence Protection**

In the event of Phase sequence reversal at the input, UPS system shall continue to work on the main power supply, or UPS systems shall go into battery mode, and shall not trip the UPS system.

### **5. Bypass And Static Transfer Switch**

5.1. A bypass circuit shall be provided as an alternate source of power other than the inverter. A high speed switch and wrap-around contactor shall be used for the critical load during automatic transfers to the bypass circuit. The static switch and wrap-around contactor shall drive power from an upstream bypass feed circuit breaker internal to the UPS module provided for overload protection. The wrap-around contactor shall be electrically connected in parallel to the static switch and shall at the same time as the static switch, energize and upon closure, maintain the bypass source. The static switch shall only be utilized for the time needed to energize the wrap-around contactor thus increasing reliability. The bypass circuit shall be capable of supplying the UPS rated load current and also provide fault clearing current. The UPS system logic shall employ sensing which shall cause the static switch to energize within 150 microseconds thus providing an uninterrupted transfer to the bypass source when any of the following limitations shall exceed:

- Inverter output under voltage or over voltage.
- Overload beyond the capability of the inverter
- DC circuit under voltage or over voltage
- Final end voltage of system battery is reached.
- Bypass source present and available
- System failure (e.g. Logic fail, fuse blown, etc.)

5.2. Keeping the above requirements in view, the static switch shall have the following minimum rating.

- Capacity continuous equal to 100% of continuous rating of the inverter.

- Capacity overload equivalent to overload characteristics specified for UPS.



### 5.3

Nominal bypass input voltage	: 415 V / 240 V, 3 phase, 4 wire
Voltage Range	: $\pm 10\%$ of nominal
Nominal Frequency	: 50 Hz
Frequency range	: $\pm 2\%$ Please refer to selectable range of Inverter given in point 4.3 & 4.8

#### **Output Fault Clearing :**

Current	: 1000%
Duration	: 20 milli seconds
Ambient operating temperature	: 0 to +40 degree C continuous
Operating relative humidity	: 0-95% non-condensing
Operating altitude	: Sea level to 1000 meters
Cooling	: Natural Convection
Duty	: Continuous

### **5.4 Automatic Re-Transfer**

In the event that the critical load must be transferred to the bypass source due to an overload, the UPS system logic monitors the overload condition and, upon the overload being cleared, performs an automatic re-transfer back to the inverter output. The UPS system logic shall only allow a re-transfer to occur three times within a ten minute period. Re-transfer shall be inhibited on the fourth transfer due to the likelihood of a recurring problem at the UPS load distribution. The re-transfer a load to the inverter shall also be inhibited due to the limitations set in section 5.3.

### **5.5 Manual Transfer**

The UPS shall be capable of transferring the critical load to / from the bypass source via LCD touch panel. When performing manual transfer to inverter or automatic re-transfers, the UPS system logic shall force the inverter output voltage to match the bypass input voltage and then parallel the inverter and bypass source providing a make-before-break transition allowing a controlled walk-in of load current to the inverter.

### **5.6 Maintenance Bypass Switch (Mbs)**

The UPS shall include as standard equipment, a zero energy maintenance bypass switch. Full UPS wrap-around enables personnel to do work inside the UPS module or maintenance bypass switchboard without danger for high voltage conditions.

## **6 UPS Battery System**

- a. The UPS system shall, as an integral part, provide battery system for backup time as specified in the Schedule (Full Load) standby capacity.
- b. The latest state of the art Valve Regulated Sealed Maintenance Free Lead Acid Batteries shall be used with a 20 hours discharge rating.

- c. The battery system shall be sized to provide backup time as specified in the schedule of quantity when the UPS is supplying 100% rated load at 0.8 load power factor.

- d. An ageing factor of 15% shall be applied to the capacity arrived at, to allow for compensation against capacity loss during float operation.
- e. The battery system design shall be provided with necessary devices to prevent deep discharge beyond recommended limits to prevent the batteries discharging beyond end cell voltage specified by the battery maker. The connections from battery to battery shall be by using copper bus bar strips and the entire battery system shall be used in IP20 steel cabinet enclosure and shall be similar to the UPS enclosure.
- f. All batteries shall be clearly identified and identification numbers marked on the batteries and a schematic diagram along with the complete calculations, including manufacturers supporting curves, shall be submitted with the tender.
- g. The UPS shall have a properly rated and sized circuit breaker to isolate it from the battery

## **7. Operation**

- a. Under normal operation, the UPS load will be fed from the Inverter with the bypass switch inhibited. The Converter, apart from providing DC power to the Inverter, also charges the battery under the float charge mode. The battery charge system shall have float charge, equalising charge and recovery charge modes, to replenish the batteries self-discharging part while the battery is fully charged, equalising the battery cell voltage to a constant value forcibly, and recharging the battery system to the required values when the batteries have been used, respectively.
- b. The Inverter shall constantly monitor the AC source frequency and shall be in synchronisation with the AC input source till the frequency of the AC input source is within synchronising limit and if the frequency of the standby source exceeds the synchronising limit the Inverter will work on its own internal oscillator maintaining an output frequency of 50 Hz +/- 0.01% under all conditions of load. When the Inverter operates on its internal oscillator, it shall continuously monitor the frequency of the input source and when the input source frequency returns to within synchronisation limit, the Inverter shall automatically synchronise itself with the input A/C source frequency and use it as a signal for Inverter output frequency control.
- c. Battery Operation:
  - i. When the A/C input voltage drops below specified limits or in case of a power failure the Inverter continues to supply AC power of constant voltage and constant frequency utilising the battery system as a power source until the input voltage returns to normal requirement. When the power supply is resumed or the input voltage returns to limits, the Converter shall automatically start and the load fed for normal operation status.
  - ii. If the power failure continues beyond battery backup time or the battery voltage drops to the final discharge voltage, the Inverter should automatically stop and at the same time transferring the load to the bypass circuit. On resumption of power supply, the Converter shall automatically re-start the operations and charge the batteries whereas the Inverter should inhibit automatic start and should be started manually.
- d. Bypass Operation:

When power is supplied from the Inverter in synchronisation with the bypass, it shall accomplish the following:

- i. When the UPS output current reaches overload status it shall automatically transfer the load to bypass circuit with no interruption and when the overload status is cleared it automatically re-transfers the load to Inverter.

- ii. When the battery final discharge condition is reached, the load shall automatically be transferred to the bypass circuit without interruption.
- iii. In case of failure of the UPS, the load shall be automatically transferred to the bypass circuit with no interruption and when the failure is cleared, re-transfer the load to the Inverter shall be done manually.
- iv. There should be provision made in the system to prevent, when necessary, asynchronous transfer.

- v. When the UPS goes on bypass mode in any of the conditions described above and if at that time there is no bypass power supply available due to power failure, the UPS shall remain in standby mode and as soon as the bypass power supply is available will transfer the load to bypass.
- vi. A maintenance bypass transfer switch shall be provided with lock and key arrangement and should be manually done by authorised personnel only.

## **8. Battery Monitoring System**

- a. The Battery Monitoring System shall provide for the automatic acquisition, trending, alarming and storage of information from every cell or jar in a battery bank. It will have the interactive ability to first identify and then provide an isolated equalizing charge current to any individual cell or jar that deviates below a user-specified set point, from the cell average, within the same string or bank.
- b. The Battery Monitoring System shall test the relative charge state and health of each individual cell or jar by injecting a DC current, recording the magnitude of this current & comparing it to previous benchmark values. Systems that require battery discharge for testing are not acceptable. The system shall provide estimated backup time remaining during an actual discharge.
- c. The Battery Monitoring System shall monitor and maintain historical files for:
  - Individual cell or jar voltage
  - Total bank voltage
  - Discharge current
  - Ambient and pilot cell temperature
  - Relative current response value
- d. Display shall be via local LCD display, with capability for viewing at a remote terminal. All files shall be written to a fixed solid state disk within the enclosure. All functions shall be accessible via modem using common communications software.
- e. The system shall operate a “form C” relay contact when any parameter is in alarm. Alarm data shall be written to a file in ASCII format for future retrieval.
- f. The system shall be capable of remote communications for remote access to all functions via modem or ANSI terminal.
- g. The Battery Monitoring System shall be capable of monitoring a minimum 264 jars per string, 9 parallel strings per system, and 6 cells per jar.
- h. Resolution shall be 12 bit accuracy, with up to 10 per second channel test rate.
- i. Cell voltage measurements must be made to within plus or minus 5 millivolts over the entire operating and temperature range.
- j. Documentation. Manuals and installation documentation for the equipment shall be provided which lists block diagrams, schematics parts list and theory of operating for each unique component of the system. Installation drawings and documentation shall be site specific for each string at this facility. Marked up building drawings shall be provided to show any changes to building wiring including power wiring and communications cables.
- k. The system shall be factory tested fully and completely before shipment.

## **8. Cabinet And Enclosures**

- 8.1 The entire UPS system, including all components like inverter, static switch, maintenance bypass, shall

be housed in free-standing steel type factory-finished enclosures complying with the protection standards of IP20. The enclosure shall be open able using a special tool for internal access. The colour shall be light grey.

## **8.2 Ventilation**

Forced air-cooling shall be provided to allow components to operate within their rated temperature specified. The cooling fans shall have thermal relays protection using a latched cut fire re-setting, as a protection for the cooling fans.

Similarly, the backup battery system shall also be housed as described earlier in an IP20 cabinet.

## **9. Control And Monitoring**

- a. The UPS shall utilise state of the art full DDC control software driven Control and Monitoring System.
- b. It shall be provided with LED displays.

Metering should display the following parameters on the control panel

1. Input AC voltage line-to-line and line-to-neutral for each phase
2. Input AC current for each phase
3. Input frequency
4. Battery voltage
5. Battery charge/discharge current
6. Output AC voltage line-to-line and line-to-neutral for each phase
7. Output AC current for each phase
8. Output frequency
9. Percent of rated load being supplied by the UPS
10. Battery time left during battery operation.
11. Bypass power available.

Following alarm messages to be displayed at the control panel:

- a. Input power out of tolerance
- b. Input phase rotation incorrect
- c. Incorrect input frequency
- d. Charger in reduced current mode
- e. Battery Charger Problem
- f. Battery failed test
- g. Low battery warning (adjustable 1 to 99 minutes)
- h. Low battery shutdown
- i. DC bus overvoltage
- j. Bypass frequency out of range
- k. Load transferred to bypass
- l. Excessive retransfers attempted
- m. Static switch failure
- n. UPS output not synchronized to input power

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- o. Input power single phased
- p. Input voltage sensor failed



- q. Inverter leg over current in X-phase
  - r. Output under voltage
  - s. Output overvoltage
  - t. Output over current
  - u. System output overloaded
  - v. Load transferred to bypass due to overload
  - w. Overload shutdown
  - x. Control Error
  - y. Critical power supply failure
  - z. Load transferred due to internal protection
  - aa. External shutdown (remote EPO activated)
  - bb. Fan failure
  - cc. Over temperature shutdown impending
  - dd. Over temperature shutdown.
  - ee. Lamp test.
- c. The UPS logic should provide one set of normally open dry contact / relay output to allow interfacing of UPS operating status to an external system and should be capable of providing, as a minimum, 10 numbers status and, should the UPS manufacturer's standard product does not provide such software, the bidder must add additional equipment and cost for the same.
  - d. The UPS shall also have an RS485 port with MODBUS interface card if required for interfacing to BAS system or client's centralized computer network.
  - e. LCD touch panel (Optional)
    - i. The UPS shall be provided with an operator friendly large scale LCD touch panel.
    - ii. The LCD touch panel shall also include graphic measurement display, operational procedures of each activity, fault status display and also have capability to record at least 50 faults.
    - iii. The touch screen panel shall clearly define specified areas for operational function, execution and message display.
    - iv. It should be possible to operate the entire UPS system and its components and obtain all measurements and data through the touch screen operation. The measurement software should provide capability to measure phase voltage, current in each phase, frequency, power factor, available battery time etc.
    - v. Under all operating conditions, the system software should have capability for displaying fault alarm automatically. The tenderer should describe in detail the faults that would be displayed under this mode.

## **10. UPS Testing**

- a. The Contractor shall perform the following tests, as a minimum, at site prior to handing over, to confirm the functional and the performance specification of the UPS as specified. All required test

equipment like Digital Oscilloscope, Voltage Regulator, and Measurement Meters etc. shall be the responsibility of the Contractor without any additional cost.

- b. The Contractor shall demonstrate as a minimum the following features on site by providing all required test equipment, such as power factor improvement, input current THD, output voltage THD, output frequency and all other performance monitoring requirements detailed before as required by the EMPLOYER.

## **E12. Earthing**

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### **1.1 Earthing**

The system shall be TNS with four wire supply system (R, Y, B, N and 2 Nos. E) brought from the main L T Panel. All the non-current carrying metal parts of electrical installation and all metal conduits trunking, cable sheaths, switchgear, distribution panels, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All metal work such as pipe lines, ducts, cable trays, stair case railing etc shall be bonded to earth.

All earthing shall be in conformity with IS: 3043 1987, and the basic system of earthing shall be TNS.

### **1.2 Earthing Conductors**

Earthing conductors shall be of copper / GI as mentioned in schedule of quantities and shall be protected against mechanical injury and corrosion.

### **1.3 Sizing Of Earthing Conductors**

The cross sectional area of earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80 Sq.mm. If the area of the largest current carrying conductor or bus bar exceeds 160 sq.mm then two or more earthing conductors shall be used in parallel, to provide at least half the cross sectional area of the current carrying conductor or bus bars. All fixtures, outlet boxes, junction boxes and power circuits up to 15 amps shall be earthed with PVC insulated copper wire.

All 3 phase switches and distribution panels up to 60 amps rating shall be earthed with 2 Nos. distinct and independent 4 mm dia. copper / GI wires. All 3 phase switches and distribution panels upto 100 amps rating shall be earthed with 2 Nos. distinct and independent 6 mm dia. copper / GI wires. All switches, bus bar, ducts and distribution panels of rating 200 amps and above shall be earthed with minimum of 2 nos. separate and independent 25 mm x 3 mm copper / GI tape.

### **1.4 Connection Of Earthing Conductors**

Main earthing conductors shall be taken from the earth connections at the main L T panel to an earth electrode with which the connection is to be made. All joints in tapes shall be with four rivets and shall be brazed in case of copper and by welding bolting in case of GI, wires shall be connected with crimping lugs, all bolts shall have spring washers. Sub- mains earthing conductors shall run from the main distribution panel to the sub distribution panel. Final distribution panel earthing conductors shall run from sub-distribution panel.

Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution panel. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to distribution panel at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of the equipment shall be earthed by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord. Switches, accessories, lighting fitting etc. which are rigidly secured in effective electrical contact with a run of metallic conduit shall not be considered as a part of the earthing conductor for earthing purposes, even though the run of metallic conduit is earthed.

The plate/pipe electrode, as far as practicable, shall be buried below permanent moisture level but in any case not less than 2.5 M below finished ground level.

The plate/pipe electrode shall be kept clear of the building foundation and in no case, it shall be nearer by less than 2 M from outer face of the respective building wall / column.

The plate electrode shall be installed vertically and shall be surrounded with 150 mm. thick layers of Charcoal dust and Salt mixture.

19 mm. dia. G.I. pipes for watering shall run from top edge of the plate / pipe electrode to the mid level of block masonry chamber.

Top of the pipe shall be provided with G.I. funnel and screen for watering the earth / ground through the pipe.

The funnel with screen over the G.I. pipe for watering to the earth shall be housed in a block masonry chamber as shown in the drawing.

The masonry chamber shall be provided with a Cast Iron hinged cover resting over the Cast Iron frame which shall be embedded in the block masonry.

Construction of the earthing station shall in general be as shown in the drawing and shall conform to the requirement on earth electrodes mentioned in the latest edition of Indian Standard IS: 3043, Code of Practice for Earthing Installation.

The earth conductors (Strips / Wires copper / hot dip G.I.) inside the building shall properly be clamped / supported on the wall with Galvanised Iron clamps and Mild Steel Zinc Passivated screws / bolts. The conductors outside the building shall be laid at least 600 mm. below the finished ground level.

The earth conductors shall either terminate on earthing socket provided on the equipment or shall be fastened to the foundation bolt and / or on frames of the equipment. The earthing connection to equipment body shall be done after removing paint and other oily substances from the body and then properly be finished.

Over lapping of earth conductors during straight through in joints, where required, shall be of minimum 75mm. long.

The earth conductors shall be in one length between the earthing grid and the equipment to be earthed.

### **Earth Leads And Connections**

Earth lead shall be bare copper or Galvanised steel as specified with sizes shown on drawings. Copper lead shall have a phosphor content of not over 0.15 %. G.I strips buried in the ground shall be protected with bitumen and hessian wrap or polythene faced hessian and bitumen coating. At road crossing necessary Hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles so that strip is at least 8 mm away from the wall surface.

The complete earthing system shall be mechanically and electrically bonded to provide an independent return path to the earth source.

### **1.5 Prohibited Connections**

Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system. The electrical resistance measured between earth connection at the main L T panel and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate or circuit breakers, and shall not exceed 1 ohm. All switches carrying medium voltage shall be connected with earth by two separate and distinct connections. The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in G I pipe of adequate size. The overlapping in strips at joints where required shall be minimum 75 mm. The joints shall be riveted and brazed in case of copper and by welding / bolting in case of GI in an approved manner. Sweated lugs of adequate capacity and size shall be used for termination of all conductor wires above 6 sq.mm size. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned. Equipotential bonding of all metallic structures shall be done.

### **1.6. Earthing**

The following must always be ensured in earthing system.

- All earths must be interconnected at the earth pits. This includes generator neutrals, transformer neutrals, transformer body, lightning protection system earths, UPS earths etc.

- Extraneous conductive parts such as gas pipes, other service pipes and ducting risers and pipes of fire protection equipment and exposed metallic parts of the building structure.

The Contractor shall get the soil resistivity test done at his own cost of the area where earthing pits are to be located before starting the installation.

### **1.8 Resistance To Earth**

The resistance of earthing system shall not exceed 1 ohm.

### **1.9 Specification For Hot Dip Galvanizing Process For Mild Steel Used For Earthing For Electrical Installation**

#### **General Requirements**

##### **I. Quality Of Zinc**

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS: 209-1992.

##### **ii. Coating Requirement**

Minimum weight of zinc coating for mild steel flats with thickness up to 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.

The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters.

Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing. Jointing of earthing tape shall be by welding. All joints and cut ends shall be properly painted with aluminium paint.

### **1.10 Chemical Earthing System – specification**

Earthing system should offer a resistance of less than 2 ohms throughout the year. In places where Soil resistivity is more, total length of the earthing rod has to be increased by adding 1m length rods (one over the other) to achieve low and stable resistance value. In rocky places, multiple earth rods have to be installed and inter- connected to get the required value.

Solid Copper coated rods are recommended as earth electrode than a pipe due to the fact that solid rods have much longer life and can be easily driven by electric/hydraulic hammers. Copper has much longer life than all other materials as explained in IS 3043. Deep driven rods provide more stable and less Earth Resistance. Doubling the length of the rod will reduce earth resistance up to 40 %, whereas doubling the diameter will reduce the resistance by only 10 %, but may increase the cost by 4 times. Lower earth resistance can also be achieved by increasing the number of earth rods. E.g. 40 % reduction in earth resistance is possible if the rods are increased from 1 to 2. The minimum spacing between earth pits should be equal to TWICE the length of the rod. Increasing the spacing between earth pits also reduces the earth resistance significantly.

#### **Need and importance of Earthing:**

- Human and Personnel safety.
- Equipment protection.

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- Provides low impedance path for fault currents.
- To ensure good quality power.
- Protection against lightning and transient currents, noise reductions, Limitation of EMI.



**References:**

IEC 60364: Low Voltage Electrical Installations-Part 5-54: Selection & Erection of Electrical equipment- Earthing arrangement & protective conductors.

IEC 62561: Lightning Protection system Components. Part 1 to 7.

IEC 62305: Protection Against Lightning –Part 3: Protection of structures & life

Hazards IS 2309: Code of practice for protection of buildings & allied structures from lightning IS 3043: Code of practice for earthing.

**Components of earthing system:**

- Earth electrode
- Connectors and fasteners
- Inspection Chamber (Earth Pit)
- Earth enhancement material
- Connecting cable/tape/strip with accessories.

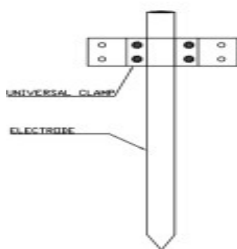
**Earth Electrode:**

Copper coated Solid steel Rods shall be made of high tensile low carbon steel rod, molecularly bonded with 99.9% electrolytic copper with minimum coating thickness of 250 microns as per IEC 62561 part -2: Requirement for Conductor & Earth Electrodes. The length of the earth rod shall be 1 meter so that driving into the ground is easier (scaffolding is not necessary). For dry areas, length of the rods can go up to several meters by driving the rods one over the other. Earth rods should be of diameter 20 mm. These rods should have facility to couple with hammer inserts so that they could be driven easily with an electric/hydraulic hammer. Additional rods should be added without external couplers. The earth rods should have peg & bore arrangement so that additional rods are added without external couplers.

Interconnecting Strips / Earthing Conductor: Copper coated steel strips / tapes should be used to interconnect different earthing rods as well as horizontal earthing (Ring earthing). These strips should have a coating thickness of minimum 70 microns.

**Couplers / Connecting clamps:**

Connectors/fasteners for connecting Electrode with Earthing conductor/strip should be of Stainless Steel as it is compatible with all other materials viz Copper, GI etc. Fasteners should be made of Stainless steel

**Inspection Chamber :**

Should have an inner dimension of 250 mmX 250 mm X 250 mm made of FRP material. Flush Mounted, removable cover of the earth pit should be able to withstand moderate loads. The area inside the inspection chamber should be such that, the UNIVERSAL CLAMP/EBB/Bus bars not too deep inside the inspection chamber or projecting out of inspection chamber. The chamber should have facility

for marking earth resistance and latest testing date by paint at the cover and previous recorded values inside the cover.

**Earth Enhancement material:**

This is a conductive mineral compound to provide low resistance to the earth termination system. Earth enhancing compound should contain minerals which in normal use is reliable and without creating any hazards to persons and the surroundings. The material shall be chemically inert to sub soil and shall not pollute the environment. It shall provide a stable environment in terms of physical and chemical properties and exhibit low resistivity. It shall not be corrosive to the earth electrode itself. The material should have a resistivity less than 50 Ohm meter

**Installation:**

Dig a pit of 1m\* 1m \* 0.5m depth.

At the center of the pit, Earth rod of 1 m has to be hammered electrically or hydraulically. The number of Earth rods can be added one over the other to get the required length.

Fill the dug up area with Earth enhancing compound mixed with water & soil to get slurry form in such a way that the earth inspection pit is in flush with the earth surface.

Connect the connectors with fasteners & connect the down conductors. Close the lid of earth inspection pit.

**Inspection & maintenance:**

Maintenance of the earthing system has to be done at least once in 6 months, preferably before the monsoon period and a record should be maintained to verify earthing system conductors and components, electrical continuity, earth resistance value, re-fastening of components viz-nuts, bolts etc.

**1.11 Test**

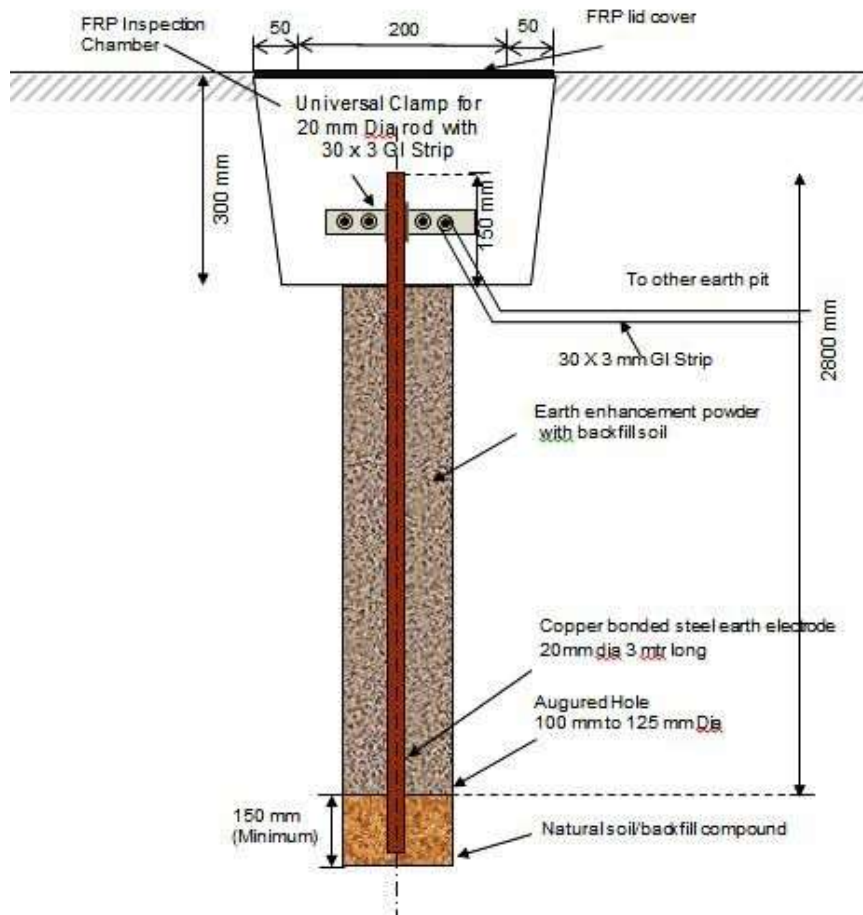
The entire earthing installation shall be tested as per requirements of Indian Standard Specification IS: 3043. The following earth resistance values shall be measured with an approved earth megger and recorded.

- 1) Each earthing station
- 2) earthing system as a whole
- 3) Earth continuity conductors
- 4) Earth conductor resistance for each earthed equipment shall be measured which shall not exceed 5 ohm in each case.

Measurements of earth resistance shall be carried out before earth connections are made between the earth and the object to be earthed.

All tests shall be carried out in presence of the client's representative.

## Earthing Auguring Method



## **E13. Addressable Fire Detection and Voice Evacuation System**

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### **PART 1 GENERAL**

#### **1.1 DESCRIPTION**

- A. The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.
- B. The facility shall have an emergency voice alarm communication system. Digitally stored message sequences shall notify the building occupants that a fire or life safety condition has been reported. Message generator(s) shall be capable of automatically distributing up to eight (8) simultaneous, unique messages to appropriate audio zones within the facility based on the type and location of the initiating event. The Fire Command Center (FCC) shall also support Emergency manual voice announcement capability for both system-wide or selected audio zones, and shall include provisions for the system operator to override automatic messages system-wide or in selected zones.
- C. The system shall support additional, alternate Fire Command Centers, which shall be capable of simultaneous monitoring of all system events. Alternate Fire Command Centers shall also support an approved method of transferring the control functions to an alternate Fire Command Center when necessary. All Fire Command Centers shall be individually capable of assuming Audio Command functions such as Emergency Paging, audio zone control functions, and Firefighter's Telephone communication functions.
- D. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication network.

#### **1.2 SCOPE**

- A. A new intelligent reporting, microprocessor controlled fire detection system shall be installed in accordance to the project specifications and drawings.
- B. Basic Performance:
  - 1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Class A Signaling Line Circuits (SLC).
  - 2. Device Circuits (IDC) shall be wired NFPA Class A as part of an addressable device connected by the SLC Circuit.
  - 3. Notification Appliance Circuits (NAC) shall be wired NFPA Class A as part of an addressable device connected by the SLC Circuit.
  - 4. On Class A configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
  - 5. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.
  - 6. Speaker circuits may be controlled by NAC outputs built into the amplifiers, which shall function as addressable points on the Digital Audio Loop.
  - 7. NAC speaker circuits shall be arranged such that there is a minimum of one speaker circuit per

- floor of the building or smoke zone whichever is greater.
8. Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.
  9. NAC speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.

Two-way emergency telephone communication circuits shall be supervised for open and short circuit conditions.

Speaker circuits shall be arranged such that there is a minimum of one speaker circuit per smoke zone.

Speaker circuits shall be electrically supervised for open and short circuit conditions. If a short circuit exists on a speaker circuit, it shall not be possible to activate that circuit.

10. Audio amplifiers and tone generating equipment shall be electrically supervised for abnormal conditions. Digital amplifiers shall provide built-in speaker circuits, field configurable as four Class B, or two Class A circuits.
11. Digital amplifiers shall be capable of storing up to two minutes of digitally recorded audio messages and tones. The digital amplifiers shall also be capable of supervising the connection to the associated digital message generator, and upon loss of that connection shall be capable of one of the following system responses:
  - a. The digital amplifier shall automatically broadcast the stored audio message.
  - b. The digital amplifier shall switch to a mode where a local bus input on the digital will accept an input to initiate a broadcast of the stored message. This bus input shall be connected to a NAC on a local FACP for the purpose of providing an alternate means of initiating an emergency message during a communication fault condition.
  - c. Speaker circuits shall be either 25 VRMS or 70VRMS. Speaker circuits shall have 20% space capacity for future expansion or increased power output requirements.
  - d. Two-way emergency telephone (Fire Fighter Telephone) communication shall be supported between the Audio Command Center and up to **thirty (30)** remote Fire Fighter's Telephone locations simultaneously on a conference in multiple FFT Risers.
  - e. Means shall be provided to connect FFT voice communications to the speaker circuits in order to allow voice paging over the speaker circuit from a telephone handset.
  - f. The digital audio message generator shall be of reliable, non-moving parts, and support the digital storage of up to 32 minutes of tones and emergency messages, shall support programming options to string audio segments together to create up to 1000 messages, or to loop messages and parts of messages to repeat for pre-determined cycles or indefinitely.

**12. The proposed product shall not restrict the buyer to one single organization, nor shall it require any proprietary dongle or other programming tools for after sales & maintenance activity.**

### **1.3 DESIGN INTENT**

- a) Main fire alarm panel with digital voice command system, Fire fighters telephone, amplifier, zone selector keypad and announcement console – Ground floor – Near passenger lift lobby.
- b) Secondary fire alarm panels- At each level – near lift lobby
- c) Active repeater panels at security cabin
- d) All fire alarm panels connected as pier to pier.
- e) Class - A cabling to loop all detectors, devices & MCP's to control panel.
- f) Coverage per detector as per NFPA -2015, considering > 60 ACH
- g) System integration (Soft integration) with all standalone panels such as agent release panels for deluge valves,  
Pre-action panels, lift switchboard, DG fresh air switchboard, etc

- h) Emergency communication system, integral with the Main FACP, including voice alarm system components, microphones, amplifiers, zone selector keypads and tone generators
- i) Audible Alarm Notifications



j) Fire fighters telephone system as part of main fire alarm system which is two-way, supervised voice communication proposed to link between the MFACP and remote fire fighters' telephone stations throughout the building (at all staircases at all levels)

#### 1.4 GENERAL INSTRUCTIONS

- a) Protect from moisture by using appropriate coverings. Store at dry interior locations.
- b) Sequence work to avoid interferences with building finishes and installation of other products.
- c) Supply as maintenance stock, consumable devices, components as recommended by Supplier, but shall not be less than two units of each type/ rating of installed consumable material/ component/ device.
- d) For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for #18 to #12 AWG wire. Terminal blocks that are permanently fixed are not acceptable.

#### 1.5 WARRANTY

- A. The fire alarm control panel, voice panels and any head-end equipment shall have a manufacturer's warranty of a minimum of 12 months.

#### 1.6 APPLICABLE STANDARDS AND PRODUCT APPROVALS

- A. The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.
- B. National Fire Protection Association (NFPA) - USA:

NFPA 12	Extinguishing Systems (low and high)
NFPA 12A	Halon 1301 Extinguishing Systems
NFPA 13	Sprinkler Systems
NFPA 15	Water Spray Systems
NFPA 16	Foam / Water Deluge and Spray Systems

NFPA 17	Dry Chemical Extinguishing Systems
NFPA 17A	Wet Chemical Extinguishing Systems
NFPA 2001	Clean Agent Extinguishing Systems
NFPA 70	National Electric Code
NFPA 90A	Air Conditioning Systems
NFPA 92A	Smoke Control Systems
NFPA 92B	Smoke Management Systems in Malls, Atria, Large
NFPA 72	National Fire Alarm Code
NFPA 101	Life Safety Code

- C. Underwriters Laboratories Inc. (UL) - USA:

<b>UL 268, 7<sup>th</sup> Edition</b>	<b>Smoke Detectors for Fire Protective Signaling Systems</b>
<b>UL 864, 10<sup>th</sup> Edition</b>	<b>Control Units for Fire Protective Signaling Systems</b>
UL 2572	Mass Notification Systems
UL 217	Smoke Detectors, Single and Multiple Station
UL 228	Door Closers - Holders for Fire Protective Signaling Systems

UL 268A	Smoke Detectors for Duct Applications
UL 521	Heat Detectors for Fire Protective Signaling Systems
UL 464	Audible Signaling Appliances
UL 38	Manually Actuated Signaling Boxes

UL 1481	Power Supplies for Fire Protective Signaling Systems
UL 346	Waterflow Indicators for Fire Protective Signaling Systems
UL 1076	Control Units for Burglar Alarm Proprietary Protective Signaling Systems
UL 1971	Visual Notification Appliances
UL 2017	Standard for General-Purpose Signaling Devices and Systems
UL60950	Safety of Information Technology Equipment

- D. Factory Mutual – USA
- E. Local and State Building Codes.
- F. All requirements of the Authority Having Jurisdiction (AHJ).
- G. The system shall be certified for seismic applications in accordance with the International Building Code (IBC). The basis for qualification of seismic approval shall be via shake table testing.
- H. The System shall be FM 6320 (Factory Mutual) approved as a Gas Detection system when employed with the 4-20 monitor module and industry standard 4-20 mA gas detectors.

## **PART 2.0 PRODUCTS**

### **2.1 MAIN FIRE ALARM CONTROL PANEL OR NETWORK NODE:**

- A. Main FACP or network node shall contain a microprocessor based Central Processing Unit (CPU) and power supply. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system controlled devices.
- B. In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:
  1. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
  2. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.
  3. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.

### **System Capacity and General Operation**

- A. The FACP shall can communicate on a peer-to-peer, inherently regenerative communication format and protocol. The network shall support communication speed up to 100 Mbps and support up to 200 panels / nodes per network.
- B. The control panel shall be capable of expansion via up to 10 SLC loops. Each loop shall support minimum 250 analog/addressable devices for a system capacity of 3000 points. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 600- character liquid crystal display, individual, color coded system status LEDs, and a QWERTY keypad for the control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either company.

- C. All programming or editing of the existing program in the system shall be achieved without interrupting the alarm monitoring functions of the fire alarm control panel.
- D. The FACP shall be able to provide the following software and hardware features:

1. Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.
2. Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.
3. Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.
4. Action: If programmed for Action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on Alarm level.
5. The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.
6. Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.
7. NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the sensitivity testing requirements of NFPA 72.
8. Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.
9. On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop. A single change to one CPU database shall not require a database download to other CPUs.
10. History Events: The panel shall maintain a history file of atleastlast 5000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. **The control panels shall also maintain a 1000 event Alarm History buffer**, which consists of the 1000 most recent alarm events from the 5000 event history file.
11. Smoke Control Modes: The system shall provide means to perform Fire Smoke Control Station mode. This mode controls all dampers, smoke extraction fan, fresh air supply fans, etc during Fire condition. Smoke Control to meet NFPA-92A and 90B and HVAC mode to meet NFPA 90A.
12. **The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address.** The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.
13. Passwords and Users: The system shall support two password levels, master and user. Up

to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.

14. Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions

15. Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.
16. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.
17. Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.
18. Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.
19. Read status preview - enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.
20. Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bit-mapped graphic to the display screen.
21. **Group Decision Making by Smoke Detectors: The system shall provide means to link one detector with minimum two more detectors in group decision making. The group of minimum three detectors shall work in tandem to take fast and genuine alarm decision mitigating the risk of false alarm. There shall be no requirement of cross zoning or mandatory sequential address setting in the detectors to achieve this function. This shall be a built-in intelligence in the system to take fast & reliable decision on genuine alarm triggering. The alarm event shall be a result of group of detector chamber readings considered as a consolidated alarm signal.**
22. ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control-by-Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) Shall display ACTIVE on the LCD as well as display a FIRE CONTROL Type Code and other information specific to the device.
23. NON-FIRE Alarm Module Reporting: A point with a type ID of NON-FIRE shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation nor shall it display a message at the panel LDC. Activation of a NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.
24. Mass Notification Override: The system shall be UL 2572 listed for Mass Notification and shall be capable, based on the Risk Analysis, of being programmed so that Mass Notification/Emergency Communications events take precedence over fire alarm events.

25. **Security Monitor Points:** The system shall provide means to monitor any point as a type security.
26. **One-Man Walk Test:** The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can



be enabled for the test, all shall default to the disabled state. During an advanced walk test, field-supplied output point programming will react to input stimuli such as Control By Event and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.

27. **Control By Event Functions:** CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.
28. **Permitted zone types** shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.
29. **1000 General Zones:** The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.
30. **1000 Logic Equations:** The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.
31. **100 trouble equations per device:** The system shall provide support for up to 100 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.
32. **Control-By-Time:** A time based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24 hour time schedule on any day of the week or year.
33. **Multiple agent releasing zones:** The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zone and four abort options to satisfy any local jurisdiction requirements.
34. **Alarm Verification, by device, with timer and tally:** The system shall provide a user-defined global software timer function that can be set for a specific detector. The timer function shall delay an alarm signal for a user-specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period.

## **E. Central Processing Unit**

1. The Central Processing Unit shall contain and execute all control-by-event (including

Boolean functions including but not limited to AND, OR, NOT, ANYx, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.

2. The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.
3. The CPU shall be capable of being programmed on site without requiring the use of any external

programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.

4. The CPU shall provide an RS-232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.
5. The CPU shall provide two RS-485 ports for the serial connection to annunciation and control subsystem components.
6. The RS-232 serial output circuit shall be optically isolated to assure protection from earth ground.
7. In the event of CPU failure, all SLC loop modules shall fallback to **degrade mode**. **Systems not offering degrade mode shall offer Redundant CPU**. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

#### F. Display

1. The system display shall provide a **600-character** backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide eleven Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, CONTROLS ACTIVE, and CPU FAILURE.
2. **These characters shall be only for fire alarm / trouble information and not for Logo or other purpose. It shall be UL Listed. Repeater panel displays in FACP is not allowed unless until approved by UL**
3. The system display shall provide a QWERTY keypad for ease of operation.
4. The keypad shall have control capability to command all system functions, entry of any alphabetic or numeric information, and **field programming without the use of any external equipment or laptop**. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.

#### G. Loop (Signaling Line Circuit) Control Module:

1. The control panel shall be capable of expansion via up to **10 SLC loops**. Each loop shall support minimum **250 analog/addressable devices** for a system capacity of **3000 points**.
2. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.
3. Each loop shall maintain 20% spare capacity for future expansion.
4. Each Loop shall be capable of operating as a NFPA Class B circuit in case of single open circuit fault in existing SLC Circuit
5. The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble

conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the

accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

## H. Network Communication

The FACP shall communicate over a peer-to-peer communication network, inherently over a regenerative communication format and protocol. The network shall support communication speed up to 100 Mbps and support up to **200 Control Panels/ Network Nodes**, over a **single medium** (copper conductor / fiber optic), redundant ring, communication channel for fire alarm, voice evacuation and telephone talk-back system. The system shall support up to **200 such networks** in a single system.

**The network card shall have inbuilt Fiber port for terminating Fiber Optic Cable without any third party converters.**

## I. Digital Voice Command Center

1. The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset.
2. Function: The Voice Command Center equipment shall perform the following functions:
  - a. Operate as a supervised multi-channel emergency voice communication system. Operate as a two-way emergency telephone system control center.
  - b. Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.
  - c. Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.
  - d. Provide all-call Emergency Paging activities through activation of a single control switch.
  - e. As required, provide vectored paging control to specific audio zones via dedicated control switches.
  - f. Provide a factory recorded "library" of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.
  - g. Provide a software utility capable of off-line programming for the DVC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files.

Uploading or downloading the DVC shall not inhibit the emergency operation of other nodes on the fire alarm network.

- h. Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SLC controlled switching.
- i. The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.
- j. The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.

**Fire, Voice & Telephone data shall flow through single network cable.**

**The Voice Evacuation System shall be capable of establishing communication between the master voice controller and amplifier over fiber optic cable network without using any third party media converter.**

**Failure of Fire Panel CPU shall not affect the operation of DVC. In case DVC / Amplifiers are controlled by Fire Panel CPU, a separate panel with dedicated CPU shall be considered for each DVC & Amplifier.**

## **J. Power Supply**

1. The Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.
2. The Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.
3. The Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 7-**200 amp-hours** within a 48-hour period.
4. The Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
5. The Main Power Supply shall be power-limited per UL864 requirements.
6. The Main Power Supply shall communicate power supply, line voltage, battery status and charger status to the local LCD display. Any abnormal condition shall be annunciated and logged to the system alarm history log.
7. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means. Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire.
13. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.
14. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of zero, two, eight or sixteen hours shall be programmable.
15. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be programmable.
16. The addressable power supply mounts in either the FACP backbox or its own dedicated surface mounted backbox with cover.
17. Each of the power supply's four output circuits shall be programmed- for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.
18. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of

and end-of-line resistor. When the power supply's output circuit is selected as General 24 VDC power, the circuit shall be individually supervised when an end-of-line relay is used.

19. When selected for Notification Appliance Circuits, the output circuits shall be individually programmable for Steady, March Time, Dual Stage or Temporal.
20. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.

21. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.
22. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

#### **K. Audio Amplifiers**

1. The Audio Amplifiers shall provide Audio Power for distribution to speaker circuits.
2. Multiple audio amplifiers may be mounted in a single enclosure, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).
3. **The audio amplifier shall include an integral power supply**, and shall provide built-in LED indicators for the following conditions:
  - a. Earth Fault Detection & Annunciation for Communication bus
  - b. Audio Amplifier Failure Trouble Annunciation
  - c. External trigger input indication in case of Amplifier failure
  - d. Audio Detected on Firefighter's Telephone Riser
  - e. Receiving Audio from digital audio riser
  - i. Short circuit on detection & annunciation on each speaker circuit
  - j. Communication Status
  - n. Board failure
  - r. Active fiber optic media connection
  - t. Power supply monitoring of below conditions –Earth fault, Low Battery, Charger Trouble
5. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.
6. Includes audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).
7. **System shall be capable of backing up digital amplifiers.**
8. One designated backup amplifier shall be capable of backing up multiple primary amplifiers mounted in the same or adjacent cabinets.
9. Multi-channel operation from a single amplifier shall be supported by the addition of an optional plug-in amplifier card.
10. **System shall support distributed architecture of voice evacuation system to enable remote installation of amplifiers.** Remote Amplifier's shall communicate with the centrally located Digital Voice Command.

#### **L. Controls with associated LED Indicators**



1. **Speaker Switches/Indicators**

- a. The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.
- b. The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.

2. **Emergency Two-Way Telephone Control Switches/Indicators**

- a. The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.
- b. The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.

**M. Field Programming**

1. **The system shall be programmable, configurable and expandable in the field without the need for special tools.** There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.
2. All field defined programs shall be stored in non-volatile memory.

**N. Specific System Operations**

1. **Smoke Detector Sensitivity Adjust:** A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. **Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.**
2. **Alarm Verification:** Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 0 to 60 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

**O. System Point Operations**

1. Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or Graphics User Interface.
2. System output points shall be capable of being turned on or off from the system keypad or the video terminal.
3. **Point Read:** The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:
  - a. Device Status.
  - b. Device Type.
  - c. Custom Device Label.
  - d. Software Zone Label.
  - e. Device Zone Assignments.
  - f. Analog Detector Sensitivity.
  - g. All Program Parameters.

4. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 5000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History events shall include all alarms, troubles, operator actions, and programming entries.
5. The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.

6. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
7. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
8. The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.

## 2.2 SYSTEM COMPONENTS

### A. Network Control Annunciator

A network control annunciator shall be provided to display all system intelligent points. The NCA shall be capable of displaying all information for **200,000 points on the network**. Network display devices, which are only capable of displaying a subset of network points, shall not be suitable substitutes.

**The NCA shall include a 10" (1024 x 600) Color touchscreen display with QWERTY Keypad.** Additionally, the network display shall include environmental adjustment controls to maximize LCD legibility and the ability to scroll events by type. i.e. Fire Alarm, Supervisory Alarm, Trouble, etc.

The network control annunciator shall have the ability to display multiple events in order of priority and time of occurrence. Counters shall be provided to indicate the total number of events by type.

The NCA shall mount in any of the network node fire alarm control panels. Optionally, the network display may mount in a backbox designed for this use and shall connect to the network over either a wire or fiber interface.

The network control annunciator shall have an event history buffer capable of storing a minimum of 1000 events in non-volatile memory. Additionally, the NCA shall have a fire alarm history buffer capable of storing a minimum of 200 events in non-volatile memory. Systems that do not protect fire alarm events from being overwritten by other events are not suitable substitutes.

The NCA shall include Three USB connection, USB C, USB B Micro, and USB A, industry standard RS-232 ports for UL864 listed printers and CRT's. These peripheral devices shall print or display network activity.

The network control annunciator shall include control switches for system wide control of Acknowledge, Signal Silence, System Reset, Drill, and local Lamp Test. A mechanical means by which the controls switches are "locked out", such as a key, shall be available.

The NCA shall include long life LEDs to display Power, Fire Alarm, Pre-Alarm, Security Alarm, System Trouble, Supervisory, Signals Silenced, Disabled Points, Other (non-fire) Events, and CPU Failure.

The network control annunciator shall include a Master password and up to nine User passwords. Each password shall be up to eight alpha-numeric characters in length. The Master password shall be authorized to access the programming and alter status menus. Each User password may have different levels of authorization assigned by the Master password.

The NCA shall allow editing of labels for all points within the network; control on/off of outputs; enable/disable of all network points; alter detector sensitivity; clear detector verification counters for any

analog addressable detector within the network; clear any history log within the network; change the Time/Date settings; initiate a Walk Test.

The network control annunciator shall support an optional Windows<sup>TM</sup> based program utility. This utility shall allow the user create an NCA database, upload/download an NCA database, and download an upgrade to the NCA executive. To ensure program validity, this utility shall check stored databases for errors. A compare function shall be included to identify differences between databases.

For time keeping purposes the NCA shall include a time of day clock.

## **B. Network Control Station / Graphics User Interface**

The NCS shall utilize a Microsoft(tm) operating system. Each Network Control Station shall be capable of graphically annunciating and controlling all network activity and at least **2,50,000 network points**. Network display devices that are only capable of displaying a subset of network points shall not be suitable substitutes.

The NCS shall be an IBM (or compatible) personal computer with the following minimum requirements: Intel Pentium II(tm)-processor, operating at a minimum of 400 Mhz, 128Mbytes of RAM, 8 Mbytes Video RAM, 1.44 Mbyte floppy drive, 3.2 Gbyte hard disk, mouse, 32X CD-ROM, 3PCI / 1 ISA expansion slots, internal 3.2 Gbyte tape drive, sound card, 200 watt power supply, and SVGA graphics with a screen resolution of 1024 x 768. The network control station shall include a 19-inch monitor.

The NCS shall be capable of storing over **100,000 network events** in a history file. Events shall be stored on hard disk and shall be capable of back-up storage to a tape drive. The history buffer allows the operator to view events in a chronological order. A filter shall be available for displaying chronological events by operator, date, time, fire alarms, troubles (including security, supervisory and system/device), disabled points/zones, system programming, operator response and operator log in/log out. The ability to print NCS history files shall also be available.

The NCS shall use a Windows(tm) dialog box technology to address, interrogate, control, and/or modify intelligent points on each fire alarm node. This shall include, and not be limited to: Activating outputs, enabling or disabling points, adding or removing intelligent points, viewing intelligent detector sensitivity levels and modifying point information (custom messages, detector type, verification, day/night selection etc.)

The NCS shall include the ability to display system information in a graphical (floor plan) form. Each view, created using standard Windows bitmap files, shall include icons created for intelligent devices. These icons shall blink and change to the appropriate programmed icon when an event occurs. When the device has been acknowledged, the icon shall become steady. Once the point has returned to normal, the normal icon is displayed. In addition to the graphical representation of the device, the user shall be able to link pictures, documents and sound files to the device. The NCS shall also provide the ability to auto-vector to the floor plan (screen) of the device that is active. By selecting a device in the graphic presentation, the operator of the NCS

shall have the ability to log onto the corresponding node and interrogate the associated intelligent point.

The NCS shall have the ability to provide the following information through a Windows(tm) pull down menu: An Event Counter that contains the number of new and total events on the network. The information that is displayed shall consist of Fire Alarms, Pre-Alarms, Security Alarms, Supervisory Alarms, and Troubles. A Detailed Event window that contains all Off-Normal events, both unacknowledged and acknowledged that are present in the system. It shall contain two views, Fire events and Non-fire events that shall be user selectable. A Current Event window that shall contain all network and local events as well as system messages with a maximum of 1,000 events displayed. A Disabled Device window that shall contain all disabled devices in the system.

The NCS shall have the option, from a Windows pull down menu, to connect to a third party paging service that allows the NCS to automatically send text-based messages regarding system status to a typical text pager.

The NCS shall include help screens, available to aid the user without leaving the selected application screen.

The NCS shall be UL-Listed for fire protection (UL864) and burglary (UL1076).

**The NCS shall interface with other panels as a node in the peer to peer network.**

**The operator shall be able to monitor the FFT system from GUI software and shall be able to monitor and control Integrated Voice Evacuation System.**

The NCS shall have a flexible way of assigning operator passwords. There shall be an unlimited number of possible operators, each with specific levels of control. Each operator shall have his/her own password. Operator password and control selection shall be available to a high level "administrator" who shall have complete control over levels of control. If no action has taken place on the NCS after 10 minutes, the current operator shall be logged out and require a new log-in.

The NCS shall include an industry-standard RS-232 port for a UL864 listed printer. The NCS shall be a table top hardware configuration.

**C. Interactive Firefighters' Touchscreen Display**

The network will interface and report the individually monitored system's alarm status via a user-friendly Graphical User Interface (GUI) based software.

The software shall operate under Microsoft® Windows® 7 or Higher Operating System in Embedded platform as manufactured by Microsoft Corporation.

The GUI based software must be capable of graphically representing the facility being monitored with floor plans and icons depicting the actual locations of the fire alarm device locations. It shall be capable of mapping at least **2,50,000 network points**

The software shall use a 1280 pixel x 1024 pixel GUI display capable of showing a large primary floor plan display, a site plan representative of an aerial view of the facility, the first active fire alarm on the system.

The software shall permit automatic navigation to the screen containing an icon that represents the first fire alarm device in alarm in the event of an off-normal condition.

The fire alarm device icon shall be visible only when it is in an alarm (or active) condition.

The software shall display the activated smoke detectors in a time sequence to track smoke progression.

The software shall allow the importation of externally developed floor plans in Windows Metafile



(WMF), JPEG (JPG), Graphics Interchange Format (GIF) and Bitmap (BMP) format.

The software shall provide a intuitive and easy way to navigate to different screens representing floors and areas within a facility.

The system shall provide for continuous monitoring of all fire alarm conditions regardless of the current activity displayed on the screen.

The software shall display “YOU ARE HERE” along with icons representing standard building objects (stairs, elevators, etc) to be shown on the floor plan.

The software shall allow icons that represent hazardous materials stored in a facility.

The software shall provide a screen that displays preprogrammed building contact information.

The software shall provide a screen the displays building occupancy and other general building information.

The software shall allow a site plan to be imported that shows an aerial view of the facility. The software shall display all active fire, supervisory, and security events within an event list.

**Bidders also have the option to propose UL Listed Software with UL Listed Industrial Grade Hardware to achieve this functional requirement.**

**D. Cloud Based Facility Management Software**

Remote health monitoring solution utilizing cloud based software-as-a-service web application & supplementary network gateway hardware. System shall provide secure web access to cloud based web application using any of the web browsers like Google Chrome (preferable), Internet Explorer etc. from any computer/ tablet/ smartphone connected over internet via defined credentials – username and password. Supplementary FACP gateway hardware furnished in this section shall be programmable directly from the embedded webpage in the hardware, upon completion of this project. The use of configurable or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable. The cloud based web application shall capture all fire alarm system data as received from the system via supplementary gateway hardware. EMPLOYER shall receive login and passwords at first training session. The EMPLOYER shall have full licensing and full access rights for remote monitoring system.

**PRODUCT DATA SHEET 0 - Cloud Based Application:** The cloud hosted web application shall provide an intuitive user interface and shall provide the following features as a minimum:

- 1.1 Real time view of fire system effectiveness
- 1.2 Multi-location unified view
- 1.3 Custom dashboard view
- 1.4 Device level detailed information including current status
- 1.5 Event list
- 1.6 System reports
  - A. Fault Handling
  - B. Device Replacement & contamination
  - C. Panel & System report
  - D. Custom reports
- 1.7 Report export in PDF/ DOC format
- 1.8 Report scheduler Settings – add, delete, modify email addresses
- 1.9 Email ID settings for emailing critical alarms

**PRODUCT DATA SHEET 1 - Web Browser Navigation:** The cloud hosted web application shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using Google Chrome web browser to accomplish requirements of this specification. The

Web application shall (as a minimum) provide for navigation, and for display of intuitive dashboards, device information, alarms/events, reports, configuration menus for report settings

**PRODUCT DATA SHEET 2 - Login:** On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and strong password. Navigation in the system shall be dependent on the operator's role-based application control privileges.

**PRODUCT DATA SHEET 3 - Navigation:** Navigation through the web application shall be accomplished by clicking on dynamic links on dashboards to access detailed system information and by clicking on appropriate tabs for application settings and preferences. Both the tabs and dynamic links shall be displayed simultaneously, enabling the operator to select a specific system information and application

settings and preferences.

**PRODUCT DATA SHEET 4 - System Dashboards:** The system dashboard shall provide several functional information for each system specified. This view shall be accessed by right after logging in to the system:

- 1.1 Each building dashboard (in case of multiple buildings) shall be visible along with system effectiveness and fire alarm system information like –
  - A. Number of panels
  - B. Number of loops
  - C. Number of devices
- 1.2 Detailed information Section – this can be accessed upon clicking relevant links. Detailed system information like device list along with corresponding address, current status and time stamping can be viewed. Events data is also visible.
- 1.3 Search: User shall have multiple options for searching data based upon device type, device status.

**PRODUCT DATA SHEET 5 - Reports:** The Web application can be used to access system health reports of past and as-on-date. Provision for system reports to be emailed to predefined email IDs and time intervals in PDF or DOC format. Different report types –

- 1.1 Fault Handling report – Effective measurement of turnaround time (TAT) of various issues and capable of drawing detailed report at individual fault level.
- 1.2 Device Replacement Report - Proactive alerts along with active insights on the faulty devices & detectors which need attention or replacement helping customers save time and reducing fire risk.
- 1.3 Device Contamination Report - Real time statistics of device contamination showing dirt levels along with detector efficiency
- 1.4 Panel & System Report - List of panel faults with trouble date and time stamped, beyond the panel memory of 5000 events can store upto 100,000 events

**PRODUCT DATA SHEET 6 - Alarms:** Alarms associated with a specific equipment and or device, shall be displayed dynamically in a window.

- 1.1 The Alarm remain in the application until it is acknowledged or Panel is reset.
- 1.2 The Alarm status also viewed in the LIST VIEW section of the application.

**PRODUCT DATA SHEET 7 - Security Access:** Cloud hosted Remote monitoring web application for fire alarm system can be accessed by Google chrome web browser and shall require a Login Name and Strong Password. Separate access credentials for EMPLOYER and service provider shall be provisioned.

## 2.3 GATEWAY AND WEB SERVERS

- A. BACnet Interface Gateway: The system shall be capable of being interfaced with BACNet compliant clients. A BACnet interface supporting BACnet/IP communication shall be available from the fire alarm control panel manufacturer. **BACnet shall support 14000 data points. BACnet gateway shall communicate with all the panels in a peer to peer network.**
- B. MODbus Interface Gateway: The system shall be capable of being interfaced with MODbus

compliant clients. A MODbus interface supporting MODbus/TCP communication shall be available from the fire alarm control panel manufacturer.**MODbus shall support 12000 data points.MODbus gateway shall communicate with all the panels in a peer to peer network.**

- C. **Webserver:** The system shall support a webserver allowing remote connection via the Internet or Intranet. Authorized users will have the ability to view panel/network history, event status and device properties. The webserver shall also support sending event information via email or text to up to 50 registered users, the webserver shall be available from the fire alarm control panel manufacturer.
- D. **Web Portal Interface:** The system shall be capable of being interfaced with a web portal to integrate with

Inspection and Service Manager utilities. The web portal and inspection and service manager utilities shall be available from the fire alarm control panel manufacturer.

## 2.4 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

### A. Addressable Devices – General

1. Addressable devices shall provide an address-setting means using **rotary decimal switches**. Addressable devices that require the address be programmed using a programming utility are not an allowable substitute.
2. Addressable devices shall use simple to install and maintain decade, decimal address switches.
3. Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute. Addressable devices that require the address be programmed using a special tool or programming utility are not an allowable substitute.
4. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel Signaling Line Circuits.
6. **Addressable smoke and thermal detectors shall provide dual alarm and power/polling bi-colour LEDs.** Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
7. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.
8. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.
9. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base options shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications. The system shall also support an intelligent programmable sounder base, the programmable sounder base shall be capable of providing multiple tones based on programming and at a minimum be capable of providing a Temp-4 tone for CO (Carbon Monoxide) activation and a Temp-3 tone for fire activations and be capable of being synchronized with other programmable sounder bases and common area notification appliances; 85 DBA minimum.
10. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (PHOTO, THERMAL).
11. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal

decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.

12. Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.
13. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.
14. Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. An optional surface mount Lexan enclosure shall be available.
15. **Detectors / Bases with connection terminals exposed to Ceiling / False Ceiling shall be provided with Protective Insulation of the same make as of Detectors.**

**B. Addressable Manual Call Point (Break Glass / Pull Down Type)**

1. Addressable manual call point shall send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
3. Manual fire alarm boxes shall be constructed of Lexan / ABS Plastic with clearly visible operating instructions provided on the cover. The word FIRE / Fire Sign shall appear on the front of the stations.

**C. Intelligent Photoelectric Smoke Detector:**

The intelligent photoelectric smoke detector shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

1. **Designed to meet UL268 7th Edition.**
2. Modern profile with White color for improved aesthetics.
3. Sensitivity Range of 0.5% to 4.0% obs/ft
4. Stable communication technique with noise immunity.
5. Low standby current. 200 micro Amps @ 24 VDC
6. Two-wire SLC connection.
7. Rotary, decimal addressing
8. Dual bi-color LED design providing 360° viewing angle. LEDs blink green in normal condition and illuminate steady red on alarm
9. Remote test feature from the panel.
10. Walk test with address display
11. Built-in functional test switch activated by external magnet.
12. Built-in tamper-resistant feature.
13. Sealed against back pressure.
14. Expanded color options.
15. Optional relay, isolator, and sounder bases.

**D. Intelligent High Sensitivity Photo Smoke Detector**

The intelligent high sensitivity photo smoke detector shall be a spot type detector that incorporates an extremely bright high sensitivity diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.

**1.01 Designed to meet UL268, 7th Edition**

- 1.02 The high sensitivity detector shall have conductive plastic so that dust accumulation is reduced significantly.
2. **The intelligent high sensitivity photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.02 percent per foot.**
3. The high sensitivity detector shall not require expensive conduit, special fittings or PVC pipe.
4. The intelligent high sensitivity photo detector shall support standard, relay, isolator and sounder detector bases.
5. The high sensitivity photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.
6. The high sensitivity photo detector shall include two bicolor LEDs that flash green in normal operation and turn on steady red in alarm.

**E. Intelligent Multi Criteria Detector**

The intelligent multi-criteria detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The detector design shall allow a wide sensitivity window, 0.5 to 4.0% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.

1. **Designed to meet UL268, 7th Edition**
2. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
3. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

**F. Intelligent Thermal Detectors**

The intelligent thermal detectors shall be addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. **A high heat thermal detector rated at 190 degrees Fahrenheit (87.8 degrees Celsius) shall also be available.** The thermal detectors shall connect via two wires to the fire alarm control panel signaling line circuit.

1. Modern profile with White color for improved aesthetics.
2. Advanced thermal technology for fast response.
3. Fixed temperature model factory preset to 135°F
4. Rate of Rise model preset to 15°F/min
5. High temperature model factory preset to 190°F
6. Low standby current. 200 micro Amps @ 24 VDC
7. Two-wire SLC connection.



8. Rotary, decimal addressing
9. Dual bi-color LED design providing 360° viewing angle. LEDs blink green in normal condition and illuminate steady red on alarm
10. Remote test feature from the panel.
11. Walk test with address display
12. Built-in functional test switch activated by external magnet.
13. Built-in tamper-resistant feature.
14. Sealed against back pressure.
15. Optional relay, isolator, and sounder bases.

#### G. **Intelligent Duct Smoke Detector**

The smoke detector housing shall accommodate an intelligent photoelectric detector that provides continuous analog monitoring and alarm verification from the panel. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system. The Intelligent Duct Smoke Detector shall support the installation of addressable Photoelectric detector capable of being tested remotely.

#### H. **Advanced Multi-Criteria Intelligent Fire/CO Detector**

1. Advanced Multi-Criteria Fire/CO detector be an addressable advanced multi-criteria smoke detector with a separate signal for carbon monoxide (CO) detection per UL 2075 standards.
2. **The detector shall be comprised of four sensing elements, including a photoelectric (light- scattering) particulate sensor, an electrochemical CO sensor, a daylight-filtered infrared (IR) sensor and solid state thermal sensor(s) rated at 135°F (57.2°C).** The device shall be able to indicate distinct smoke and heat alarms.
3. The advanced multi-criteria detection device shall include the ability to combine the signal of the photoelectric signal with other sensing elements in order to react quickly in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a nuisance alarm condition. The detector shall be capable of selecting the appropriate sensitivity levels based on the environment type (office, manufacturing, kitchen, etc.) in which it is installed, and then have the ability to automatically change the setting as the environment changes.
4. The CO detector component shall be capable of a functional gas test using a canned test agent to test the functionality of the CO sensing cell.
5. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The device shall provide unique signals to indicate when 20 percent of the drift range is remaining, when 100 percent of drift range is used, and when there is a chamber fault to show the unit requires maintenance.
6. The detector shall indicate CO trouble conditions, including six months of sensor life remaining and sensor life has expired. The detector shall indicate a combined signal for any of the following: low chamber trouble, thermistor trouble, CO self-test failure, IR self-test failure, and freeze warning.
7. The detector shall provide address-setting means on the detector head using rotary switches. Because of the possibility of installation error, systems that use binary jumpers or DIP switches to set the detector address are not acceptable. The detector shall also store an internal identifying code that the control panel shall use to identify the type of detector. Systems that require a special programmer to set the detector address (including temporary connection at the panel) are labor intensive and not acceptable. Each detector occupies any one of at least 159 possible addresses on the signaling line circuit (SLC) loop. It responds to regular polls from the system and reports its type and status.

8. The detector shall provide a test means whereby it will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a switch) or initiated remotely on command from the control panel. There shall be four test methods: functional magnet, smoke entry aerosol, carbon monoxide aerosol or direct heat method.
9. The detector shall provide two LEDs to provide 360° visibility. The LEDs shall be placed into steady red illumination by the control panel indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED. The detector must be capable of connecting to a sounder base that provides both temporal 3 and temporal 4 patterns for fire and CO alarm.
10. Two LEDs on the sensor shall be controlled by the panel to indicate sensor status. Coded signals, transmitted from the panel, shall cause the LEDs to blink, latch on, or latch off. Refer to the control panel technical documentation for sensor LED status operation and expected delay to alarm.
11. The detector shall be plug-in mounted into a twist-lock base. The detector shall be constructed of off-white, UV-resistant polymer and shall be detachable from the mounting base to simplify installation, service and maintenance. Mounting base wiring connections shall be made by means of SEMS screws. The detector shall allow pre-wiring of the base and the head shall be a plug-in type. The mounting base shall be mounted on a junction box that is at least 1.5 inches (3.81 cm) deep. The mounting base shall be available to mount to standard junction boxes. Suitable boxes include:
  - a. 4.0" (10.16 cm) square box with and without plaster ring.
  - b. 4.0" (10.16 cm) octagonal box.
  - c. 3.5" (8.89 cm) octagonal box.
  - d. Single-gang box.
  - e. Double-gang box
12. Meets Agency Standards
  - a. ANSI/UL 268 -Smoke Detectors for Fire Alarm Signaling Systems
  - b. CAN/ULC-S529- Smoke Detectors for Fire Alarm Systems
  - c. FM 3230-3250- Smoke Actuated Detectors for Automatic Fire Alarm Signaling
  - d. UL 2075 – Gas and Vapor Detector and Sensors – Systems Connected

#### **I. Intelligent Addressable Aspiration Detector**

**The intelligent aspiration detector shall be an addressable aspiration detector that communicates directly with the fire alarm control panel via the SLC communication protocol, no modules or high level interfaces shall be required..** The aspiration detector shall have Infra-red laser optical smoke detection for a wide range of fire detection with enhanced immunity to nuisance particulates. The FACP shall be capable of monitoring and annunciating up to five smoke event thresholds and eleven trouble conditions. Each event threshold shall be capable of being assigned a discrete type ID at the FACP.

**J. Intelligent Addressable Reflected Beam Detector**

1. The intelligent single-ended reflected beam smoke detector shall connect with two wires to the fire alarm control panel signaling line circuit (SLC). The detectors shall consist of a transmitter/receiver unit and a reflector and shall send data to the panel representing the analog level of smoke density. The detector shall be capable of being tested remotely via a keyswitch; It shall be equipped with an integral sensitivity test feature.
2. The Beam Detectors shall be long range, projected beam type smoke detectors which consist of a Transmitter and receiver in a single unit and reflector on the other side.
3. The Beam Detector shall have a range upto 100 mtrs. There shall be multiple sensitivity levels. Starting from 25 %, 30 %, 40 %, 50 % and acclimate levels also 30 % to 50 % and 40 % to 50 %. There shall be trouble alarm if obscuration block is more than 96 %.

**K. Addressable Dry Contact Monitor Module**

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.
2. The IDC zone shall be suitable for Class A or Class B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

**L. Two Wire Detector Monitor Module**

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device)
2. The IDC zone may be wired for Class A or B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

**M. Addressable Control Module**

1. Addressable control modules shall be provided to supervise and control the operation of one conventional circuit of compatible Notification Appliances, 24 VDC powered, polarized audio/visual notification appliances
2. The control module NAC may be wired for Class A/B with a current rating of 2 Amps
3. Audio/visual power shall be provided by a separate supervised circuit from the main fire alarm control panel or from a supervised UL listed remote supply.

**N. Addressable Releasing Control Module**

1. An addressable releasing module shall be available to supervise and control compatible releasing agent solenoids
2. The module shall operate on a redundant protocol for added protection.
3. The module shall be configurable for Class A/B and support one 24 volt or two 12 volt solenoids.

**O. Addressable 4-20 mA Module**

Addressable 4-20 mA module shall be available to monitor industry-standard, linear-scale, 4-20 mA protocol sensors. The module converts the sensor output to communication protocol that can be interpreted by the FACP for monitoring and display

1. The module shall support programming of up to five programmable event thresholds.

2. The System shall be FM 6320 (Factory Mutual) approved as a Gas Detection system when employed with the FMM-4-20 monitor module and industry standard 4-20 mA gas detectors.

**P. Addressable Relay Module**

1. Addressable Relay Modules shall be available for HVAC control and other network building

- functions
- 2. The module shall provide two form C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive.
- 3. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary devices energize at the same time on the same pair of wires;
- 4. For multiple relay control a module shall be available that provides 6 programmable Form-C relays.

**Q. Addressable Two-In / Two-Out Monitor/Relay Module**

- 1. An addressable Two-In / Two-Out module shall be available.
- 2. The two-in/two-out module shall provide two Class B/Style B dry-contact input circuits and two independent Form-C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive.

**R. Isolator Module**

Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.

- 1. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
- 2. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
- 3. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.
- 4. **If Isolator Bases are proposed, Vendor needs to consider Isolator base for all detectors**

**S. Serially Connected Annunciator**

- 1. The annunciator shall communicate to the fire alarm control panel via an EIA 485 (multi-drop) two-wire communications loop. The system shall support two 6,000 ft. RS-485 wire runs. Up to 32 annunciators, each configured up to 96 points, may be connected to the connection, for a system capacity of 3,000 points of annunciation.
- 2. An RS-485 repeater shall be available to extend the RS-485 wire distance in 3,000 ft. increments. The repeater shall be UL864 approved.
- 3. Each annunciator shall provide up to 96 alarm and 97 trouble indications using a long-life programmable color LED's. Up to 96 control switches shall also be available for the control of Fire Alarm Control Panel functions. The annunciator will also have an "ON-LINE" LED, local piezo sounder, local acknowledge and lamp test switch, and custom zone/function identification labels.
- 4. The annunciator may be field configured to operate as a "Fan Control Annunciator". When configured as "Fan Control," the annunciator may be used to manually control fan or damper operation and can be set to override automatic commands to all fans/dampers programmed to the annunciator.
- 5. Annunciator switches may be programmed for System control such as, Global Acknowledge, Global Signal Silence, Global System Reset, and on/off control of any control point in the system.
- 6. An optional module shall be available to utilize annunciator points to drive RS-485 driven

relays. This shall extend the system point capacity by 3,000 remote contacts.

7. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

#### **T. Speakers**

1. The Speaker appliance shall be listed to UL 1480 for Fire Protective Signaling Systems. It shall be a dual-voltage transformer speaker capable of operation at 25.0 or 70.7 nominal Vrms. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. It shall mount to a 4 x 4 x 2 1/8-inch back box.

2. A universal mounting plate shall be used for mounting ceiling and wall speaker products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate.
3. Speakers shall be plug-in and shall have the ability to check wiring continuity via a shorting spring on the universal mounting plate. The shorting spring shall also provide tamper resistance via an open circuit if the device is removed. Speaker design shall isolate speaker components to reduce ground fault incidents.
4. The speaker shall have power taps (from ¼ watt to 2 watts) and voltage that are selected by rotary switches. All models shall have a maximum sound output of 86 dB at 10 feet and shall incorporate an open back construction.
5. All notification appliances shall be backward compatible.

#### U. Advance Speaker Strobes

1. The Speaker Strobe appliance shall be listed to UL 1971 and UL 1480 and be approved for fire protective signaling systems. It shall be a dual-voltage transformer speaker strobe capable of operation at 25.0 or 70.7 nominal Vrms. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. It shall mount to a 4 x 4 x 2 1/8- inch back box.
2. A universal mounting plate shall be used for mounting ceiling and wall speaker strobe products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate. Also, Advance speaker strobes shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts (includes fire alarm panels with built in sync). 12-volt rated notification appliance circuit outputs shall operate between 8.5 and 17.5 volts; 24-volt rated notification appliance circuit outputs shall operate between 16.5 to 33 volts.
3. Speaker strobes shall be plug-in and shall have the ability to check wiring continuity via a shorting spring on the universal mounting plate. The shorting spring shall also provide tamper resistance via an open circuit if the device is removed. Speaker strobe design shall isolate speaker components to reduce ground fault incidents.
4. The speaker strobe shall have power taps (from ¼ watt to 2 watts) and voltage that are selected by rotary switches. All models shall have a maximum sound output of 86 dB at 10 feet and shall incorporate an open back construction. The strobe shall consist of a xenon flash tube with associated lens/reflector system and operate on either 12V or 24V. The strobe shall also feature selectable candela output, providing options for 15 or 15/75 candela when operating on 12V and 15, 15/75, 30, 75, 110, or 115 when operating on 24V. The strobe shall comply with NFPA 72 and the Americans with Disabilities Act requirement for visible signaling appliances, flashing at 1 Hz over the strobe's entire operating voltage range.
5. All notification appliances shall be backward compatible.
6. Strobe lights shall meet the requirements of the ADA, UL Standard 1971 and be fully synchronized.

#### V. Programmable Directional Sounders

1. **Shall follow NFPA 72 2019 edition Clause 18.4.8.**
2. Electronic sounders shall operate on 24 VDC nominal.
3. Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device.
4. Shall be capable to broadcast pre programmed Voice Message.
5. Shall be flush or surface mounted as shown on plans.
6. Shall produce broad band directional sound with **20 Hz to 20 Khz frequency band** to guide occupants to safe exists even in complete darkness.

**W. Addressable Portable Emergency Telephone Handset Jack**

1. Portable emergency telephone handset jacks shall be flush mounted on stainless steel plates as indicated on plans. Handset jacks shall be approved for emergency telephone system application.
2. Insertion of a remote handset plug into a jack shall send a signal to the fire command center which shall audibly and visually indicate the on-line condition, and shall sound a ring indication in the handset.
3. The two-way emergency telephone system shall support thirty five (35) handsets on line without



degradation of the signal.

4. **Remote Telephone Handset shall be capable of making paging announcement across all the zones in the system.**

#### **X. Addressable Fixed Emergency Telephone Handset**

1. The telephone cabinet shall be painted red and clearly labeled emergency telephone. The cabinets shall be located where shown on drawings.
2. The handset cradle shall have a switch connection such that lifting the handset off of the cradle shall send a signal to the fire command center which shall audibly and visually indicate its on-line (off-hook) condition.
3. The two-way emergency telephone system shall support thirty five (35) handsets on line (off-hook) without degradation of the signal.
4. **Remote Telephone Handset shall be capable of making paging announcement across all the zones in the system.**

#### **Y. Batteries**

**The battery shall have sufficient capacity to power the fire alarm system for not less than 48 hours in standby plus 2 hours of alarm upon a normal AC power failure.**

The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.

If necessary to meet standby requirements, external battery and charger systems may be used.

### **PART 3.0 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.
- C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.
- D. Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

#### **3.2 CAUSE & EFFECT LOGIC**

System shall be programmed as per the attached cause & effect logic.

#### **3.3 TESTING**

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72.

- A. Before energizing the cables and wires, check for correct connections and test for short

- circuits, ground faults, continuity, and insulation.
- B. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
  - C. Verify activation of all waterflow switches.
  - D. Open initiating device circuits and verify that the trouble signal actuates.
  - E. Open and short signaling line circuits and verify that the trouble signal actuates.

- F. Open and short notification appliance circuits and verify that trouble signal actuates.
- G. Ground all circuits and verify response of trouble signals.
- H. Check presence and audibility of tone at all alarm notification devices.
- I. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.
- J. Each of the alarm conditions that the system is required to detect shall be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
- K. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

### **3.4 FINAL INSPECTION**

- A. At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

### **3.5 INSTRUCTION & TRAINING**

- A. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.
- B. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

### **3.6 SUBMITTALS**

#### **a) Power calculations.**

- Battery capacity calculations.
- Supervisory power requirements for all equipment.
- Alarm power requirements for all equipment.
- Justification showing power requirements of the system power supplies.
- Voltage drop calculations for wiring runs in worst case condition.

#### **b) Complete manufacturer's catalogue data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements.**

#### **c) Submit panel configuration and interconnection of modules and all other data as required to make an informed judgment regarding product suitability. As a minimum, data shall be submitted on the following:**

- Main system including all fire detection with main and secondary control panels.
- Circuit interface panels including all modules.
- Power supplies, batteries and battery chargers.
- Equipment enclosures.
- Intelligent addressable manual pull stations, multi-criterion detectors, heat detectors, analogue smoke detectors, alarm monitoring modules, and supervised control modules.
- Audible and visual evacuation signals and devices.
- Software and firmware as required providing a complete functioning system.
- Wiring.
- System driven remote annunciators.

- Interface module and wiring configuration from local system to Fire Command System.
- d) Submit copies of UL listing or FM approval data showing compatibility of the proposed devices or appliances and the panels being provided.

e) Submit the following shop drawings.

- Floor plans showing all initiating, end of line, supervisory, indicating appliances, and output control devices; including circuit interface panels, enunciators, printers, Control panel location.
- Raceways, marked for size, conductor count with type and size
- Calculations and mathematical justification for audible devices shall meet the code requirement of 15 dBA above ambient at 10 feet distance for audible warning signals.
- Wiring diagrams showing points of connection and terminals used for all electrical connections to the system devices and panels.
- Complete single-line riser diagram showing all equipment and the size type and number of all conductors.

f) Submit Method Statement for systems component wiring, installation, testing, commissioning and operating.

g) Typical installation drawings

h) Complete operation and maintenance manual with two sets of proposed installation drawings shall be submitted.

i) Warranty all system components, devices, peripherals, wiring, for Three years from date of practical completion Certificate.

j) Guarantee all wiring and raceway to be free from inherent mechanical or electrical defect for one year from date of practical completion certificate.

## E14. IP CCTV Systems

### OBJECTIVE

**To have an Enterprise Level Surveillance & Security System.** The vendor shall supply and commission an IP based CCTV system with the objective to provide high degree of surveillance system for the entire site.

The purpose is to monitor & supervise the entire area for security purpose, as well as record and inform officials on unwanted, untoward incidents. It is also essential to have recorded images to be stored at least for **min 30 days at D1 resolution, participant to give calculation for HDD.** of all critical area's to facilitate investigations of a reported incidents.

The hardware required for the system including servers, workstations, monitors, networking components, cables, connectors, conduits, power supplies etc. will be in vendor's scope. It will be the responsibility of the vendor/bidder to make the entire system fully functional as per the specifications. Vendor/bidder shall consider any equipment/devices required to make the system functional if not mentioned herewith.

Further, the CCTV system shall be seamlessly integrated with other security systems such as the Access Control Systems & Intrusion Alarm System.

### ➤ SYSTEM ARCHITECTURE:

#### 1.1 SYSTEM COMPONENTS

- A. NVR: The NVR shall contain the recording engine, database of all network-connected cameras and encoders, integrated components and their configurations. Server shall be provided as a combined hardware and software device.
- B. Workstation Software (NVR Client): The NVR Client software shall render video and act as a main human/machine interface.

#### 1.2 OPERATIONAL REQUIREMENTS

- A. NVR shall provide a user-friendly graphical user interface (GUI) to configure the cameras, create schedules for recording, perform video surveillance and recording operations, and view various reports.
- B. NVR shall be configured to store and to view images captured by minimum 4 cameras and scalable on same hardware for upto 64 cameras.
- C. NVR shall have following major capabilities:
  - 1. Record and monitor up to 64 IP channels at 1920 fps @ 4CIF/VGA or 1920 fps @ 720p HD or 1920 fps @ 1080p (4 Mbps bitrate) HD. Network bandwidth/throughput supported per NVR with Incoming: 256 Mbps, Outgoing: 425 Mbps providing a Total:

681 Mbps. Archival support of 25 channels @ 4 Mbps bitrate each, with outgoing archival storage throughput of 275 Mbps. Multi-stream support with maximum 128 streams. Support for configuring one (1) preferred stream for continuous recording and one (1) preferred stream for live video/motion based recording per camera. Support for One-Way Audio (for specific IP cameras) with live, playback and clip export on NVR desktop client for up to 64 IP channels.

2. Live viewing of up to 64 IP cameras on a single remote workstation with up to two (2) monitors set up at CIF resolution. For 4CIF and HD resolution, the number of live streams needs to be benchmarked based on client hardware configuration deployed. Cost-effective enhanced HD

video rendering on remote desktop clients with support for monitoring of up to 23 1080p HD cameras in real time (30 fps)/690 fps 1080p HD with no-time lapse using the GPU capabilities of in-built processor graphics with 6th generation Intel® Core™ Processors for client systems. Up to 4 1080p HD @ 30 fps/120 fps on local client.

3. Powerful investigation and video archive search tools from remote client.
  4. Native device integrations supporting equiP<sup>®</sup> Series cameras' new features: 4K resolution, H.265 video compression codec, 3D PTZ control, 360° camera support, and intelligence events.
  5. Capable of managing motion detection-based recording with pre-event and post-event recording based on camera based motion detection or Server based motion detection events (SMART VMD) and “advanced” search on recordings from remote client.
  6. Preview and Calendar Search permitting search for videos and events based on user-selected date and time from remote client. SMART motion search — fast and efficient forensic search and investigation for objects/motion on recorded video using SMART motion detection Analytics algorithms on the client PC without impacting the NVR Server load.
  7. Simultaneous use of multiple video compressions including MJPEG, MPEG-4, H.265 and H.264.
  8. Internationalization – supports the following languages: French, German, Russian, Italian, Spanish, Dutch, Arabic and English.
  9. Email on alarm.
  10. Instant clip creation from snapshot.
  11. Dynamic IP Camera Discovery – Automatically discover all compatible cameras connected to NVR.
  12. Multi-level user access rights for viewing and manages access to the recorder functions.
  13. Capable of managing continuous, scheduled, manual, event-based, and alarm-based recording features.
  14. Advanced security features with encryption support for communication between desktop client to NVR and secure https login for Web Client and mobile apps.
  15. Support for web client and mobile apps.
- D. Mode for User Login: NVR shall have the option of two modes of user logins:



1. Windows Authentication: Uses Windows logged-in user name.
  2. User DB Authentication: Uses preconfigured user name and password.
- E. Workstation (NVR Client) shall provide the following operator options:
1. Configuration: The operator (with Administrator privileges) shall have the option to configure the NVR. Live update of all configurations is supported. The following configurations shall be possible:
    - a. System Configuration: Provide options to configure the system level settings.
    - b. Camera Configuration: Provide options to add/edit/delete IP cameras and encoders.

- c. Schedules: Provide options to configure schedule based recording for cameras connected to the NVR.
- d. Input and Output: Provide options to configure camera input and output.
- e. Sequences: Provide options to group a fixed number of cameras to view video.
- f. User Management (Users and Roles): Provide option to add/edit/delete users.
- g. Clip Deletion Settings: Provide the ability to automatically utilize more storage on event- initiated recording.
- h. Independent deletion setting for continuous recording.
- i. Independent deletion setting for event recording.
- j. Surrounding Cameras: Provide option to grant a user the ability to view a single camera surrounded by the cameras programmed as the “Surrounding Cameras”.
- k. 3D Positioning: The user shall be able to view a specific object in the live video in a 3- dimensional view. This feature is available in the Context menu options and is only supported for PTZ Cameras. 3D positioning options include: Click-based camera positioning, Rectangle selection 3D positioning, and Restore to last PTZ position.
- l. Profile Cameras: Multi-zoom views on HD video and support to create virtual cameras by digitally zooming into the field of view. For example: zooming in on a cash register in one view of the HD camera while at the same time monitoring the cashier in the zoomed out view of that HD camera.

F. Configurations for cameras connected to NVR:

- 1. Camera Configuration: The user shall be able to configure the following parameters for each camera connected to the NVR.
  - a. Camera Name
  - b. IP Address
  - c. Camera Type
  - d. Fixed/PTZ
  - e. Continuous Recording: All cameras added shall be defaulted to "24/7" recording with the option to select other recording modes.
  - f. Event Based Recording: Shall be “None” by default, with the option to select

motion- based recording.

- g. User name: Shall display and enable setting the user name for a camera.
- h. Password: Shall enable setting the password for a camera.
- i. Camera Advanced Settings: Shall enable configuration of Video Format, Compression Format, Resolution, Compression, Video Frame Rate, GOP, Record Quality Settings, Clip Deletion Settings, Launching Web View of camera for Advanced Setup, Motion detection zones configuration for Server based motion detection, Video Archival

Settings, Multi-Stream Settings and Video Preview. Shall enable configuration of RTSP URL for cameras or encoders added with camera type – Generic RTSP.

2. The following video recording options shall be supported:
  - a. Scheduled based recording: The system shall support the ability to schedule recordings for each individual camera for times in the future. By default, the NVR shall be pre-loaded with the following four schedules: 24x7, Weekday, Daytime, and Nighttime, which cannot be edited. A maximum of 50 schedules can be created in the NVR.
  - b. User based recording: The user shall be able to configure user activated settings for recording moments of interest while viewing live video from a camera. After configuring the user activated settings, the operator can start recording of video when needed. The video is recorded for the time period specified in the System settings for user activated recording. The User based Recording Time Duration shall be selectable from a list of values ranging between 30 seconds and 5 minutes.
  - c. Event based recording: Event based recording shall be possible on SMART Video Motion Detection and alarm triggers. The NVR must be capable of managing motion detection-based recording with pre-event and post event recording based on camera and Server-based motion detection events. The server-based SMART VMD analytics must be object-based and not traditional pixel-based, reducing false alarms due to changing light conditions, video noise, rain or other false alarm triggers that occur using pixel-based (traditional) VMD.
- G. Viewer: The NVR Viewer shall have the following minimum capabilities:
  1. Main video viewing screen capable of showing 1, 4, 9, 16, and other customized split salvos of live or recorded video. Standard presets shall be customizable to the user preferences.
  2. Capable of saving current salvo as a View and allowing the user to drag this view at any later point in time.
  3. Capable of configuring and running scan sequences.
  4. Capable of adjusting the contrast, brightness, and saturation settings for each camera independently.
  5. Capable of exporting user selected image or video clips in simple .wmv, .asf, .mpvc and .bmp formats. Capable of attaching a digital signature for authentication of exported clips in .wmv format.

6. Capability to play back the video clips exported. Each video channel that is being recorded by the recording system shall be overlaid with text and a time stamp that is customizable by the user.
7. Video format support — only playable in desktop clients and standalone Clip Player. Features quicker exports of raw video and support for estimating clip size and split to multiple clips to ensure clip storage media matches. Include the clip player with exported clip for easier review of video evidence and efficient investigation. Clip Player — Portable standard secure player for archived and exported clips (\*.mpvc), 360 camera de-warping and 2x2 Salvo support. Smooth playback support with up to 256x review speed. No software needed to run on a Windows PC, with the option to include the clip player with the exported clip.
8. Allow the user to initiate recording through the GUI or a controller.

9. Capability of complete alarm management for the alarms coming from the NVR.
  10. Facility of surrounding camera view.
  11. Option to perform various operations through context menu on a particular video (live/recorded/sequence). These operations include: Full screen, point and drag, maintain aspect ratio, toggle text, digital PTZ, add bookmark, start recording, stop recording, mark in, mark out, save image, save image as, show surrounding cameras.
  12. Ability to manage timeline control of the recording device, which provides camera recording statistics. Timeline control shall have the following features: Mark input (with looping facility), bookmark, snapshot, time slider, time jump, play controls.
  13. Preference configuration including: frame rate of unselected panels, rendered type, preview pane, text display format.
- H. Search: The Search facility shall include search for recorded video and events based on date and time.
- I. Reports: The Report facility shall include event history report and audit log report.

### 1.3 NVR INTEGRATIONS

A. NVR shall be compatible with the following interoperability standards:

1. Physical Security Interoperability Alliance (PSIA)
2. Open Network Video Interface Forum Profile S and G (ONVIF Profile S and G)
3. Real Time Streaming Protocol (RTSP)

B. NVR shall be compatible with the following Fixed and PTZ IP cameras

1. Supports IP cameras from the following manufacturers.
  - a. Honeywell
  - b. AXIS<sup>®</sup> Communications
  - c. Sony
  - d. Panasonic
  - e. Bosch

f. Vivotek

g. Pelco

C. NVR shall be compatible with the following encoders:

a. Honeywell

b. AXIS<sup>®</sup> Communications

c. Sony

d. Panasonic

e. Bosch

f. Vivotek

D. NVR shall be compatible with the following 360° Camera solutions.

1. Honeywell

2. OnecamGrandeye

3. Immervision Enables<sup>®</sup> - Panomorph

Lenses 4. AXIS<sup>®</sup> 360°/180°

5. Arecont 360°/180°

E. NVR shall be compatible for Multi-site Video Management Systems:

F. NVR shall be seamless integrated and compatible with various Enterprise level Access Control Security Systems

Details	Specification	Compliance
Platform	Latest version of Windows OS	
Functions	Event handling, motion detection, Live & Recorded Video, Alarm Management, Map based monitoring, and System Setup & Configuration	
Failover	Software should support N+1 redundancy	
Compatibility	Latest standard of ONVIF Profile S and Profile G and must be listed on the ONVIF global website	
License	License for 200 cameras should be bundled with the software keeping in view of future expansion. 10 Client License should be offered. Any additional server / hardware required to cater to these licenses must be provided at no extra cost to HAL. All Camera firmware upgrades to be free during warranty period	
	Should record audio / video.	
	Continuous recording, by trigger (motion or alarm), by schedule	



Recording	Any camera should record on any recording Server as configured.	
	During playback of video recording, operator should not have to manually switch/choose between primary and redundant recording servers. All playback must be seamless without operator intervention for retrieving footage residing on any recording servers on the	

Storage	Multi-level storage: should support multi-level storage (live recording on primary disk, archiving on secondary, and so on) should delete video after configurable duration (FIFO based). Should Support	
Video Search	Should be able to search video based on date / time, camera. Should have advanced, smart, quick search function	
	Should be able to search video based on Motion detection on recorded Video.	
	Should be able to export searched video to standard video codec (or with video player in case of proprietary format) with audit trail intact and Digital Signature/Certificate for Authentication so it can be determined if clip is tempered or not.	
Viewing	Simultaneous viewing and recording from various cameras by multiple users, Multi Monitor viewing and Camera sequence mode.	
	Should Support 3D Positioning (Drag and Zoom) and other Control PTZ function of PTZ camera.	
	The VMS should have viewing client (not applicable in distributed / decentralized / web based VMS) to enable to feed the display on the workstation / remote	
	Drag and drop camera viewing.	
	Motorized Zoom and focus for all cameras (ptz, fixed bullet , dome, anpretc...) remotely from client workstations or control room	
Event Management	Register event associated video and alert operator on screen with audio.	
	Motion detection and camera tampering events should be alerted to the operator	
Camera Management	Show connection status of cameras, alert operator in case of connection failure to any camera. Manage firmware upgrades, setting IP addresses	
	User management, password management, user access level management	

Security	Multi-map Presentation Options and User-Friendly PTZ Controls	
	Alarm Management Options, and data Editing	

	Notification to user of changing default password and Expired password as per pre defines Predefined Password Policy	
	Admin should be able to define expiry date of password as per pre defines Organization Predefined	
	The VMS software should shall follow enhance policy such Non recoverable password and enforcing complex password	
	Software should have secured firewall configuration	
	Access to registry and VMS folder should be restricted.	
	Software should support organization on customized digital / security certificate to prevent access to VMS from	
	The VMS OEM must provide a Cyber security hardening guidelines.	
	Password should be stored in encrypted format in VMS Database.	
Report	System Configuration Report - Operator Logs, Keyboards, Recorders, Macro's, User's, Inputs, outputs and other elements	
	System Health Report	
	Failover Reports	
	Create and save custom reports as per pre define an	
	Email reports directly from VMS	
ANPR Feature	Automatically detect and capture the image of license/number plate of a vehicle, convert the image into characters, then generate an event for VMS	
	Filters and categorizes the events as Black listed or White listed or unknown entry, then pushes the events	
	In VMS Searching/viewing the video clip of specific license plate vehicle based on the time stamp.	

General Feature	a) Capable of Ingesting video and sensor inputs into an open architecture format, onto one screen	
	b) Provide a monitoring capability of the video/	

	subsystem, to be relayed to the key operations Centre	
	c) Multi-site video surveillance, command and control	
	d) Provides a multiple-perspective geographic display of site locations with site- Specific surveillance information including Sensor locations and alarm	
	e) Provides a remote ability to set and/or modify operational characteristics of surveillance devices and storage	
	f) Online control of Pan/Tilt/Zoom (PTZ) cameras,	
	g) Ability to Record and Retrieve stored video.	
	h) Ability to slue PTZ cameras to alarm-generated areas	
	i) Capability to filter large amounts of video and support display of time Line, Customizable Site Map, Live Video, Video Playback, Integrated Site Map , Remote live view, Multi-site capability, Event based Recording all over local LAN	
	j) Capability of video analytics based on defined policies pre fed at the time of installations with features like Motion & Blackout masking, Perspective settings , environment selection, map configurations, disk	
	k) Should support floor maps in various formats. Auto discovery of devices-ONVIF and UPnp protocols supported.	
	l) Storage statistics and incident report.	
	m) Alarm recording, scheduled recording based on daily/weekday, activity based, duration of pre and post alarm. Chart based reports on the alarms, by category, source by source and status	
	n) Video analytics software shall be bundled with VMS. Wherever applicable analytics, as mentioned above, will be installed for fixed cameras and PTZ	
	o) Live view and control of each camera continues indefinitely, even if Recording server is	

	<p>p) Surrounding Camera View: VMS Client application shall have facility of surrounding camera view. It shall support setting presets in surrounding cameras.</p> <p>i. In a surround view, video from a specific device shall be playing in the Centre and the other surround videos will be from surrounding video devices. Once the object moves to some other camera's FOV, operator can pull that camera in the center and surrounding videos from the associated surrounding camera plays in the surround views. Every video device can be configured one surround view with related 12 surrounding cameras. There shall not be any limit in defining such surround views.</p> <p>ii. Surround video can be called through keyboard</p>	
	q) The VMS client should have multiple Access levels, the supervisor should be able to view the complete camera which viewed by Operator.	
	r) VMS should support H.264, H.265 GPU rendering.	
	s) Video Motion detection for a particular area in frame can be defined in recorded Video to reduce search	
	t) VMS should allow Create, save, and share salvos (Set of Camera) to Other operator	
	u) VMS supports Windows user account password (LDAP)	
	v) Software Should support ANR ( Automatic Network replenishment) Feature where camera should Record to Camera SD card during it gets disconnects from Storage. Once connection is established recording in SD card can be replenished automatically to storage.	
	w) Redundant Failover constraints can be applied based Failure of Network, Server restart and Service	

### **Video Management Software**

Details	Specification	Compliance
Platform	Latest version of Windows OS	
Functions	Event handling, motion detection, Live & Recorded Video, Alarm Management, Map based monitoring, and System Setup &	
Failover	Software OEM should vet on their Letter head for No of recording Server required to support 200 No of Cameras in N+1 configuration. Bidder should quote minimum 3 of recording servers and 01 Video Management Server or more as per guidelines by Software OEM whichever is	
Compatibility	Latest standard of ONVIF Profile S and Profile G and must be listed on the ONVIF	
License	License for 200 cameras should be bundled with the software keeping in view of future expansion. 10 Client License should be offered. Any additional server / hardware required to cater to these licenses must be provided at no extra cost to HAL. All Camera firmware upgrades to be free during warranty period as	
Recording	Should record audio / video.	
	Continuous recording, by trigger (motion or alarm), by schedule	
	Any camera should record on any recording Server as configured.	
	During playback of video recording, operator should not have to manually switch/choose between primary and redundant recording servers. All playback must be seamless without operator intervention for retrieving footage residing on any recording servers on the network	
Storage	Multi-level storage: should support multi-level storage (live recording on primary disk, archiving on secondary, and so on) should delete video after configurable duration (FIFO based). Should Support NAS through iSCSI transfers	



Video Search	Should be able to search video based on date / time, camera. Should have advanced, smart,	
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	function	
	Should be able to search video based on Motion detection on recorded Video.	
	Should be able to export searched video to standard video codec (or with video player in case of proprietary format) with audit trail intact and Digital Signature/Certificate for Authentication so it can be determined if clip is	
Viewing	Simultaneous viewing and recording from various cameras by multiple users, Multi Monitor viewing and Camera sequence mode.	
	Should Support 3D Positioning (Drag and Zoom) and other Control PTZ function of PTZ camera.	
	The VMS should have viewing client (not applicable in distributed / decentralized / web based VMS) to enable to feed the display on the workstation / remote location.	
	Drag and drop camera viewing.	
	Motorized Zoom and focus for all cameras (ptz, fixed bullet , dome, anpretc...) remotely from client workstations or control room	
Event Management	Register event associated video and alert operator on screen with audio.	
	Motion detection and camera tampering events should be alerted to the operator	
Camera Management	Show connection status of cameras, alert operator in case of connection failure to any camera. Manage firmware upgrades, setting IP addresses	
	User management, password management, user access level management	
	Multi-map Presentation Options and User-Friendly PTZ Controls	
	Alarm Management Options, and data Editing	

Security	Notification to user of changing default password and Expired password as per pre defines Predefined Password Policy	
	Admin should be able to define expiry date of password as per pre defines Organization	

	Password Policy	
	The VMS software should shall follow enhance policy such Non recoverable password and enforcing complex password	
	Software should have secured firewall	
	Access to registry and VMS folder should be restricted.	
	Software should support organization on customized digital / security certificate to prevent access to VMS from any unauthorized user and	
	The VMS OEM must provide a Cyber security hardening guidelines.	
	Password should be stored in encrypted format in VMS Database.	
Report	System Configuration Report - Operator Logs, Keyboards, Recorders, Macro's, User's, Inputs, outputs and other elements	
	System Health Report	
	Failover Reports	
	Create and save custom reports as per pre define and frequent format with in VMS or Various	
	Email reports directly from VMS	
ANPR Feature	Automatically detect and capture the image of license/number plate of a vehicle, convert the image into characters, then generate an event for	
	Filters and categorizes the events as Black listed or White listed or unknown entry, then pushes the events to VMS.	
	In VMS Searching/viewing the video clip of specific license plate vehicle based on the time	
General Features	a) Capable of Ingesting video and sensor inputs into an open architecture format, onto one screen	

	b) Provide a monitoring capability of the video/sensor subsystem, to be relayed to the key operations Centre	
	c) Multi-site video surveillance command	

	control	
	d) Provides a multiple-perspective geographic display of site locations with site- Specific surveillance information including Sensor locations and alarm conditions.	
	e) Provides a remote ability to set and/or modify operational characteristics of surveillance devices and storage	
	f) Online control of Pan/Tilt/Zoom (PTZ) cameras, sensors,	
	g) Ability to Record and Retrieve stored video.	
	h) Ability to slue PTZ cameras to alarm-generated areas	
	i) Capability to filter large amounts of video and support display of time Line, Customizable Site Map, Live Video, Video Playback, Integrated Site Map , Remote live view, Multi-site capability, Event based Recording all over	
	j) Capability of video analytics based on defined policies pre fed at the time of installations with features like Motion & Blackout masking, Perspective settings , environment selection, map configurations, disk usage limits, footage expirations, software health monitoring etc	
	k) Should support floor maps in various formats. Auto discovery of devices-ONVIF and UPnp protocols supported.	
	l) Storage statistics and incident report.	
	m) Alarm recording, scheduled recording based on daily/weekday, activity based, duration of pre and post alarm. Chart based reports on the alarms, by category, source by source and status	
	n) Video analytics software shall be bundled with VMS. Wherever applicable analytics, as mentioned above, will be installed for fixed cameras and PTZ cameras.	

	o) Live view and control of each camera continues indefinitely, even if Recording server	
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	<p>p) Surrounding Camera View: VMS Client application shall have facility of surrounding camera view. It shall support setting presets in surrounding cameras.</p> <p>i. In a surround view, video from a specific device shall be playing in the Centre and the other surround videos will be from surrounding video devices. Once the object moves to some other camera's FOV, operator can pull that camera in the center and surrounding videos from the associated surrounding camera plays in the surround views. Every video device can be configured one surround view with related 12 surrounding cameras. There shall not be any limit in defining such surround views.</p> <p>ii. Surround video can be called through keyboard and VMS Client</p>	
	q) The VMS client should have multiple Access levels, the supervisor should be able to view the complete camera which viewed by	
	r) VMS should support H.264, H.265 GPU	
	s) Video Motion detection for a particular area in frame can be defined in recorded Video to reduce search time.	
	t) VMS should allow Create, save, and share salvos (Set of Camera) to Other operator	
	u) VMS supports Windows user account password (LDAP)	
	v) Software Should support ANR (Automatic Network replenishment) Feature where camera should Record to Camera SD card during it gets disconnects from Storage. Once connection is established recording in SD card can be replenished automatically to storage.	
	w) Redundant Failover constraints can be applied based Failure of Network, Server restart and Service Failures.	

#### 1.4 RECORDING SOFTWARE SYSTEM HARDWARE



Details	Specification	Compliance
Operating System	Licensed 64 Bit Windows Server OS suitable for Video Recording Server	
CPU	Min 2x Intel Xeon 6 core E5 2620 2.1GHz CPU 15 MB Cache or higher	
RAM	128 GB memory using 32 GB DIMMS (upgradable to 1024)	
Chipset	Suitable chipset	
RAID Controller	RAID Levels 0-1,5,10, 50, 6, 60 & Hot swap disks	
HDD	4 TB, Two separate hard drives or two sets of RAID arrays	
Networking	4x1GbE LAN ports	
Storage Connectivity	necessary HBA to be provided with redundancy	
Power	Hot Swap Redundant power supply	
Chassis	Rack Mount Form Factor with rack sliding kits	
Accessories	Keyboard, Mouse, DVD-R/W OR Better.	
RAID protected Storage	For Recording of Camera Streams Entire Storage requirement as computed and recommended by OEM shall be supplied in N+1 configuration distributed across all the recording servers	
a) Server Connectivity	Minimum 10Gbps as required	
b) RAID Controller	RAID Levels 0-1,5,10, 50, 6, 60 & Hot swap disks	
c) Hard Disk and Storage	NLSAS/ SAS/ SATA/ SSD drives. Storage size should be such that 90 days of video footage of 200 Nos cameras (80 Nos, PTZ and 20 Fixed Dome, 85 Fixed Bullet & 15 ANPR all @ 15 fps and 1080P as per detail specification attached in this tender document). Industry standard RAID 5 / 6 with hot spare disk. Standard RAID	

	total HDD Requirement.	
d) Power	Dual Hot Swap Redundant power supply	
e) Chassis	Rack Mount Form Factor with rack sliding kits	
f) Power	Redundant Hot Plug	
g) Cooling	2x(PSU+FAN Module)	
Approved Makes	DELL / HP/ IBM / Software OEM	

### VMS Server

Details	Specification	Compliance
Make& Model	Vendor has to specify, data sheet to be supplied.	
Operating System	Microsoft Windows® 2012 Server STD 64- bit, or Higher as per VMS Software Compatibility	
CPU	Min 2x Intel Xeon 6 core E5 2620 2.1GHz CPU 15 MB Cache or higher	
RAM	128 GB memory (upgradable to 1024)	
Chipset	Suitable chipset	
RAID Controller	RAID Levels 0,1,5,10,50,60 & Hot swap disks	
HDD	4 TB, Two separate hard drives or two sets of RAID arrays	
Networking	4x1GbE LAN ports	

Storage Connectivity	Necessary HBA to be provided	
Power	Hot Swap Redundant power supply	

Chassis	Rack Mount Form Factor with rack sliding kits	
Accessories	Keyboard, Mouse, DVD-R/W OR Better.	
Approved Makes	DELL / HP/ IBM / Software OEM	
On Site OEM Warranty (Year)	Minimum 02 years or as per OEM standard which ever is higher	

### Workstation

Details	Specification	Compliance
a) Processor	Intel Core i7-6700, 3.4GHz or better	
b) Core	4	
c) Clock Speed	3.4 GHz or Better	
Chipset	Suitable Intel chipset	
Memory	8 GB DDR4 or better	
Expansion Slot	Standard Configuration	
I/O Port	Standard IO Ports with 4 USB 2.0 connectors or Better	
Bays	Standard Configuration	
Graphic Card	Integrated Intel HD graphics or NVIDIA - 2GB OR better/equivalent	
Display Controller	Compatible display controller with at least 64MB on-board memory or	
Optical Drives	DVD Writer or better	
HDD	1 TB SATA or better	
Ethernet	10/100/1000, Auto Negotiating Ethernet controller	
OS	WIN 10 Pro or latest	
Approved Makes	DELL / HP/ IBM	

I. **2 MP Fixed Lens IR Dome Camera**

<b>Parameter</b>	<b>Required Minimum Specifications</b>	<b>Compliance Yes/No/Remar</b>
Imaging Device	1/2.8" 2Megapixel progressive scan CMOS	
Imager Type	2.8 lens fixed lens	
Imager Readout	Progressive scan	
Maximum Resolution	2MP - 1920x1080	
ONVIF Protocol	Profile S and G	
Minimum Illumination (May vary depending on the lens)	Color : 0.001Lux @f/2.0, B/W : 0Lux @f/2.0(IR on)	
Day/Night Method	Mechanical ICR (ON / OFF / AUTO selectable)	
Signal-to-Noise Ratio	50 db minimum	
Auto Iris Lens Type	DC IRIS	
Electronic Shutter	Auto/Manual, 1/3~1/100000s	
Wide Dynamic Range	120 db minimum	
Lighting compensation	BLC / HLC / WDR	
Digital Noise Reduction	3D Noise Reduction (ON / OFF selectable)	
Privacy Zone	4 configurable windows	
Motion Detection	Off/ On / By Schedule	
Log Function	Log file with specified fields	
Image Settings	Compression,3D digital noise reduction (ON/OFF) color, brightness, sharpness, contrast, white balance, exposure control, exposure zones, backlight compensation, fine tuning of behavior at low light, rotation , and all other Image Settings in Web UI	
Network	RJ-45 (10/100Base-T)	

Power Input	PoE/12VDC	
Power Consumption	Max 4.4W	
Local Storage	Micro SDXC Capacity Max 128GB	
Audio	1 Built-in Mic	
IR Range	15 mtr range	
Video Encoding Video Streams	H.265, H.264 and MJPEG bit rate control (CBR and VBR)	
	Main Stream: 1080P(1~50/60fps)	
	Sub Stream: D1(1~50/60fps)	
	Third Stream: 1080P(1-25/30fps)	
Frame Rate	Simultaneous Main stream and Third stream at 1080P (Main stream	
	Selectable for each independent stream	
	1080P - 60 (full) ~ 1 fps	
Resolution	720P - 60 (full) ~1 fps	
	1080P(1920x1080)	
	1.3M(1280x960)	
	720P(1280x720)	
	D1(704x576/704x480)	
	VGA(640x480)	
	CIF(352x288/352x240)	
Supported Protocols	HTTP; HTTPs; TCP; ARP; RTSP; RTP; UDP; SMTP; FTP; DHCP; DNS; DDNS; PPPOE; IPv4/v6; QoS; UPnP; NTP; Bonjour; 802.1x;	

Users	20users	
Security Access	Multiple user access levels with password	

	IP filtering, HTTPS, IEEE 802.1x	
Cybersecurity Chipset	Required	
12VDC / 24VAC	DC12V	
IP 66/67	IP 67	
Vandal Resistant	IK10	
Operating Temperature	–30°F to 140°F (–30°C to 60°C)	
Operating Humidity	0% to 95%, non-condensing	
Certifications	FCC, CE and UL	
Cyber Security	PCI-DSS and UL-CAP	

## **II.2 MP IP Varifocal Bullet/Box Camera**

<b>Parameter</b>	<b>Required Minimum Specifications</b>	<b>Compliance Yes/No/Remar</b>
Imaging Device	1/2.8" 2Megapixel progressive scan CMOS	
Lens	2.7-13.5 mm motorized zoom and auto focus lens F1.6	
Maximum Resolution	2MP - 1920x1080	
ONVIF Protocol	Profile S and G	
Minimum Illumination	Color : 0.01Lux @f/1.6 B/W : 0Lux @f/1.6(IR)	
Day/Night Method	Mechanical ICR (ON / OFF / AUTO selectable)	
Signal-to-Noise Ratio	50 db minimum	
Auto Iris Lens Type	DC IRIS	
Electronic Shutter	Auto/Manual, 1/3(4)~1/100000s	



IR Illuminator	Required, IR range 50 mtr or better	
Wide Dynamic Range	120 db minimum	
Lighting compensation	BLC / HLC / WDR	

Digital Noise Reduction	3D Noise Reduction (ON / OFF selectable)	
Privacy Zone	4 configurable windows	
On-board Analytic s Event	Motion Detection/Video Tampering/Face Detection/Audio Detection/Tripwire/Intrusion/Object Abandoned/Object Missing/Trigger line/loitering	
Motion Detection	Off/ On / By Schedule	
Image Settings	Compression, 3D digital noise reduction (ON/OFF) color, brightness, sharpness, contrast, white balance, exposure control, exposure zones, backlight compensation, fine tuning of behavior at low light, rotation, and all other Image Settings in Web UI	
Network	RJ-45 (10/100Base-T)	
Power Input	PoE/12VDC/24VAC	
Power Consumption	Max 20.5W (with IR on, motorized lens working)	
Local Storage	Required, Micro SDXC Capacity Max 128GB	
Audio In / Out	1 In / 1 Out	
Alarm In / Out	2 In / 1 Out	
Audio Encoding	G.711a/ G.711u/ AAC/G.726	
Video Encoding	H.265, H.264 and MJPEG bit rate control (CBR and VBR)	
Video Streams	Main Stream: 1080P(1~50/60fps)	
	Sub Stream: D1(1~50/60fps)	
	Third Stream: 1080P(1-25/30fps)	

Frame Rate	Selectabl for each independent e stream	
	1080P - 60 (full) ~ 1 fps	
	720P - 60 (full) ~1 fps	

Resolution	1080P(1920x1080)	
	1.3M(1280× 960)	
	720P(1280× 720)	
	D1(704× 576/704× 480)	
Supported Protocols	HTTP; HTTPS; TCP; ARP; RTSP; RTP; UDP; SMTP;FTP; DHCP; DNS; DDNS; PPPOE; IPv4/v6; OnS-LDnD-NTD-Porting-802.1x	
Security Access	Multiple user access levels with password protection IP filtering, HTTPS, IEEE	
Users	20users	
Ingress Protection	IP 67	
Vandal Resistant	IK10	
Operating Temperature	–22°F to 140°F (–30°C to 60°C)	
Operating Humidity	0% to 95%, non-condensing	
Certifications	UL, CSA 60950-22, CE (EN 50130-4 & EN 55022) , FCC Part 15	
Cyber Security	PCI-DSS and UL-CAP	

### III. Automatic Number Plate Recognition Camera

Details	Specification	Compliance
Type	Bullet / Box type, Indoor, IR, IP, Day/Night with Wide Dynamic Range, Motion Detection	
Image Sensor	1/3”, Progressive Scan CCD/CMOS (or better)	

Power	PoE Based Camera (IEEE 802.3) and able to draw power from normal type source.	
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Lens	The minimum focal length should be in the range of 5 mm to 15 mm or better and compatible with the size of the image sensor	
Type of lens	Wide Angle with Manual/Remote zoom/focus	
IR Illuminator	50 Meters minimum	
ONVIF	Latest standard of ONVIF Profile S/Profile G and must be listed on the ONVIF global website	
S/N Ratio	>50 Db	
Communication	10/100 Base-T Ethernet, RJ-45 connector.	
Protocol Support	IPv4, TCP/IP, UDP/IP, RTP(UDP), RTSP, NTP, HTTP, HTTPS, SSL, DNS, DDNS,	
Minimum Illumination	Colour Mode : 0.01 Lux, @ 30 IRE 0 lux with IR LEDs on	
Functions & Features remotely through camera or VMS	Configuration, control command including clock synchronization, firmware up gradation , Auto/manual mode selection for Automatic Gain Control(AGC), back light compensation (BLC) , White Balance etc	
Local Memory in camera (Storage)	Capacity to hold minimum 128 GB Memory Card (1 Nos. to be provided with each camera) Functions like Automatic recording when	
Type of video compression (Minimum Dual streaming	H.264/ H.265,Motion JPEG Should support dual streams.	

Video resolution	5 MP or better	
Frame rate per second	Minimum 25 fps (configurable in increment of 1 frame)	

Alarms	Notification to the operator for Video Motion detection and Active tampering.	
Security	IEEE 802.1x	
	Camera should support Security features which include individual signed certificates	
	High strength encrypted algorithm AES-256	
	For Secure communication camera should Comply with PCI-	
	To Reduce Vulnerability By default Telnet closed and FTP disabled for reducing the surface	
	For Access & Authorization camera should Strong Digest authentication for Access permission; Multiple user access levels with enhanced password	
Audio support	One way audio function support. G.711 or equivalent or	
Access level of cameras	To be provided for Administrator, Operator and	
Video Analytics	License Plate Recognition System (At camera edge or Server). It should be integrated with VMS Software. if any additional Server etc. is required to fulfill the requirement will be in the scope of vendor without any extra cost	
Operating Temperature	-10° C To 55° C or better.	
Housing	Should be from the camera OEM only.	
	Environment protection as per Outdoor application IP66 rated and IK10 rated or better.	



	Vandal resistant as per IEC.	
Mounting	Should be from the camera OEM only.	

	Ceiling or wall type.	
	To be mounted on the 6/9 Mtr. GI Pole as per site requirement. All accessories to be provided	
Certification	Specific model should be UL/IS/IEC listed, FCC and CE	
	Open network video compliant with APIs and SDKs available without any additional charge.	

## **E16. Lift Work**

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### **14.1 Features**

- [1] GEAR LESS LIFT DRIVE comprising of High Starting torque Lift duty 3 phase 440 V A. C. Permanent magnetic synchronous motor of proper rating with high efficiency shall be used.
- [2] Micro processor based / PLC, ACVVV, vector control drive with encoder feedback closed loop system shall be used for lift car and door operation which shall be full collective selective operation hall call demand response, UP/DOWN hall stops, Main, Up/ Down Contactor with overload and phase reversal relay and safety controls.
- [3] Car with M S platform with bracings of adequate size and to sustain the impact load cabin + passenger with safety factor of fire for steel and side panels of Stainless steel of sheet of grade 304 duty. Car ceiling will be S.S. finishes with aesthetic appearance with LED ceiling lights. Car flooring shall be of anti skid PVC with choice of colour of engineer in charge. Car doors shall be of stainless steel grade 304, hairline finish with centre opening / telescopic automatic doors. Car panel will also be S.S. 304 finished with emergency stop device, mechanical door safety device, facility of auto/ attended mode. All car panel buttons and all floor switches must be with brail language as per lift act.
- [4] All landing doors shall be fully automatic centre opening/ telescopic opening made of hairline finish steel grade of 304 with key holes and infrared curtains with Unlocking facility from outside.
- [5] Appropriate battery operated emergency light in the car along with alarm switch shall be provided.
- [6] Digital scrolling indicator system for up-down arrow along with floor position indicator shall be provided inside the car and at all floors.
- [7] Full height infra red curtain with multiple criss / crossing light beams shall be provided. [8] Automatic Rescue Device (ARD) shall be provided accordingly of passenger capacity.
- [9] Audio visual indication in the lift car showing over loading shall be provided such that doors kept open till excess load is removed.
- [10] Spring buffers/PU Buffers shall be provided.
- [11] Car fan with automatic sleep timer shall be provided.
- [12] Voice annunciater with suitable music shall be provided in lift car.
- [13] Self diagnostics system for operational and safety parameters shall be provided in control panel.
- [14] Mechanical over speed governor, door key holes in the floor doors, fireman switch shall be provided.
- [15] Lift machine hoisting arrangement in the lift machine room and monkey ladder for lift pit should be provided by the lift agency, along with the other steel structure works, foundations for the machine etc...
- [16] In the hoist way fascia plate shall be provided without any extra cost, where ever required as / if directed by engineer in charge.
- [17] Permanent wiring in lift machine room and lift well with proper numbers of light points, with fixtures, exhaust fan and plug points shall be provided by the agency. Power supply of 3 phase 440 V shall be made available by department in lift machine room.
- [18] Any civil/ electrical works for additional and alteration in lift shaft and machine room related to

erection of lift shall be made by lift agency without any extra cost.(granite/marble fixing around all landing door openings are not in lift agency's scope.)

[19] Agency has to provide all working drawings and documents and liaison services for obtaining all necessary permission from lift inspector and other authorities.

[20] As per statutory requirement of Govt. Of Gujarat lift & escalator act 2000, lift

[20A] As per statutory requirement of Govt. Of Gujarat lift & escalator act 2000, lift agency has to provide

1. Car top safety barricade
2. Push & talk communication system.
3. Fireman's switch operation at Ground Floor.
4. carrying out third party lift inspection during/after lift erection and provide report by third party authorized by concern licensing authority
5. agency has to provide third party insurance upto completion of free maintenance period and submit the document for the same.

[21] Car Panel Operating Buttons with floor position indicator/buttons must be of Auto Glow type clearly visible when view from inside cabin.

[22] For Physically Handicapped person Full Length Handrails of hairline finish steel grade of 304 should be provided at appropriate height on the Rear & Side Wall Panels in Lift Car.

agency has to provide

1. Car top safety barricade
2. Push & talk communication system.
3. Fireman's switch operation at Ground Floor

**Note: 1** - Advanced control system dual 32bit embedded microprocessor with CANBUS Serial Communication mode including Regenerative power efficient operation on site programming facility, Anti nuisance, Pre- opening, BMS/RMS system supporting hardware & Software.

2. Floor indication LCD Display with call registration & brail mark with arrival gong and hall lantern & TFT Screen in the car with MP3 Voice Announcer.
3. CAR PANEL should be scratch resistive SS Moonrock finish for car and all Doors, All landing doors must have fire rating up to 1 hours and car door must have multi-level crisscross beam door protection.
4. To & Fro communication system & wiring (i.e. car, control room, guard room)

passengers. And floor specified as per tender with Rated Speed of 1.5m/sec with microproce/PLC control and ACVVVF drive. Supplying and erecting approved make, solid state in building emergency rescue Device, for automatically rescues Passenger strapped in the lift car in between floors in the event of power failure having following features.

- (i) Automatic operation & immediate action in the event of mains failure capable to move the lift to the nearest landing, opens the automatic doors of the lift car & floor.
- (ii) Sealed, maintenance free battery back-up of suitable size with automatic charging unit & auto change over device on mains failure.
- (iii) RESCUE OPERATION message indicator in the lift car
- (iv) Applicable to Passenger, Goods cum Passenger, Stretcher cum Passenger lift with AC2, ACVV, ACVVVF drives & automatic doors suitable as specified.

## **14.2 Technical Specification**

### **1.0 Scope**

This section deals with technical requirements of lift installation, its components, safety devices various type of controls and methods of operation.

### **2.1 Drive Machinery:**

## **2.2 ElectricSupply**

Threephase, 50 Hz, 415 V electric supply shall be made available. The entire lift equipments should be suitable for operation at +10% to -20% of the rated supply voltage.

### **2.3 Gearless machine**

The gearless machine shall consist of a motor, traction sheave and brake drum completely aligned on a single shaft. Gearless machine shall have A.C. Permanent Magnet Synchronous Motor suitable to operate with synchronous VVVF drive.

#### **2.3 Sheaves:**

Sheaves and pulleys shall be of hard alloy, cast iron, SG iron or steel and free from cracks, sand holes and other defects. They shall have machine drop grooves. The traction sheave shall be grooved to produce proper traction and shall be of sufficient dimension to provide for wear in the groove. The deflector sheave shall be grooved so as to provide a smooth bed for the rope. The deflector or secondary sheave assemblies where used shall be mounted in proper alignment with the traction sheave. Such deflector sheaves shall have grooves larger than rope diameter as specified in IS 14665 (Part-4 Sec3): 2000. The size of all the sheaves shall be in accordance with IS 14665 (Part-4 Sec3): 2000. Wherever necessary suitable protective guards may be provided.

#### **2.4 Brake:**

The lift drive machinery shall be provided with an electro-magnetic brake or motor operated brake normally applied by means of springs in compression when the operating device is in off position. The brake shall be suitably curved over the brake drum or brake disc and provided with fire proof friction lining. The operation of brake shall be smooth, gradual and with minimum noise. The brake shall be designed to be of sufficient size and strength to stop and hold the car at rest with rated load. The brake should be capable of operation automatically by the various safety devices, current failure and by the normal stopping of the car. The brake shall be released electrically. It shall also be possible to release the brake manually, such releases requiring the permanent application of manual force as to move the lift car in short stops. For this purpose suitable brake release equipment wherever necessary shall be supplied with each lift installation and the same shall be kept in safe custody to prevent misuses.

#### **2.5 Hand winding wheel or handle:**

At times of lift stoppage due to any reasons, it shall be possible to move the lift car to the nearest landing manually. The manual operation shall be by means of winding wheel or handle mounted on the end of the motor shaft.

The up or down direction of the movement of the car should be clearly marked on the motor or at suitable location.

A warning plate written in bold signal red colour advising the maintenance staff to switch off the mains supply before releasing the brake and operating the wheel is to be prominently displayed.

#### **2.6 Bearings:**

Bearings shall be either of the anti-friction metal sleeve type with oil reservoirs, self-lubrication, oil gauges, capped filler openings and drains of the ball roller or sintered type subject to oil flood lubrication or greased lubrication.

Grease lubricated bearings shall have grease gun connections and drain plugs. The bearings and lubricant reservoirs shall be dust tight and shall incorporate effective seals to prevent leakage.

The outer end of the bearings shall be closed with a removable oil tight plate.

Thrust bearings shall be of the ball or roller type and shall have two sets of balls or rollers arranged to minimize backlash for efficient working.

### **3.0 Type of controls:**

**Variable Voltage Variable Frequency (VVVF):**

Incoming mains AC power shall be first rectified to DC and then inverted to provide controlled AC current to the elevator drive. Precision monitoring of motor speed and car direction, position and load enable the pulse width of the AC power supplied to the motor to be adjusted to ensure that elevator speed is maintained very accurately to an ideal profile.



Thus in VVVF controls pulse width modulation control of AC motors should have following minimum features :-

- (a) Total control at all stages of the motion cycle
- (b) A consistent fully adjustable smooth ride
- (c) Better levelling accuracy under all conditions
- (d) A higher power factor
- (e) Lower starting currents
- (f) Energy saving through reduced power consumption

#### **4.0 Guide rails**

Guide rails shall be in accordance with IS14665 (Part 4– Sec2) 2000. Only machined guide rails shall be permitted for cars. Formed sheet metal rails shall be used up to speeds of 2.50mps for counter weight applications. The guide shall be continuous throughout the entire travel and shall withstand without any deformation the action of safety gear with a fully loaded car.

The guide rails shall be supported by brackets secured to the hoistway frame at each floor. The rails shall be securely fastened to the brackets or other supports by approved heavy rail clamps.

All necessary guide rails packing or additional supports shall be provided to prevent guide rail deflection and stress exceeding the prescribed limits. The stresses on the guide rail due to the horizontal forces imposed on it during loading, unloading and running calculated without impact, shall not exceed 1100 kg/sq. cm based upon the class of loading and the deflection shall not exceed 5mm. The guiderail brackets, their fastenings and supports shall be capable of resisting the horizontal forces mentioned above, with the total deflection at the point of support not in excess of 3mm.

Guide rails shall extend from pit floor to be underneath of concrete slabs or grouted at top of the lift well. They shall be erected in plumb and parallel with a maximum deviation of 3mm.

All shimming required shall be of metal securely held in place. Jointing plates shall be so located as not to interfere with supporting clamps and brackets. The bolts shall be used with spring lock washers.

The guide rail anchorage at pit floor must be made without puncturing the water proofing. The expansion joints in the guide rails shall be so designed as to avoid jerks in the lift car. Machined guide rails shall have finished surfaces, which shall be coated with corrosion preventive compound, which shall be maintained till the commissioning of the installation. Before the car is placed for operation, the preventive coating shall be removed and the guide rails thoroughly cleaned and smoothened.

#### **5.0 LiftCar**

##### **5.1 CarFrame**

The car frame shall be in accordance with IS14665(Part 4-Sec 3): 2001 made of sheet steel of rigid construction to withstand without permanent deformation the operation of safety gear. The car shall be so mounted on the frame that vibration and noise transmitted to the passengers inside is minimized.

##### **5.2 Carplatform**

The car platform shall be framed construction and designed on the basis of rated load evenly distributed. The dimensions shall conform to IS:14665(part 1)2000 unless otherwise specified. The flooring shall be smooth and of anti-skid surface.

### 5.3 Carbody

The car shall be enclosed on all sides by a stainless steel enclosure of grade 304 in scratch free and al finish walls. Ventilation openings if specified shall be as per IS14665 (Part 4/Sec 3)–2001. A load data plate giving the rated load and permissible maximum numbers of passenger should be fitted in each lift car in a conspicuous position. The false ceiling in the lift car shall be crafted from stainless steel with LED Lighting fixtures with aesthetic features.

### 5.4 Cardoor

Lift car door shall be power operated horizontal sliding centre opening Automatic type made from Stainless steel in scratch free and al finish.

### 5.5 Fireman's Switch

Grounding switch, at ground floor level, shall be provided on all the lifts to enable the fire service to ground the lifts.

### 5.6 Car roof

The roof of the car shall be solid type capable of supporting a weight of at least 140kg and as per IS14665(Part-4Sec 3): 2001.

### 5.7 Car Thresholds

Car entrance shall be provided with aluminum thresholds having a grooved surface. Thresholds for lifts having horizontally sliding car doors or gates shall have machined or extruded guide grooves

### 5.8 Toe Guard Aprons

The toe guard apron of gauge not less than 1.6 mm sheet steel may be provided extending at least 15mm beyond entrance jambs at each side. The guards shall have a straight vertical face extending below the level of the finished car floor and not less than the depth of the leveling zone plus 7.5mm. The bottom of guard shall extend 1000mm for lifts above speed of 2.5mps below vertical face and be veled at 15° angle from the vertical. It shall be seamed to car platform construction and be reinforced and braced.

### 5.9 Clearance

The clearance between the top of the car and the top of the lift shaft roof, bottom of the car and the pit floor, the buffers etc., and the clearance between the car and the lift well, between the car and the landing sill, between two lift cars in the same shaft etc., shall be provided as per IS14665(Part 1,2&4) and relevant lift rules.

### 5.10 Inter-Communication system

A push to talk communication system should be available between lift car and ground floor to communicate in case of emergency or stuck the car between two floors.

### 5.11 Operating Panel Inside the car

The car-operating panel shall be of stainless steel(SS) flush mounted and duly finished to match the car

interior décor and shall contain all the devices as may be specified depending upon the type of operation required. All switches shall be with brail language, fadeproof and the device shall be of approved quality.

## **6.0 Landing entrances**

The landing doors shall be power operated horizontal sliding centre opening Automatic type made from Stainless steel in scratch free vendal finish and the openings shall be 2000mm clear in height. All the landing door shall have a fire resistance rating of one hour. Power operated car and landing doors shall be so designed as not to injure any person during their closure by means of infrared door detector, it shall be possible on power failure to open them from car side. The door opening and closing shall be accomplished smoothly and quickly without undue noise, vibration and shock. Each landing door shall be complete with locks, sills, frames, rims, hanger supports with cover plates etc. The finished work shall be strong, rigid and neat in appearance. The opening for the landing gates or doors shall not be wider than that of the lift car.

Detailed instructions as specified for guidance of passengers shall be prominently displayed inside the car by contractor. The instruction on Do's and Don'ts, as per provision of the relevant IS, should be displayed in lift cars at a conspicuous location with larger and under standable script.

## **7.0 CounterWeight**

The counter weight for lift cars shall be in accordance with IS14665(Part 4,Sec-3):2001 and shall be designed to balance the weight of empty lift car plus approximately 50 percent of the rated load. It shall consist of cast sections firmly secured in relative movement by at least two numbers steel tierods having lock nuts/split pins at each end and passing through each section and Housed in a rigid steel framework. Cracked and broken subweights shall not be accepted.

Guards of iron metal/mesh shall be provided in the lift pit to a suitable height above the pit door to eliminate the possibility of injuries to the maintenance personnel.

## **8.0 Guide shoes**

Two numbers of guide shoes at the top and two numbers at the bottom shall be provided on the lift car and counter- weight with nylon liners.

## **9.0 Lift Ropes**

Round strand steel wire ropes made from steel wire ropes having a tensile strength not less than 12.5tonnes/cm<sup>2</sup> and of good flexibility shall be used for lift. Lubrications between the strands shall be achieved by providing impregnated hempcore. The lift ropes shall conform to IS2365 and the following factor of safety shall be adhered to.

The minimum diameter of rope for cars and counterweight of passenger and service lift shall be 8mm.

Rope speed of passenger & service lifts (m/s) Factor of safeties

0.5 or less	8
exceeding 0.5 to 1.0	8.6
exceeding 1.0 to 2.0	10
exceeding 2.0 to 3.5	11
exceeding 3.5	12

The contractor must indicate the number and size of lift ropes and governor ropes proposed to be used, the ironing in, type, ultimate strength and factor of safety. The contractor should furnish certificate of ropes from the rope manufacturers.

### 10.0 Governor

The car safety shall be operated by speed governor located in overhead and driven by governor rope suitably connected to the car and mounted on its own pulleys. The rope shall be maintained intension by means of weight edorspring loaded tension sheaves located in the pit. The governor rope shall be not less than 6mm in dia and shall be made of steel.

Governor for car safety gears shall be adjusted to actuate the safety gear at the speed as specified in relevant IS.

### 11.0 Terminal limit switches

These shall stop the car automatically at terminal floors within the top and bottom permissible over travel. They shall act independently of the operating devices, the ultimate limits switches and the buffers. Terminal stopping devices located in shaft or in the car and operated by cams shall be fitted with rollers having a rubber or other approved composition to provide silent operation when actuated by the cam. When the lift car cross head is 60cm from the nearest obstruction above it, no projection on the car shall strike any part of the overhead structure.

### 12.0 Ultimate Terminal Switches

These shall be provided in accordance with the statutory requirements and standing practices. These shall arrange to stop the car automatically within top and bottom clearances independently of the normal terminal switches but with the buffers operative.

### 13.0 Buffers –

Buffers shall be spring type or as required under provision of IS14665. All buffers shall be tested at manufacturers works and a copy of the test report shall be submitted. When the lift car rests on fully compressed buffers there shall be atleast 60cms clearance between the lowest point in its car frame and any obstruction in the pit exclusive of buffers and their supports. Similarly when the lift car cross head is 60cm from the nearest obstruction above it, no projection on the car shall strike any part of the overhead structure.

### 14.0 Door Locks

Electro-mechanical door locks shall be provided for all the landing doors and they shall be such that the doors cannot open unless the car is at rest at the particular landing. The lift car is to be provided

with automatic leveling devices and it shall be permitted to move the car with both the doors open in the leveling zone for the purpose of leveling.

All the locks and contacts shall conform to IS: 14665(Part 1/Sec6)– 2001 shall be positive and pass the prescribed endurance and reliability test from a recognized approved testing laboratory. They shall be so located as to be inaccessible to un-authorised personnel. The electromechanical latch should be so designed that it is accessible or invisible to the passengers in the car.

### **15.0 Voice Announcing System**

As of voice announcing to be provided for arrival of each floor and for emergency messages. It should have provision of soft music during travelling of the lift, it should have a volume control to adjust the volume.

### **16.0 Automatic Rescue Device**

Lift should be equipped with ARD facility to bring the car at nearest landing and opens the door in case of power failure. It should be operated with required number of batteries

### **17.0 Other safeties**

Besides these safety devices mentioned above, motor operated electro-mechanical brake, counter-weight guards, alarm bell, emergency door lock release operating key and associated safety and other safety requirements shall also be included as per the relevant IS code.

### **18.0 Lift operations**

Simple x Selective – Collective operation with/without attendant Automatic operation by means of one button in the car for each landing level served and by up – and - down buttons at the landings, where in all stops registered by the momentary actuation of the car made as defined under non-selective Automatic Operation but where in the stops registered by the momentary actuation of the landing buttons are made in the order in which the landings are reached in each direction of travel (irrespective of the sequence in which the buttons have been actuated). With this type of operation, all ‘up’ landing calls are answered when the car is traveling in the down direction, except in the case of the uppermost or lowermost calls which are answered as soon as they are reached in- respective of the direction of travel of the car.

### **19.0 Control circuits**

The control circuit shall be designed to the type of lift specified for safety operation. It shall not be possible to start the car unless all the car and landing doors are fully closed and landing doors locked.

The circuit shall have an independent fuse protection for fault and over loads and be arranged so that earth fault or an open circuit shall not create unsafe condition.

The circuit shall be so arranged that for the stoppage of the car at specified landing or for actuation of a contactor by emergency switches or operation of safety gears the system shall not depend upon the completion or maintenance of an electrical circuit to cut off power supply and apply the brakes. This requirement is not applicable to dynamic braking and speed control devices.

### **20.0 Auxiliary Switches**

#### **a) Emergency stop switches:**

On top of the lift car an emergency stop switch shall be provided for use by maintenance personnel.

Stop switch shall also be provided in the machine room.

Operation of these switches/buttons shall cancel all the registered calls and landing calls for that particular lift.

**b) Maintenance switch on top of the car**

For purpose of inspection and maintenance, maintenance switch shall be provided on top of the car. The control circuitry shall be so arranged that in the event of the operation of this switch:

(a) The car speed shall be less than the rated speed not exceeding 1.5metres/sec.

(b)) The car movement shall be possible only on the application of the continuous pressure on a button. It shall be so mounted as to prevent any inadvertent operation.

**21.0 Control Wiring**

In case of control cables also the harness shall be separate as far as feasible for separate functions and laid separately in suitably dimensioned metal duct or in a separate conduit such as the signaling, locking, lamp indication and safeties. Control cables for different voltages in the lift installation works should be laid as per IE Rules.

All relays shall be suitable for lift service and shall incorporate adequate contact wipe for reliable operation. Relays shall operate satisfactorily between 80percent to 110percent of their voltage.

Main motor contactors shall be suitable for A.C.duty. Tenderer shall be required to furnish full details of make, type, applicable standard, voltage and current rating, duty class, type and routine tests done etc., on contactors and relays. Copies of type test certificates and other test certificates shall also be furnished by the successful tenderer.

All cables shall be with copper conductors and flame retardant of appropriate size. The cables feeding motor and in heavy current flow paths shall be so selected that the size matches the protecting fuses and will not result in more than 2percent voltage drop from the main board to the terminals of motor. Control cables shall not be less than 0.5sq.mm. if stranded; where installation of heavy gauge conduits present difficulties, short lengths of flexible conduits will be permitted but effective electrical continuity and earth bonding shall be ensured.

For rules shall be slipped at the ends of all cables as per standard control wiring practice. All terminal blocks shall be suitably marked.

**22.1 Trailing Cables:**

All the conductors of the trailing cable/s shall be insulated for maximum voltage running through any one conductor of this cable. The lengths of the cables shall be adequate to prevent any strain due to movement of the car. All cables shall be properly tagged by metallic/plastic tags for identification.

Trailing cables shall run from a junction box on the top of the car to a junction box located in the shaft near midpoint of travel and from these junction boxes conductors shall be run to the various locations.

Trailing cables shall run so that the strain on individual cable conductors will be reduced to a minimum and the cables are free from contact with the car counterweight, shaft walls or other equipment.

Trailing cables shall have steel supporting fillers and shall be suspended directly by them without rubbing over other supports. Five percent of the total capacity subject to a minimum of 5 wires shall be available unutilized in the trailing cable everywhere suitably distributed between various functions.

### 3.1 Mode of measurement and payment:

- 3.2 The relevant specifications shall be followed as specified in item shall be measured under this item. The rate shall be for a unit of one number.

### OTHER CONDITIONS :

All type of steel items like chennals, beams, coils, sheet, chequerred plate etc shall be provided by the agency at their cost.

The tenderer shall ensure smooth functioning of elevators. The shutdown of elevators without any valid and genuine reason and without approval shall not be permitted. All motors and other allied accessories shall also be subject to necessary preventive maintenance check by the tenderer along with all mechanical equipment.

Offer shall include the comprehensive maintenance of all machineries and equipment involved (electrical & mechanical items both) of the elevator upto the defectliability period of 12months.

Alogcard/sheet for the elevator shall be maintained in the machine room where in all details of break down and preventive maintenance shall be clearly and legibly logged in and the signature of EMPLOYER or his authorized representative shall be obtained. The checklistin shall also be submitted. All scraps / dismantled parts of elevators generated during any maintenance work shall be property of the tender and shall be properly cleaned.

The tenderer shall provide necessary uniforms, safety protection gears, tools as required by the nature of work to maintenance personnel.

The tenderer shall also suggest ways and means to improve safety and efficiency of the functioning of the elevator during the course of maintenance contract. Capacity plate and safety precaution charts shall be provided as and when required during the course of maintenance without any extra cost.

The tenderer shall co-ordinate with Inspector of Lifts for inspection of elevators and when desired by inspector of lifts during the period of contract for the elevator covered under contract and defects. If any pointed out by him shall be attended to immediately at no extra cost.

### STANDARD FEATURES REQUIRED FOR LIFTS

Sr.No	DESCRIPTION	CONFIRMATION BY TENDERERS
1	Microprocessor Based AC V3F Full Collective Controller	
2	Micro Push Buttons with call registration indications with Brail Language.	
3	Stainless Steel Face plates For Car Operating Panel & For Landing Operating Panel	
4	Emergency Alarm & Lighting car with Battery Back Up & Inbuilt Charger Unit	

5	<b>Phase Failure &amp; Phase ReversalProtection</b>	
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6	<b>Firemen's Switch Operation</b>	
7	<b>Auto Fan Off Control &amp; Auto Attendant Function</b>	
9	<b>Digital Dot Matrix Type scrolling indicators For car and All Floors.</b>	
10	<b>Intercom 2-Ways</b>	
11	<b>Voice &amp; Music System in Car</b>	
12	<b>Blower Fan For Ventilation</b>	
13	<b>Floor announcement</b>	
14	<b>Over Load Warning Device</b>	
15	<b>Automatic Rescue Device</b>	

## **E17. Comprehensive Maintenance and Operat**

### **ions A SITC Comprehensive Maintenance and O&M**

#### **Work**

- SITC, Comprehensive Maintenance and O&M of Electrification work, Light Fixture, Lift, Elv. System, Parking System, Ventilation System.
- SITC, Comprehensive Maintenance and O&M of all HT/LT electrical Installation.
- Building & Perimeter Road Lighting, Street lighting, Parking light, garden lights and Other Electrical installations as per requirement.
- To carry out maintenance as well as new works of above said locations as and when required.
- The scope of work includes the daily operation of CSS / Transformer, Electrification work, Light Fixture, Lift, Elv. System, Parking System, Ventilation System as per AMC guide lines (daily, weekly, fortnightly, half yearly & yearly) and daily entries of various parameters in log books of installations.
- Maintenance of all the above records & any other record as decided by engineer in-charge shall be the responsibility of contractor.
- Ensuring service ability/ satisfactory working condition of Electrical system and equipment's included under maintenance contract.
- Attending to complaints / fault / breakdowns & carrying out necessary rectification / repair works.
- Making minor additions & alterations where required.

#### **B Uniform**

The contractor /agency has to provide every year during the currency of the contract, 2 sets of uniforms (pant and shirt), 1 pair of shoes & 3 pair of socks to his staff of approved colour during the contract period, (within one month from the date of award) failing which, AAI recover an amount of Rs. 200/-per person per week till the compliance of the same from the contractor's running /final bill. In the event of non-compliance of wearing uniform & shoes by workers on daily basis a recovery of RS. 50/-per day per person shall be made from running bills. The workers should wear a badge on the left pocket of the shirt mentioning company's name.

#### **C Rates :-**

Price shall be including of all taxes, excluding GST, EPF, ESI & Bonus.

##### **The Rate Quoted shall be inclusive of**

- a. All taxes GST, EPF, ESI & Bonus.
- b. Cost towards wages (should not be less than applicable minimum wages rates) for labour engaged for execution of contract.
- c. Cost towards materials to be used as per scope of work.
- d. Cost towards normal tools and plants for execution of contract.
- e. Cost towards the special tools to be provided as per scope of contract.
- f. Additional wages for the workmen employed on National holidays.
- g. Cost towards uniform, safety shoes etc as per scope of contract.
- h. Cost towards consumables, registers, log books, preventive maintenance schedule log book, Vehicle parking charge etc as per scope of contract.
- a. Contribution towards labour welfare fund.
- b. Over Head and profit

#### **D The Monthly duty roster for the staff shall be prepared by the contractor by**

**keeping 8hrs./shift as required by Engineer-in-charge or his representative in advance :-**

**Minimum Qualification and Experience :**

- a) **Highly skilled manpower (Engineer) :** Shall be Diploma holders with 03 year experience / Graduate with 02 years experience (In Electrical).
- b) **Skilled manpower ( Electrician) :** Shall be ITI holder in Electrician / Wireman with minimum 03 Years experience in similar nature work or wireman trade licence with minimum 02 years experience in similar nature work / filed and shall be paid as per minimum wages.
- c) **Unskilled manpower (Helper) :** Shall be ITI holder in Electrician / Wireman with good physique & shall have basic knowledge of similar electrical works and shall be paid as per minimum wages.

**E Replacing the workman :-**

The contractor is liable to replace the workman on the directives of Annual maintenance contract in the following condition.

- If the workman is not proficient enough to the requirement of the work.
- If the workman is misbehaving.
- If the workman is acting against the interest of AMC.
- If the workman is non-punctual or irregular.
- If the output of the workman is not to the expectation of AMC.
- The decision/assessment of engineer-in-charge on this matter will be final and binding

**F Handling / Taking over of the Equipment after contract :-**

All the equipment's/installations/systems with accessories complete in all respect shall be checked by agency before taking over the site and same has to be handed over AMC contractor in good running condition at the end of the contract. List of defects, If any notified during contract period shall be rectified by the agency before the closure of the contract. If the agency failed to rectify the defects, notified to him (during contract period) the EIC shall rectified the defects at the contractors risk & cost. The decision of EIC in this regard will be final & binding on the agency.

**G Complaints :-**

Complaints have been categorized into three parts as indicated to desire response.

**i.Critical Complaints:** to be attended within 30 minutes from the time of receipt of complaint.

- a) Failure of power in any portion of buildings /Pump Room/LIFT/ ELV. System/ Parking System /CCTV Surveillance system/ Ventilation System/ sub-station.
- b) Failure of Pumps/Motors of water supply.
- c) Failure of power supply to water supply system.
- d) Failure of power supply to communication installations.
- e) Failure in Distribution boards and LT Panels
- f) Failure of Power Cables
- g) Failure of Light Fixture
- h) Failure of CSS.
- i) Failure of façade lighting.
- j) Failure of UPS

**ii.Urgent Complaints:** Fuse off call in terminal buildings/navigational installations and other operational facilities shall be attended within 60minutes from the time of receipt of complaint.

**iii. Other Complaints:**

- (a) Power supply failure to non-critical areas (as decided by the Engineer-in-charge) shall be attended within 1 hour from the time of receipt of complaint.
- (b) Complaints like replacement of MCB, bulbs, tubes, switches, sockets, repairing of fans, regulators, rectification and attending of cable faults etc. shall be attended within one hour from the receipt of complaints / instruction from Engineer-in charge or from users department.
- (c) All other complaints which are not specified above are also covered and decision regarding type of complaint shall be final as decided by Engineer-in charge.

## **H Safety & availability of Material : -**

- i. The firm /agency shall submit test certificate, wherever applicable as per CPWD/IS/ manufactures practice and the department reserves the right to get them independently checked for the material supplied by contractor as required.
- ii. All debris due to works shall be removed and site shall be cleared by the contractor as soon as the task is completed. Non –removal of debris from site will attract a penalty of Rs.500/- per day from the running bill/final bill.
- iii. This scope of work is comprehensive Maintenance scope. Contractor needs to supply, Installation, Testing and Commissioning of all required material for operation and maintenance during this maintenance period. In case of Material needs to be replaced Due to Vandalism / theft of items. The rate for item shall be as per the negotiated final rate of each item in the BOQ and it shall be payable as per the actual quantity executed during the maintenance period.
- iv. The consumables such as insulation tape, test Lamps, cotton waste, soap, dusters, grease, petroleum jelly, hack- saw blade, etc, will be provided by the contractor. Stationeries such as log books, diaries to workmen, printed maintenance records, log book of various installations, various registers, preventive maintenance schedules as per AMC format and as per the instructions of Engineer –in-charge will be provided within the 15 days of award of contract and maintained by the contractor at the site. Reserve Stock quantity to be decided by the ELC & nothing extra payment will be made in this regard and the agency has to keep minimum quantity of consumables for one month in stock depending on the actual requirement failing which the material will arranged by the AMC and the expenditure will be recovered from the agency with 15% over head.

## **I Make of Items : -**

The contractor shall use /supply the material as per approved make of the tender or as per schedule of quantities or exact replacement of existing material suitable to site after taking permission from EIC / authorized representative in writing in case makes are not defined for particular material and the department reserve the right to accept or reject any other makes offered by the contractor.

The contractor has to supply the materials as and when required /ordered by the Engineer-in-charge or his representative during the currency of the contract.

## **J Tools & Tackles: -**

The contractor shall provide all the tools and tackles for the works including Measuring instruments and safety gadgets for attending a breakdown of equipments. Cost of transportation of labour and material to premises shall have to be borne by the contractor .

- i. Each skilled manpower will be provided with the following minimum tools of reputed brand (Make : Taparia or equivalent ) along with carrying bag for routine maintenance works:-

- 01 no. Cutting pliers
- 01 no. Screw Drivers (Big & Small)
- 01 Set Wire strippers
- 01 No. Line Testers
- 01 Set. Test Lamps with holder

Compensation @ Rs 50/- Per person per shift will be made for not providing the above tools and the compensation shall be recovered from the contractor's bill.

- ii. The following tools shall be provided by the agency at AMC store /powerhouse for use of maintenance and breakdown works:-

- Box Spanner Set complete with Socket accessories, ratchet, etc. - 01 Set
- Double end spanner set (Set of 12) - 01 Set
- Ring Spanner set (Set of 12) - 01 Set

- Screw Spanners of different sizes. - 01 No.
- Hammers of different sizes. - 01 Set
- Screw Driver Set of (different sizes) - 01 Set
- Crimping tools (different sizes ) - 01 Set

- Nose pliers. - 03 Nos.
- Wire Cutters /Cutting pliers - 03 Nos.
- Punch /Chisel - 02 Nos..
- Electric Hammer drilling machine - 02 No.
- Blower - 01 No.
- Vacuum Cleaner (Big size) - 01 No.
- Hydrometer - 01 No.

iii. The following instruments /items shall be provided by the agency at Power House for use of maintenance and breakdown works:-

- Digital Multi –meter (VAO Meter) - 02 Nos.
- Digital Megger (500V) - 01 No.
- Earth Tester - 02 Nos.
- Clip-on-meter - 01 No.
- Cell Tester - 01 No.
- Raincoat - 10 Set
- High Visibility Jacket - 20 Set
- Gum boot - 10 Pairs
- Safety Gloves - HT & LT 02 pairs each.
- Rechargeable torch light - 02 Nos.
- Safety Helmet - 02 Nos.
- Safety Rope - 01 Set.
- 30 Meter measurement tape - 01 No.
- 05 Meter measurement tape - 02 Nos.

Compensation @ 500/-or part thereof Per day will be made for not providing the above tools, measuring equipments, items as per (ii) & (iii) above and compensation shall be recovered from the contractor's bill the Supervisor shall be submit the list of tool available and its serviceability status every month to the EIC of his authorized representative. The contractor shall be make his own arrangements for watch and ward for the T&P item used by him for the work and the materials issued to him by the department . AMC shall not accept any claim for any loss or damage in this regard . Any loss or damage to the materials issued by the department to the contractor shall be recovered from his bill at the local market rate assessed by the Engineer in charge and decision of the engineer –in- Charge in this regard shall be final.

#### **K Operation : -**

The work consists of Employing High-Skilled/skilled/Unskilled manpower for the following as and when required:

1. Routine operation of the Complete Installation carried out by Contractor
2. Tracing out and locating failures of power supply, MCCBs.
3. Minor repairs such as cable jointing, cable terminations, crimping of lugs, wiring works, adjustment of pumps/motors etc.
4. Attending to any power supply failure and restoring the same including carrying out temporary cabling.
5. Measurements and record of earth resistance as per maintenance schedule for all the electrical installation.
6. General cleaning and checking of all switchgears and inspection for all the equipment's regularly.
7. Routine cleaning of water pumps, external /internal light fittings, wall mounted fans, exhaust fans, circulators etc. and wiring works of the installations covered under this contract.
8. Operation and general cleaning of any other E & M installations, switch rooms, staff rooms as per instruction of Engineer-in-charge.
9. Tracing out and located failures of installation.

#### **L Maintenance checks : -**

The scope of work includes preventive maintenance checks of E & M installation as per maintenance schedules attached.

During the currency of the contract, if any other maintenance checks are found to be necessary on any

installations, as per original equipment manufacturer or sound engineering practice, the same shall be carried out without any additional cost. As far as possible maintenance checks shall be carried out during holidays or lean periods without



affecting the operation of the airport services. The contractor shall maintain necessary records for the maintenance checks.

#### **M Breakdown Repairs :-**

Any breakdown of Electrical & Mechanical shall be attended immediately. One or more registers in the standard format shall be maintained for recording the breakdown / faults by the contractor representative on duty. The same shall clearly indicate the time / mode of receipt of fault report, location and nature of fault, materials used and cause of fault. The contractor, if required, for carrying out any breakdown repairs, beyond scope of work of contract, shall be deploying additional working hand and extra payment shall be made as per terms and conditions of contract.

#### **N Works to be carried out by the contractor :-**

In addition to the Operation and Maintenance of the Installations as per the schedule of works, the following works shall be deemed to have included within the scope of the work to be executed by the contractor, whether or not explicitly indicated in the schedule of work and the rate quoted by the contractor shall be inclusive of the same.

- Operation and Routine Maintenance of complete Installations and as directed by EIC.
- Providing sundry materials such as cotton waste, duster cloths, HT Insulation Tap, Grease, Jelly, Hydro Meter, Cell Tester, CRC and other cleaning agents and minor tools etc.
- Carrying out Routine and Preventive Maintenance & Maintaining associated log book records by Supervisor as per AMC's maintenance manual/Instruction of AMC from time to time & submission of reports to AMC.
- Attending Breakdown Repairs and Trouble Shooting for minor faults.
- Rendering assistance to AMC Engineers/Specialist agencies in attending major faults and repairs.
- Providing tools and tackles for carrying out the work.
- Maintaining the Switch Rooms and premises neat and clean.
- Assisting AMC Engineers in conducting regular store audit, arranging the stores and dismantled materials.
- Ensuring serviceability/satisfactory working condition of Electrical Installation.
- Attending to complaints / fault / breakdowns / carrying out necessary rectification / repair works.
- Making minor additions & alterations where required.
- Maintenance of Records / documents and submission of Reports.
- Proper storage of dismantled materials in AMC identified store / area and handed over the same to Engineer-in-Charge at AMC store.
- Any other works assigned by AMC time to time by Engineer-in-charge.
- Carriage of materials issued by AMC from their stores to various work site for carrying out various works.
- Ensuring all necessary electrical & fire safety procedures, precautions while carrying out the work including making use of safety gadgets like hand gloves, torch light, rain coat, leather shoes boots, safety helmets as per site requirements.
- Meeting the requirement of labour regulations / Local laws and making insurance cover for the employees.
- Work has to be carried out as per Indian Electricity Rules & CPWD specification amended up to date and to full satisfaction of Engineer-in-charge.
- Calibration / Testing of protective relays & instrument such test should be carried out through Govt. approved Lab /Testing Houses.

#### **O FREE SUPPLY OF MATERIALS / EQUIPMENT BY CLIENT**

If any material / equipment is supplied by EMPLOYER to the Contractor during Project

implementation then the Contractor shall receive these materials and equipment at site, handle with care and store them as directed by the EMPLOYER's representative at site. The Contractor shall be responsible for the safe custody and shall insure all materials against theft and damage by fire and earthquake. The Contractor shall maintain records of consumption as per Engineer-in-charge instruction. In case of any damage to the material resulting in its not being suitable for use at site the Contractor shall have to replace the same material at his own cost and without

in any way affecting the time schedule of the project. The Contractor shall return the surplus material back to the EMPLOYER in original condition during the handing over process.

All Materials /Equipment supplied by Client and Contractor must have valid signed agreement.

**P**The work shall be carried out as per specifications and relevant applicable standard including ISI/CPWD specification.

**Q** The contractor shall be responsible for any damage caused to any equipment's building of AMC due to the negligence of the staff. The same shall be made good by the contractor at his cost.

**R** Agency has to submit the Preventive Maintenance Activity Plan within 15 days of award of work in line with the Preventive Maintenance Schedule, considering site requirement for approval of Engineer-in – Charge or his authorized representative.

**S**The agency shall provide minimum 01 no. mobile phone with active SIM to the site in charge /authorized representative for official use during the currency of the contract , nothing extra will be paid in this account.

## **E18. Part B: Testing**

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### **1.1 General**

At the completion of the work, the entire installation shall be subject to the following tests in the presence of the EMPLOYER's site representative.

- Wiring continuity test.
- Insulation resistance test.
- Earth continuity test.
- Earth resistivity test.
- Test as per Appendix 'E' of IS:732 -1989

Besides the above, any other test specified by the local authority shall also be carried out. All tested and calibrated instruments for testing, labour, materials and incidentals necessary to conduct the above tests shall be provided by the Contractor at his own cost.

### **1.2 Testing Of Wiring**

All wiring systems shall be tested for continuity of circuits, and earthing after wiring is completed and before installation is energized.

### **1.3 Insulation Resistance Test**

The insulation resistance shall be measured between earth and the whole system of conductors, or any section thereof, with all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it does not exceed 660 volts for medium voltage circuits. Where the supply is derived from AC three phase system, the neutral pole of which is connected to earth, either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral. The insulation resistance measured as above shall not be less than 50 divided by the number of points provided on the circuit; the whole installation shall have an insulation resistance greater than one mega ohms. The insulation resistance between the frame work of housing of power appliances and all live parts of each appliance shall not be less than that specified in the relevant standard specification or where there is no such specification, shall not be less than one a mega ohms. All equipments, cables shall be inspected at works by the Architect as per relevant IS and testing commissioning of installation as per Appendix 'E' of IS: 732-1989 shall be done and all record to be maintained.

### **1.4 Testing Of Earth Continuity Path**

The earth continuity conductor metallic envelopes of cables shall be tested for electric continuity and the electrical resistance of the same, along with the earthing lead but excluding any added resistance or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation, shall not exceed one ohm.

### **1.5 Testing Of Polarity Of Non-Linked Single Pole Switch**

In a two wire installation a test shall be made to verify that all non-lined single pole switches have been connected to the same conductor throughout, and such conductor shall be labelled or marked for connection to an outer or phase conductor or to the non-earthed conductor of the supply. In the three or four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final

acceptance of the EMPLOYER's site representative as well as the local authorities.

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**Part C: Erection, Testing & Commissioning Of Electrical Installations**


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**1.1 Scope**

The intent of this specification is to define the requirements for the installation, testing and commissioning of the electrical system like transformer, M.V panels, Cables, earthing network, Internal and External lighting, Light fixtures etc. Requirement of this project shall be as specified in bill of quantities / approved drawings / general specifications or as per the battery limits fixed by the EMPLOYER / consultant.

**1.2 Standards**

The work shall be carried out in the best workman like manner in conformity with this specification, the relevant specification / codes of practice of the Indian Standards Institution, approved drawings and the instructions issued by the authorised representative, from time to time. Some of the relevant Indian Standards are listed elsewhere in this tender document.

In addition to the standards mentioned in 2.1, all works shall also conform to the requirement of the following:

- Indian Electricity Act and Rules framed there under.
- Fire Insurance Regulations.
- Regulations laid down by the Chief Electrical Inspector of the State / State Electricity Board / Union Territory.
- Regulations laid down by the Factory Inspector of the State / Union Territory.
- Any other regulations laid down by the local authorities.
- Installation & operation manuals of original manufacturers of equipment.

**1.3 Equipment, Material And Accessories Specifications**

This defines specifications and requirements mainly for the equipment and accessories, which are generally supplied by the erection agency.

All materials, accessories, consumable to be supplied by the contractor shall be selected from the list of specified make of material in consultation with the Client/Architect/Consultant without any extra cost and shall conform to the specification given here under. The equipment shall be manufactured in accordance with current Indian Standard specifications wherever they exist or with the BS or NEC specifications, if no such IS standards are available. In the absence of any specification & if any item not mentioned in the make of the material & anywhere else, the materials shall be as approved by the EMPLOYER / consultant or his authorised representative in writing manner.

All similar materials and removable parts shall be uniform and interchangeable with one another. Makes of bought out items selected by the contractor must be furnished by him as per the pro forma given in elsewhere in this tender document. Tenderer should have to specify the list of makes considered in the tender while quoting the rates in the tender, in covering letter of separate letter enclosure. However, the final decision for accepting make specified by tenderer would be of client/Architect/Consultants.

Within a week of work order, the contractor shall submit the sample of each item / component of above

mentioned approved make for the approval of the Client/Architect/Consultant.

Bidder to submit authorization letter for supply of light fixtures and lamps only from regional sales manager/director-sales of lighting company with duly signed and stamped with mentioning the name of project, total quantity, type of light fitting etc. The letter should be submitted with valid proof and original documents to consultant. These authorizations are to be obtained prior to supply of material and should be approved by electrical consultant/architect.

### 1.3.1 Control Cables

Control cables for use on 415 V system shall be of 1100 volts grade, copper conductor, PVC insulated, PVC sheathed, armoured and overall PVC sheathed, strictly as per IS: 1554 (Part-I) 1976. Unarmoured cables to be used only if specifically mentioned in schedule of quantities.

The size of these cables shall be as specified in bill of quantities or as per approved drawing. The minimum conductor size shall be 2.5 sq.mm. (Cu.).

### 1.3.2 Cable Trays

These shall be channel type, fabricated from structural steel, hot dip galvanised, complete with all accessories such as bends, tees and reducers. Only aluminium flat clamps with G.I. / Chrome plated bolts, nuts/screws to be used for clamping cables. Sizes of these trays shall be as specified in bill of quantities or approved by client.

### 1.3.3 Cable Glands

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

### 1.3.4 Cable Connectors

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

### 1.3.5 Cable Indicators

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

### 1.3.6 G.I. Pipe For Cables

For laying of cables under floor, G.I. class “A” pipes shall be used. M.S. conduits are not acceptable for this purpose. All accessories of pipes shall be threaded type. Size of pipe shall depend upon the overall outer diameter of cable to be drawn through pipe. NO G.I. pipe less than 40 MM. I.D. shall be used for this purpose. To determine the size of pipe, assume that 40% area of pipe shall be free after drawing of cable.

### 1.3.7 Push Button Stations

These shall be floor / wall mounted type as specified in bill of quantities. These shall be fabricated from 1.6 mm. thick stainless steel sheets (SS 304). In case of floor mounted station, these shall be supported on 51 mm. “A” class

G.I. pipe. Front cover shall be removable type with suitable rubber gaskets to make them dust vermin and moisture proof.

Each feeder shall be provided with “ON” (green) push button, “OFF” (red) push button, name plate (white bakelite), indication lamp etc. Green & red push buttons shall have contact elements having 1NO + 1NC. “OFF” push button shall be provided with lockable (key operated) arrangements to prevent accidental starting. No. of feeders shall be specified in bill of quantities. The indication lamp can be combined with “ON” push button.



#### **1.4 Erection**

The contractor shall make his own arrangement for safe transportation of all the items to the erection site and also carry out complete loading / unloading during transportation. Equipment shall not be removed from packing cases unless the floor has been made ready for installing them. The cases shall be opened in presence of the client / consultant or his authorized representative. The empty packing cases shall be returned to the stores and any document if found with the equipment shall be handed over to the client's representative. Any damage or shortage noticed shall be reported to the client / consultant in writing immediately after opening of packing cases.

## **1.5 General Notes For Street Lighting**

For supplying and laying of cables, technical specification (wiring) shall be applicable reference shall be made under heading Cable Work elsewhere in the tender.

For street light poles along roads, nearest finished road level shall be taken as ground level and for poles along compound wall / away from roads, existing ground / finished ground shall be taken as ground level.

Distance of 1 mtr. shall be maintained between centre of pole and centre of kerb of road. For compound wall poles, distance between compound wall and poles shall be 3 mtrs.

A loop of 1.5 mtr. of cable shall be provided near each street light pole for all incoming and outgoing cable.

## **1.6 Completion Tests**

After supply and installation of complete project or a particular building / area, following tests shall be carried out by the contractor before switching on the power to installation and the results shall be recorded and submitted to the Site-Engineer. If results are not satisfactory / as per standards set herewith, the contractor shall identify the defects / short coming and shall rectify the same. Nothing extra shall be paid for carrying out these tests and contractor has to arrange all necessary instruments.

### **1.6.1 Insulation Resistance To Earth**

This is to be measured with all fuse links in place, all switches ON, all lamps and appliances in position by applying a voltage not less than twice the working voltage (subject to a limit of 500 V). Insulation resistance of the whole or any part of the installation to earth must not be less than 50 mega-ohms divided by the number of outlets (points and switch positions) except that it need not exceed one mega-ohm for the whole installation.

### **1.6.2 Insulation Resistance Between Conductors:**

Tests to be made between all the conductors connected to one pole or phase conductor of the supply and all the conductors connected to the middle wire or neutral or the other pole or phase conductors of the supply. For this test, all lamps shall be removed and all switches put ON. The result of the test must be 50 mega-ohms divided by the number of outlets (points and switch positions) but need not exceed 1 mega-ohm for the whole installation.

### **1.6.3 Polarity Of Single Pole Switches:**

Tests shall be made to verify that all non-linked single pole switches are on phase conductor (live) and not on neutral or earth conductor. This can be done by connecting test lamps between two terminals of switch and earth. If the lamp lights up when switch is ON and either terminal is touched, the switch is correctly installed.

### **1.6.4 Resistance Of Metal Conduits / Sheets (Earth Continuity Test):**

In case of cables encased in metal whether conduit of metallic sheathing, the total resistance of the conduit or sheathing from the earthing point any other position in the completed installation shall not exceed 2 ohms. This can be carried out by following circuit:

One end of the lead is connected to the ECC and its connection with the electrode and the other to the farthest point of the ECC. First, current through the circuit is measured with the resistance of 2 ohms short circuited by the link. Next, current is measured through the two ohms resistance by disconnecting the two leads

from the ECC and joining them together. If current is more in the first case, the resistance of ECC is less than 2 ohms.

### **1.7 Handing Over / Taking Over:**

After completion of works and tests specified above, the various installations of the project can be taken over by the employer as and when these are ready in all respects. The defect liability period of 24 months shall start from the date, when all the installations of the project have been executed, tested as described above, successfully commissioned and handed over.

The Contractor has to produce the Final As – Built drawings duly signed by Engineer In charge, Consultant, Architect & Client before finalizing the Final bill. The cost for as built drawing to be borne by the contractor.

Final bill will not be considered if as built drawings not provided by contractor as following. Process of as built Drawings:

1 set of Hard copy & editable soft copy should be submitted to Engineer In charge.

After incorporating the comments received from Engineer in charge Final As built documents as mentioned to be submitted.

Final As built documents

As built drawings with RTP (Reproducible Tracing Paper). : 1

Set As built drawings with Coloured Print out: 4 Sets

Editable Soft Copy of the same: 6 Copies

Instruction and maintenance manual - Six

copies. Test certificates - Six copies.

**Special Note :**“ All Electrical Items/ ELV Items / Equipments/ Sub-station/Process mentioned in BOQ must be as per relevant latest Indian standards/ International standard and must follow latest rules and regulations prescribed by relevant Authorities of State Government/ Central Government.”

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Part - D: List Of Approved Make For Electrical Materials

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S. No.	Item	Approved Make
1)	Rigid PVC Conduit ( FRLS only )	Precision Plastic Industries, Nihir, Finolex
2)	Accessories for conduit	Same make as of pipe.
3)	Flexible Copper Wires (FRLS)	Finolex, Polycab, RR Kable, KEI,Paramount
4)	Switches & Sockets Use different colour switch & Accessories for Raw & UPS Power IP66 Box and	Legrand, MK, Schneider, Havells
5)	Main Switch fuse upto 60 Amps - AC 23 duty	Schneider MG, L&T
6)	Above 60 Amps-A.C. 23 Duty	Schneider MG, L&T
7)	HRC Fuses	Schneider MG, L&T, ABB
8)	MCBs/ELCBs/ELMCBs / Contactor Time Switch ( Timer )	Legrand, Schneider, Siemens, ABB , L&T
9)	Distribution boards- TPN & SPN DB (IP 65),	Hensel, Spelsberg, Legrand (Plexo 3), ABB
	VTPN DB (IK 43)	Legrand , Schneider MG, Siemens, ABB Factory fabricated. double door type. PPI with additional JB on both side
10)	Rewireable Porcelain Fuse	CPL, KEW.
11)	Telephone wires	Finolex, Delton, RR cable, Avocab, Polycab, KEI
12)	Telephone cables Jelly Filled	Finolex, Delton, RR cable, Avocab, Polycab,
13)	PVC tape	Steel grip, Anchor
14)	Main Cables down Stream	XLPE armoured cable for 1.1 KV as per ISI Finolex, Polycab, RR Kable, KEI, Paramount
15)	Glands	Compression type, Heavy duty and deep with rubber ring and double washers. HMI, Raychem

Sr.No	Item	Approved Make
16)	Cable Lugs	Dowells, 3-D, Raychem.
17)	Metal Clad Plugs	Indoor –Legrand, Scame, Hensel. Outdoor - Legrand, Scame, Hensel.
18)	Connectors	Hensel, Wohner.
19)	Button holder, Angle holder, ceiling rose	Anchor, CPL
20)	M.S. Conduit ISI	BEC, Steel Craft, AKG
21)	UPS	APC, Emerson(Vertiv), Socomec, Numeric (Legrand), Eaton
22)	M.S. Boxes	Fabricated out of 16 gauge continuously welded (sample to be approved) with Powder coating.
23)	Telephone tag block	Krone
24)	MCCB With all kind of communication accessories	Schneider MG, Legrand, Siemens, ABB
25)	Meter ( Analog Only ) Digital Meter	Rushabh, L &T, Conzerv, Schneider, Conserve, Secure Meter
26)	Steel Wire Rain Forced PVC Flexible Hose	Flaxi - Hose
27)	Cable Tray (Ladder/Perforated - Hot deep GI)	Indiana, MEK, Superfab, Legrand
28)	TV Cable/CCTV Cable ( 3 +1)	Finolex, RR Cable, Avocab, Polycab.
29)	Panel Fabricators - TTA Panels	Siemens (Sivacon), Schneider (Blokset), Rittal (Ri4power), ABB (MNS)
30)	IP65 Panel	Peaton Electric, Hensel, Spelsberg. , Rittal
31)	Changeover Switch	On load type – HPL, C &S, Havell's (Euroload)
32)	Fire Extinguisher	Should be of ISI approved - Safex, Firex, Kanex, Minimax
33A)	D G Set Engine	Cummins, Kirloskar, Caterpillar, Perkins, Volvo Penta
33B)	Diesel Alternator	Stamford, Crompton, Lorey Somer, Kirloskars, Cummins
34)	R G 6 / 11 wire	Finolex, Avocab, Polycab, RR Kable, KEI
35)	Cat 6 Wire& Fibreoptic Cable and Accesaries	Legrand, SYSTIMAX, Panduit, Siemon

36)	ACB With all kind of communication accessories	Schneider, Siemens, Legrand, ABB. Must be EDO type & Microprocessor base only
37)	Engineering Plastic Cable trunking	Legrand, OBO Betterman, JMV.
38)	Call Bell	Legrand, Schneider, Hawells
39)	DIGITAL meters, Load Manager	Schneider, Conserve, Secure Meter
40)	Light Fixture indoor	Philips, Polycab, Bajaj, Crompton,
41)	Light Fixture Outdoor	
42)	Lamps	Philips, Polycab, Bajaj, Crompton
43)	Ballast	Philips, Vossloh, OSRAM, ATCO, Tridonic, Meanwell
44)	Chemical Type Earthing ( Copper Road only )	JMV, LPI, Ashlok, OBO Betterman.
45)	Energy Meter	Conserve, Schneider, Secure Meter
46)	CT	AE, Ashok, Kappa, C&S
47)	DWC Pipe( Anti Rodent Type Only)	Tirupati Plasto, REX, Duraline, Gemini, Veronica Plastomatics Pvt. Ltd.
48)	Fan (Grey colour Mat finish / White colour as mentioned in	Crompton, Usha, Havells, Bajaj (Sample to be approved by Client / Architect.)
49)	Junction Box ( PVC / Polycarbonate)	Gewiss, Hensel, Spelsberg
50)	Contactore	Telemechanique, L & T, Schneider, Legrand, ABB
51)	Panel Accessories	Telemechanique, L &T, Siemens
	Automatic Power Factor Control (APFC) Panel	Crompton,L & T, Schneider, EPCOS, KHATAU
53)	Water tight Plugs enclouser	Gewiss, Hensel, Spelsberg, Scame, Legrand
54)	Compact Sub Station	Kirloskar, ABB, Siemens, Voltamp.
55)	Dry type Transformer	Schneider, Voltamp, ABB, Areva, Crompton
56)	H T VCB Breaker / RMU	Schneider, ABB, Pascal, Siemens, Crompton

57)	Capacitor ( MPPH Gas-Filled Type ) Thyristors, Reactors	L & T, Epcos, Neptune, Electronicon, Ducati.
58)	Relay	Alsthom, Siemens, Schneider, ABB, L&T.
59)	IPFC Relay	Conserve, Secure, Schneider, BCH, Ducati, Electronicon.
60)	PLC	Schneider, Siemens, ABB, Allen Bradley
61)	Surge Protector	Merssen, Emerson, Obo Betterman, ASCO
62)	H. T. Cable 11 /	Finolex, Paramount, KEI, R.R Kabel, Havells, Polycab,
63)	RJ 11 telephone outlet	Same make as switch
64)	RJ 45 Data outlet	Legrand, SYSTIMAX, Panduit, Siemon.
65)	HT Cable Jointing KIT	Raychem, 3M
66)	Exhaust Fan ( Should be with louvers )	Usha, Havells, Crompton

67)	Timers	Theben, Legrand, Schneider
68)	Octagonal / Conical Poles	Bajaj, Schreder, Transrail, Valmont, Polycab
69)	Network Switch	Cisco
70)	Rack	Tyco
71)	Modular Patch Panel	Cisco
72)	Floor Junction Box	OBO, Betterman, Legrand.
73)	Floor UPVC Raceway	OBO, Betterman, Legrand.
74)	Floor Sheet Steel Raceways	OBO, LK, MK.
75)	Lightning Arrestor	JMV, Erico, OBO, LPI, ABB
76)	Lift	Schinler, Mitsubishi, OTIS, Orbis, Kone, TRIO
77)	High Mast	Philips, Crompton, Bajaj, polycab
78)	Man Rider	Philips, Crompton, Bajaj, RR ISPAT
79)	FRP Pole	Sumip, Bajaj, polycab
80)	Alluminium scaffolding Ladder	Penguin, BOB Eng.
81)	Fire Alarm Panel	HONEYWELL
82)	Repeater Panel	HONEYWELL
83)	Graphical User Interface	HONEYWELL
84)	Working Station	HP/DELL/IBM
85)	Printer	HP/CANON/EPSON/BROTHER
86)	Multi sensor Detector	HONEYWELL
87)	Heat Detector	HONEYWELL
88)	Manual Call Point	HONEYWELL
89)	Hooter Cum Strobe	HONEYWELL
90)	Input / Output Devices	HONEYWELL
91)	Fault Isolator	HONEYWELL

92)	Response indictor	HONEYWELL
93)	Fire fighting telephone jack	HONEYWELL
94)	Fire Telephone Handset	HONEYWELL
95)	Digital Voice Evecution	HONEYWELL
96)	Digital Amplifier	HONEYWELL
97)	Indoor Dome Camera	HONEYWELL
98)	Outdoor Bullet Camera	HONEYWELL
99)	Number Plate Recognition	HONEYWELL
100)	Network Storage Manager	HP/Dell/IBM
101)	Network Video Management & Monitoring Software	Honeywell / Bosch / Pelco / Axis
102)	Network Server	HP/Dell/IBM
103)	Workstation	HP / Dell/ IBM
104)	55" LED Monitor	Panasonic / Sony / Samsung
105)	EPABX	NEC/ Panasonic/ AVAYA/ SIEMENS
106)	IP Phone	NEC/ Panasonic/ AVAYA/ SIEMENS
107)	Push Button Phone	Beetel/ NEC/ Panasonic/ SIEMENS



108)	Multi Pair Telephone Cable	Finolex/ Polycab/ Delton
109)	Network Switch	HP/Cisco/Dell
110)	Patch Panel	Cisco
111)	Patch Cord	Tyco
112)	Face Plate and IO	Simon/Panduit/Legrand
113)	Wifi	HP Aruba

Refer “ Part C: Erection, Testing & Commissioning Of Electrical Installations “ – Para 1.3 before quoting the Tender.

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Part C

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**ELV Specifications**

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❖ **CCTV Surveillance System**

	<b>OEM Prequalification Criteria:</b>	
	The <b>OEM prequalification criteria</b> will be as under specific Requirements:	
		<b>Documents Required</b>
<b>1</b>	The CCTV OEM authorized should have its toll-free number with Mobile app for any technical support query from the SI or end customer which is very much required for such a big project.	Toll free nos. should be mentioned in the manufacturer's authorization letter and submitted along with the bid.
<b>2</b>	The CCTV OEM should have its toll-free number in India for any technical support query from the SI or end customer with the mobile application-based ticketing website for logging calls and obtain service docket /ticket status. Technical Support number should be mentioned in the manufacturer's authorization letter and submitted along with the bid.	Toll free nos. should be mentioned in the manufacturer's authorization letter and submitted along with the bid.
<b>3</b>	The MAC address of the IP cameras must be registered in the name of OEM.	Proof to be provided by the OEM
<b>4</b>	The CCTV OEM must have self-owned service center for last 5 years from the date of submission of bid ( <b>not as joint venture, partnership firms or through any other association</b> )	OEM's GST registration document clearly mentioning service tax no. to be given as
<b>5</b>	The proposed camera OEM should be a member in any of the present "ONVIF Organization Committee i.e., Steering Committee/Technical Committee or Technical Services Committee or full membership for last 4 year.	Proof to be provided by the OEM
<b>6</b>	The OEM for IP Cameras & VMS should have a registered entity and direct presence in India for more than 10 years as on bid submission date and should be present globally in the same line of manufacturing for at least 15 years. Camera, NVR OEM should submit a declaration letter along with letter of incorporation	Camera OEM should submit a declaration letter along with letter of incorporation confirming the same
<b>7</b>	The OEM of major items (like CCTV Camera of all types, VMS, Servers, Storages, switches etc.) its sister concerns, or any of its group company or Subsidiary <b>should not have been blacklisted</b> in last 10 years by any Ministry under Government of India or by Government of any State in India or any of the Government PSUs as on tender floating date.	Certificate / affidavit mentioning that the Bidder is not blacklisted by any Ministry under Government of India or by Government of any State in India or any of the Government PSUs.
<b>9</b>	The CCTV OEM must have executed a similar nature of work i.e., Supply of CCTV cameras to similar customer	Documentary proof to be submitted

	or Jails with minimum 2000 number of cameras in single order.	
11	The CCTV OEM should have own Technical, Service Support Center in India with L1, L2 & L3 Support.	Documentary proof to be submitted
11	The OEM for IP Cameras & VMS should have at least 50 employees on its payroll in India. Declaration letter from the HR/country Head/Director/CEO of OEM to be submitted along with the bid.	Documentary proof to be submitted
12	All The Camera, NVR, VMS, and Intrusion system should be from same OEM	Undertaking from OEM and Bidder

➤ **Fixed Dome Camera**

<b>Make:</b>			
<b>Model No:</b>			
<b>Sr No</b>	<b>Parameters</b>	<b>Minimum Specification</b>	<b>Bidders Compliance (Yes/No)</b>
1	Image Sensor	1 / 2.7” Progressive Scan CMOS	
2	Effective Pixels	2560 × 1440	
3	Min. Illumination	Color: 0.01 Lux @ F1.2, AGC ON; Color: 0.04 Lux @ F2.2, AGC ON; 0 lux with IR	
4	Shutter Speed	1 s to 1/100,000 s	
5	SN Ratio	≥52 dB	
6	Angle Adjustment	Pan : 0°-355°, Tilt : 0°-67°, Rotation : 0°-355°	
7	Focal Length	2.8 mm @ F2.0	
8	Iris Type	Fixed Iris	
9	Field of View 77.6°	2.8 mm @F2.0, horizontal field of view:110°,Vertical:	
10	Video Compression	H.265 / H.264	
11	H.264 Comp	Base Line / Main Profile / High Profile	
12	H.265 Comp	Main Profile @ Level 4.1 High Tier	
13	Resolution	4MP(2560×1440), 1080P(1920x1080), 720P(1280x720), D1, CIF, 480 x 240	
14	Max. Frame Rate	30fps @ 4MP (2560×1440)	

15	Video Bit Rate	64Kbps - 5 Mbps	
16	Multiple Streaming	Triple streams	
17	Main Stream	60Hz: 4MP/3MP/1080P(1-30fps); 50Hz: 4MP/3MP/1080P(1-30fps)	

18	Sub Stream	60Hz: 720P(1-15fps)/D1 /CIF (1-30fps); 50Hz: 720P(1-12fps)/D1/CIF (1-25fps)	
19	Third Stream	60Hz: D1/CIF/480x240 (1-30fps); 50Hz: D1/CIF/480x240 (1-25fps)	
20	Smart Codec	ROI, 3 zones	
21	Quality Control	Five levels under VBR; Freely adjustable under CBR	
22	Image Setting	time stamp, text overlay, flip & mirror, ROI, Saturation, Brightness, Chroma, Contrast, Wide Dynamic, Sharpen, white balance, video rotation, Scheduled profile settings, AGC	
23	Day & Night	IR cut filter with auto switch	
24	Wide Dynamic	Yes	
25	IR Distance	Up to 30M	
26	Digital Zoom	Yes	
27	Image Features	Defog, BLC, HLC, 2D/3D DNR	
28	Corridor Pattern	Yes	
29	Video Privacy	4 zones video mask	
30	Intelligent Video Analytics	Object removal (object left/missing detection), scene change and video blur detection, intrusion and line crossing	
31	Alarm Triggers	Motion detection, Intelligent video analytics, Network disconnect, video tampering, IP address conflict, illegal login, SD Card full, SD Card error, Alarm input, Alarm output	
32	Edge Storage	Built-in micro SD card slot, up to 128GB	
33	Network Protocol	TCP/IP, UDP, DHCP, NTP, RTSP, PPPoE, DDNS, SMTP, FTP, UPnP, Unicast, Multicast, ICMP, HTTP, HTTPS, DNS, DDNS, RTP, RTCP, IGMP, 802.1X, QoS,	
34	Cyber Security	HTTPS / IP Filter / IEEE 802.1X / Blacklist & whitelist / account security / telnet access control / serial	
35	Online Connection	Support simultaneous monitoring for up to 4 users; Support multi-stream real time	
36	API	ONVIF Profile (S & G)	
37	Network	1 RJ45 10M/100M self-adaptive Ethernet port	
38	Hardware Reset	Yes	
39	Operating Temperatur	- 30 °C to 60 °C	
40	Operatin g	10 % to 90 % relative humidity	
41	Ingress Protection	IP67	
42	Vandal Resistance	IK10	
43	Power Supply	DC12V / PoE	

44	Power Consumptio	< 6W	
45	Warranty	3 years	

46	Emissions	FCC Part 15.107 Class A, FCC Part 15.109 Class A , EN 55032, EN 55035 (IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-6, IEC	
47	Immunity	EN 55030-4	
48	Safety	UL 62368-1, IEC 62368-1 EN 62368-1, CAN/CSA C22.2 No.	
49	Environment	RoHS (IEC 62321-3-1, IEC 62321-5, IEC 62321-4, IEC 62321-6, IEC 62321-7, IEC 62321-7-2, IEC 62321-8), WEEE,	
50	NDAA Compliant	Yes	
51	BIS Certified	Yes	
52	Support	<ul style="list-style-type: none"> <li>• The OEM shall have a self-owned support Service Center and RMA in India from last 5 years and Toll Free number.</li> <li>• The OEM shall be registered in India for more than 10</li> </ul>	

➤ **Fixed Bullet Camera**

<b>Make:</b>			
<b>Model o:</b>			
<b>Sr N</b>	<b>Parameters</b>	<b>Minimum Specification</b>	<b>Compliance</b>
1	Image Sensor	1 / 2.7” Progressive Scan CMOS	
2	fective Pixels	2560 × 1440	
3	in. Illumination	Color: 0.01 Lux @ F1.2, AGC ON; Color: 0.04 Lux @ F2.2, AGC ON; 0 lux with	
4	utter Speed	1 s to 1/100,000 s	
5	S/N Ratio	≥52 dB	
6	Angle Adjustment	Any angle	
7	cal Length	3.6 @ F2.2	
8	s Type	Fixed Iris	
9	Field of View	3.6 mm@F2.2, horizontal field of view: 89°, Vertical: 58°	
10	ns Mount	M12	
11	deo Compression	H.265 / H.264	
12	H.264 Compression Standard	Base Line / Main Profile / High Profile	
13	H.265 Compression Standard	Main Profile @ Leve4.1 High Tier	



14	Resolution	4MP(2560×1440), 1080P(1920x1080), 720P(1280x720), D1, CIF, 480 x 240	
15	Max. Frame Rate	30fps @ 4MP (2560×1440)	
16	Video Bit Rate	64Kbps - 5 Mbps	
17	Multiple Streaming	Triple streams	
18	Main Stream	60Hz: 4MP/3MP/1080P(1- 30fps); 50Hz:	

19	Sub Stream	60Hz: 720P(1-15fps)/D1 /CIF (1-30fps); 50Hz: 720P(1-12fps)/D1/CIF (1-25fps)	
20	Third Stream	60Hz: D1/CIF/480x240 (1-30fps); 50Hz: D1/CIF/480x240 (1-25fps)	
21	Smart Codec	ROI, 3 zones	
22	Quality Control	Five levels under VBR; Freely adjustable under CBR	
23	Image Setting	time stamp, text overlay, flip & mirror, ROI, Saturation, Brightness, Chroma, Contrast, Wide Dynamic, Sharpen, white balance, video rotation, Scheduled profile settings,	
24	Day & Night	IR cut filter with auto switch	
25	Wide Dynamic Range	Yes	
26	IR Distance	Up to 50M	
27	Digital Zoom	Yes	
28	Image Features	Defog, BLC, HLC, 2D/3D DNR	
29	Corridor Pattern	Yes	
30	Video Privacy	4 zones video mask	
31	Intelligent Video Analytics	Object removal (object left/missing detection), scene change and video blur detection, intrusion and line crossing	
32	Alarm Triggers	Motion detection, Intelligent video analytics, Network disconnect, video tampering, IP address conflict, illegal login, SD Card full, SD Card error, Alarm input, Alarm output	
33	Edge Storage	Built-in micro SD card slot, up to 128GB	
34	Network Protocol	TCP/IP, UDP, DHCP, NTP, RTSP, PPPoE, DDNS, SMTP, FTP, UPnP, Unicast, Multicast, ICMP, HTTP, HTTPS, DNS, DDNS, RTP, RTCP,	
35	Cyber Security	HTTPS / IP Filter / IEEE 802.1X / Blacklist & whitelist / account security / telnet access control / serial password	
36	Online Connection	Support simultaneous monitoring for up to 4 users; Support multi-stream real time	
37	Remote Monitoring	Webviewer browsing	
38	API	ONVIF Profile (S & G)	
39	Network	1 RJ45 10M/100M self-adaptive Ethernet port	
40	Onboard Storage	Built-in micro SD/SDHC/SDXC slot	
41	Hardware Reset	Yes	
42	Operating Temperature	- 30 °C to 60 °C	
43	Operating Humidity	10 % to 90 % relative humidity	
44	Ingress Protection	IP67	
45	Vandal Resistance	IK10	
46	Power Supply	DC12V / PoE	
47	Power Consumption	< 10W	

48	Emissions	FCC Part 15.107 Class A, FCC Part 15.109 Class A , EN 55032, EN 55035 (IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC	
49	Immunity	EN 55030-4	

50	Safety	UL 62368-1, IEC 62368-1 EN 62368-1, CAN/CSA C22.2 No. 62368-1-14, J62368-1, AS/NZS 62368.1	
51	Environment	RoHS (IEC 62321-3-1, IEC 62321-5, IEC 62321-4, IEC 62321-6, IEC 62321-7, IEC 62321-7-2,	
52	NDA Compliant	Yes	
51	BIS Certified	Yes	
52	Support	<ul style="list-style-type: none"> <li>The OEM shall have a self-owned support Service Center and RMA in India from last 5 years and Toll Free number.</li> <li>The OEM shall be registered in India for more than 10 Years and present globally for more than 20 years.</li> </ul>	

➤ **PTZ Camera**

<b>Make</b>			
<b>Model</b>			
<b>#</b>	<b>Parameters</b>	<b>Minimum Specification</b>	<b>Bidders Compliance (Yes/No)</b>
1	Image Sensor	1/2.8" progressive scan CMOS	
2	Min. Illumination	Color: 0.005 Lux @ (F1.6, AGC ON) B/W: 0.001 Lux @ (F1.6, AGC ON) 0 Lux with IR	
3	Shutter Speed	1/1s to 1/30000s	
4	Slow Shutter	Supported	
5	Day & Night	IR cut filter	
6	Zoom	32x optical, 16x digital	
7	Focal Length	4.8 mm to 153 mm	
8	Zoom Speed	approx. 4.8 s	
9	Field of View	Horizontal field of view: 50.8° to 2.6° (wide-tele), Vertical field of view: 29.4° to 1.5°	
10	Aperture	Max. F1.6	
11	Focus	Auto, semi-auto, manual	
12	IR Distance	Up to 200 m	
13	Movement Range (Pan)	360°	
14	Movement Range (Tilt)	-15° to 90° (auto flip)	
15	Pan Speed	Configurable, from 0.1°/s to 160°/s	
16		Preset speed: 240°/s	
17	Tilt Speed	Configurable, from 0.1°/s to 120°/s	
18		Preset speed: 200°/s	
19	Proportional Pan	Support	
20	Presets	300	

21	Patrol Scan	8 patrols, up to 32 presets for each patrol	
22	Pattern Scan	4 pattern scans	
23	Power-off Memory	Support	
24	Park Action	Preset, pattern scan, auto scan, tilt scan, random scan, frame scan, panorama scan	

25	3D Positioning	Support	
26	PTZ Status Display	Support	
27	Preset Freezing	Support	
28	Scheduled Task	Preset, pattern scan, patrol scan, auto scan, tilt scan, random scan, frame scan, panorama scan, dome reboot, dome adjust, aux output	
29	Main-Stream	25/30 fps (1920 × 1080, 1280 × 960, 1280 ×	
30	Sub-Stream	25/30 fps (704 × 576, 640 × 480, 352 × 288);	
31	Third Stream	25/30 fps (1920 × 1080, 1280 × 960, 1280 × 720,	
32	Video Compression	Main stream: H.265+/H.265/H.264+/H.264 Sub-stream: H.265/H.264/MJPEG	
33	Video Bit Rate	32 kbps to 16384 kbps	
34	H.265 Type	main profile	
35	H.264 Type	baseline profile/main profile/high profile	
36	SVC	H.264 and H.265 encoding	
37	Region of Interest (ROI)	8 fixed regions for each stream	
38	Audio Compression	G.711alaw, G.711ulaw, G.722.1, G.726, MP2L2, AAC, PCM	
39	Audio Bit Rate	64 Kbps (G.711)/16 Kbps (G.722.1)/16 Kbps (G.726)/32-192 Kbps (MP2L2)/16-64 Kbps	
40	Audio Sampling Rate	8 kHz/16 kHz/32 kHz/48 kHz	
41	Environment Noise Filtering	Yes	
42	Face Capture	Support	
43	Basic Event	Motion detection, video tampering alarm, exception, alarm input and	
44	Smart Event	Line crossing detection, intrusion detection, region entrance detection, region exiting detection, unattended baggage detection, object removal detection, audio exception	
45	Smart Tracking	manual tracking, auto-tracking	
46	Perimeter Protection	Line crossing, intrusion, region entrance, region exiting Support alarm triggering by specified target types (human and vehicle)	
47	Alarm Linkage	Upload to FTP/NAS/memory card, notify surveillance center, send email, trigger alarm output, trigger recording, audible warning, white light flashing, and PTZ actions	
48	Day/Night Switch	Day, Night, Auto, Schedule	
49	Image	BLC, HLC, 3D DNR	
50	Wide Dynamic	120 dB	

51	Defog	Digital defog	
52	Image Stabilization	EIS	
53	Regional Exposure	Support	
54	Regional Focus	Support	

55	Image Settings	Saturation, brightness, contrast, sharpness, gain, and white balance adjustable by client software or web browser	
56	Privacy Mask	24 programmable polygon privacy masks, mask color or mosaic configurable	
57	SNR	> 52 dB	
58	Network Storage	NAS (NFS, SMB/ CIFS)	
59	Protocols	IPv4/IPv6, HTTP, HTTPS, 802.1x, QoS, FTP, SMTP, UPnP, SNMP, DNS, DDNS, NTP, RTSP, RTCP, RTP, TCP/IP, UDP, IGMP, ICMP, DHCP	
60	ONVIF	Profile S, Profile G & Profile T	
61	Simultaneous Live View	Up to 20 channels	
62	User/Host	Up to 32 users, 3 user levels: administrator, operator, and user	
63	Cyber Security	Password protection, complicated password, HTTPS encryption, 802.1X authentication (EAP-TLS, EAP-LEAP, EAP-MD5), watermark, IP address filter, basic and digest authentication for HTTP/HTTPS, RTP/RTSP over HTTPS, control timeout settings, security audit log,	
64	Web Browser	Web Browser IE11, Chrome 57+, Firefox 52+, Safari 11+	
65	Communication Interface	1 RJ45 10M/100M self-adaptive Ethernet port	
66	On-board Storage	Built-in memory card slot, support microSD/SDHC/SDXC card, up to 256	
67	Alarm	2 inputs, 1 output	
68	Audio	1 input (line in), max. input amplitude: 2-2.4 vpp, input impedance: 1 k $\Omega$ $\pm$ 10%; 1 output (line out), line level, output impedance: 600 $\Omega$	
69	Power	24 VAC, Hi-PoE to 24 VAC, max. 42 W (including max. 18 W for IR and max. 10 W for heater).	
70	Operating Condition	-30 °C to 65 °C (-22 °F to 149 °F). Humidity 90%	
71	Demist	Yes	
72	Material	ADC12	
73	Dimension	Ø 220 mm $\times$ 363.3 mm (Ø 8.66" $\times$ 13.91")	
74	Weight	Approx. 5 kg (11.03 lb.)	
75	Protection	IP66 (IEC 60529-2013), IK10 (excluding glass window), TVS 6000V lightning protection, surge protection and voltage	



76	EMC	FCC SDoC (47 CFR Part 15, Subpart B); CE-EMC (EN 55032: 2015, EN 61000-3-2: 2019, EN	
77	Safety	UL (UL 62368-1); BIS (IS 13252(Part	
78	Environment	CE-RoHS (2011/65/EU); WEEE (2012/19/EU); Reach (Regulation (EC) No 1907/2006)	

79	Support	<ul style="list-style-type: none"> <li>• The OEM shall have a self-owned support Service Center and RMA in India from last 5 years and Toll Free number.</li> <li>• The OEM shall be registered in India for more than 10 Years and present globally for more than 20 years.</li> </ul>	
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➤ **64-Channel Network Video Recorder**

Sr .	Parameter	Description	Compliance
1	IP video input	Up to 12 MP resolution	
2	Two-way audio	1-ch, RCA (2.0 Vp-p, 1 k Ω)	
3	Incoming bandwidth	321 Mbps or 200 Mbps (when RAID is enabled)	
4	Outgoing bandwidth	257 Mbps, or 200 Mbps (when RAID is enabled)	
5	Remote connection	128	
6	Recording resolution	12MP/8MP/6MP/5MP/4MP/3MP/1080p/UXGA	
7	CVBS output (Optional)	1-ch, BNC (1.0 Vp-p, 75 Ω), resolution: PAL: 704	
8	HDMI1:	HDMI1: 4K (3840 × 2160)/60Hz, 4K (3840 × 2160)/30Hz, 2K (2560 × 1440)/60Hz, 1920 × 1080p/60Hz, 1600 × 1200/60Hz, 1280 × 1080p/60Hz	
9	VGA1 /HDMI1 output resolution	VGA1: 2K (2560 × 1440)/60Hz, 1920 × 1080p/60Hz, 1600 × 1200/60Hz, 1280 × 1080p/60Hz	
10	VGA2 /HDMI2 output resolution	1921 × 1080p/60Hz, 1280 × 1024/60Hz, 1280 × 1024/60Hz	
11	Audio output	2-ch, RCA (2.0Vp-p, 1 KΩ)	
12	Decoding format	H.265+/H.265/H.264/H.264+/MPEG5	
13	Live view/Playback resolution	12MP/8MP/6MP/5MP/4MP/3MP/1080p/UXGA /720p/VGA/4CIF/D4CIF/2CIF/CIF/DCIF	
14	Synchronous playback	16-ch	
15	Capability	2-ch @ 12 MP (20fps) / 4-ch @ 8 MP (25fps) / 8-ch @ 4MP (30fps)/ 16-ch @ 4MP (30fps)	
16	Network protocols	TCP/IP, DHCP, DNS, DDNS, NTP, SADP, SMTP, NFS, iSCSI, UPnP™,	
17	SATA	9 SATA interfaces for 8HDDs	
18	eSATA	2 eSATA interface	
19	Capacity	Up to 10TB capacity for each HDD	

20	Disk Array type	RAID0, RAID1, RAID5, RAID6, RAID11	
21	Number of arrays	5	
22	Serial interface	RS-232; RS-485; Keyboard	
23	USB interface	Front panel: 2 × USB 2.0; Rear panel: 1 × USB	
24	Alarm in/out	16 In/4 Out	

25	Power supply	101 to 240 VAC, 50 to 60 Hz	
26	Max. Power	201 W	
27	Consumption (without HDD)	≤ 30 W	
28	Working temperature	-10 °C to 55 °C (14 °F to 131 °F)	
29	Working humidity	11 to 90 %	
30	Dimensions(W × D × H)	446 × 470 × 90 mm (17.5" × 18.5" × 3.5")	
31	Weight (without HDD)	≤ 8 kg (17.6 lb)	
32	Certification	CE, FCC	

➤ **Hard Disk Drive**

SR. No	Parameter	Description	Compliance
1	internal	Device Type: Hard drive	
2	10 TB	Formatted capacity <sup>5</sup>	
3	3.5-inch	Form factor	
4	YES	Advanced Format (AF)	
5	YES	RoHS compliant <sup>6</sup>	
6	Up to 64	Cameras supported	
7	16+	Drive Bays Supported	
8	32	AI Streams	
9	All Frame AI	Firmware Feature Name	
10	YES	Tarnish resistant components:	
11	6 Gb/s	Performance Interface transfer rate (max) <sup>5</sup>	
12	256	Cache (MB) <sup>5</sup>	
13	7200 RPM	Performance Class	
14	300,000	Load/unload cycles <sup>7</sup>	
15	360TB/yr	Annualized workload rating <sup>8</sup>	
16	>1 in 10	Non-recoverable read errors per bits read	
17	1,500,000	MTBF	
18	6.6 5.6 0.6	Average power requirements (W) Read/Write Idle Standby and Sleep Idle	
19	0 to 65 -40 to 70	Temperature (°C, on the base casting) Operating Non-operating	

➤ 55” Inch TV

Sr. No.	Parameters	Description	Compliance
1	<b>Panel</b>		
2	Screen Size	55"	
3	Backlight Type	Slim DLED	
4	Brightness (typical)	500 cd/m <sup>2</sup>	
5	Native Resolution	3840 x 2160 (16:9) - UHD	
6	Contrast Ratio	1200:1(typ.)	
7	Dynamic Contrast Ratio	50000:1	
8	Panel Life Time ( Min. )	50000 Hrs	
9	Response Time	8ms	
10	Active Area (H x V)	1209.6 × 680.4	
11	Viewing Angle	178° Vert., 178° Hor. (89U/89D/89L/89R) @ CR>10	
12	Color Value	1.07 G (8 bit + FRC)	
13	Screen Treatment	3H	
14	Haze Level	1%	
15	Refresh Rate	60Hz	
16	Orientation	Landscape / Portrait	
17	Operation Hours	24 / 7	
18	Area of Usage	Indoor	
19	<b>Built-in System</b>		
20	Mainboard Model	17MB135VS	
21	<b>Monitor Connectivity</b>		
22	RGB Input	VGA(DE-15F)	
23	RGB Output	N/A	
24	Video Input	4xHDMI2.0, 2xUSB2.0, USB2.0(Internal)	
25	Video Output	HDMI2.0	
26	Audio Input	Line In L/R	
27	Audio Output	Headphone, Optic SPDIF	
28	External Control	RS232(DE-9F), Ethernet(RJ45), Service(RJ12)	
29	External Sensor	RJ12	
30	<b>Mechanical</b>		
31	Product Dimensions	"1236 x 83 x 709 mm with OPS/SDM 1236 x 63 x 709 mm without OPS/SDM"	
32	Package Dimensions	1369 x 165 x 874	
33	Product Weight	17 kg	
34	Package Weight	22 kg	
35	Vesa Mounting	400 mm(W) x 400 mm(H) M6	
36	Bezel Width	9/9/9/11 mm	
37	<b>Environmental Conditions</b>		
38	Operating	0-40°C	

	Temperature		
39	Operating Humidity	10-90%	
40	<b>Power</b>		
41	Power Supply	110 VAC - 240 VAC - 50/60 Hz	
42	<b>Power Consumption</b>		
43	Typical	138 W	
44	Maximum	180 W	
45	Deep Standby	≤0.5 W	
46	<b>Features</b>		
47	Main Features	Open Content Management Support, Scheduler, USB-Autoplay, Auto-Launch, HDMI-CEC, HDMI-Wakeup, Auto-switch on Failover, Panel Lock, OSD Rotation, NoSignalPowerOff, Screen Saver, Pixel shift, Scheduler, Videowall support, Remote	
48	Mechanical Features	Joystick, Rocker Switch, Detachable Power Cable, Detachable Logo, Internal Usb Cover, 30-degrees Tilting Installation, Overlay Touch Kit Compatibility	
49	Optional Features	SDM or OPS compatibility, Embedded IR, IR extender option	
50	Speaker	2x10 W	
51	<b>Accessory</b>		
52	Standard	QSG, IB, Power cord, Remote control unit, RC battery, Mounting kit, IR extender	
53	<b>Certification</b>		
54	Safety	Yes	
55	EMC	Yes	
56	CE	Yes	

➤ **HDMI Cable**

Sr. No.	Description	Compliance
1	HDMI 1.4v / 3D 1080P	
2	60 HZ	
3	24K GOLD CONNECTORS	
4	10.2 GBPS BARE COPPER CABLE LOCKING HDMI	

➤ **Outdoor Access Point P2P**

Sr. No.	Parameters	Description	Compliance
1	General	There are 4 * 10/100Mbps RJ45 ports, WAN port support 24V/48V PoE input; LAN1 port support IEEE 802.3af/at PoE output	
		IP65 water-proof and surge protection	
		LED display to show host/ client mode/ signal strength/ IP address.	
2	Flash	8MB	
3	DDR 2	64MB	
4	Frequency	5.150GHz~5.850GHz	
5	Built-in	Directional flat plate antenna, Gain: 13dBi	
6	top speed	900Mbps	
7	Wireless Functions	Multiple SSID up to 4	
		Support SSID hidden	
		Wireless Security: Open, WPA, WPA2PSK TKIPAES. WAP2 EAP.	
		Support MAC filter	
		Support RF power adjustable, adjust the RF power based on environment	
8	Device Management	Back-up the configuration	
		Restore the configuration	
		Reset to factory default	
		Reboot the device: including time reboot or reboot	
		Admin management password modify	
		Firmware upgrade	
		System log	
		Support firmware GUI web management, AC controller management.	
		remote management and cloud management	

➤ **Workstation**

Sr. No.	General Specifications of Workstation	Compliance
<b>1</b>		
<b>1.1</b>	<b>Processor</b>	
1.1.1	Intel i7 12th Gen Eight Core 2.5GHz, 16MB cache or Higher	
<b>1.2</b>	<b>Chipset</b>	
1.2.1	Intel W680 or Higher	
<b>1.3</b>	<b>Operating System</b>	
1.3.1	Windows 11 Pro (64bit)	
<b>1.4</b>	<b>Memory</b>	
1.4.1	Min. 16GB (2x8GB) DDR4 with transfer rates up to 2133 MT/s	
<b>1.5</b>	<b>HDD/SSD Drive</b>	
1.5.1	512GB NVME SSD	

1.5.2	1TB HDD	
<b>1.6</b>	<b>DVD Drive</b>	
1.6.1	DVD RW (Optional)	
<b>1.7</b>	<b>Graphics Card</b>	
1.7.1	Integrated Intel HD Graphics	
1.7.2	NVIDIA Quadro T400 4GB GDDR6 64-bit	
<b>1.8</b>	<b>Display</b>	
1.8.1	Diagonal Size: 27" IPS Display Resolution/Refresh Rate: Full HD(1080p) 1920 x 1080 at 60Hz DisplayPort (DisplayPort 1.2 mode, HDCP 1.4) VGA HDMI (HDCP 1.4) USB 3.2 Gen 1 unstream 4 x USB 3.2 Gen 1	
<b>1.9</b>	<b>Mouse</b>	
1.9.1	USB Wired Optical Mouse	
<b>1.10</b>	<b>Speakers</b>	
1.10.1	Internal speakers (Optional)	
<b>1.10</b>	<b>Keyboard</b>	
1.11.1	Standard USB Keyboard	
<b>1.12</b>	<b>Ports Front</b>	
1.12.1	Front: USB 3.2 Type-A Gen 1 (5GB) port USB 3.2 Type-A Gen 1 (5GB) port with PowerShare USB 3.2 Type-C Gen 2 (10GB) port USB 3.2 Type-C Gen 2x2 (20GB) port with PowerShare Universal audio	
<b>1.13</b>	<b>Ports Rear</b>	
1.13.1	Rear: (2) DisplayPort 1.4 ports (2) USB 2.0 (480MB) ports with SmartPower (2) USB 3.2 Gen 2 (10GB) ports (2) USB 3.2 Type-C Gen 2 (10GB) ports RJ45 Ethernet port, 1GbE Audio Line out Optional Port (VGA, HDMI 2.0, DP++ 1.4, Type-C w/DP-Alt mode)	
<b>1.14</b>	<b>LAN</b>	
1.14.1	10/100/1000 NIC	
<b>1.15</b>	<b>Form Factor</b>	
1.15.1	Micro Tower	
<b>1.16</b>	<b>Power Supply</b>	
1.16.1	Suitable for Indian power conditions with efficiency up to 92% with active power factor correction	
<b>1.17</b>	<b>Accessories</b>	
1.17.1	All required connectors and cables.	
<b>1.18</b>	<b>Additional</b>	



1.18.1	ENERGY STAR Compliant	
<b>1.19</b>	<b>Warranty</b>	
1.19.1	3 Year	

❖ **Network System**

➤ **42U Rack**

Sr. No.	Parameters	Description	Compliance
1	<b>General Requirements</b>	Rack should have 100% assured compatibility with all equipment's conforming to DIN 41494 or Equivalent EIA /ISO / EN Standard	
		The Racks should be 357mm-2068mm in height with 800 width for Server and Network application. And 1000mm in	
2	<b>Height</b>	42U	
3	<b>Width</b>	800	
4	<b>Depth</b>	1000	
5	<b>Physical Specification</b>	support a static load of at least 350Kgs and by plinth/Levelers should support a static load of at least 750Kgs	
6	<b>Door Type</b>	Front Flat Perforated Door	
		Dual Perforated Door at Rear	
		2 no's of removable side panels with slam latch for fast access to cabling and	
7	<b>Equipment Access &amp; Installation</b>	4 no's adjustable, 19" verticals with punched 9mm square hole and Universal 12.7mm-15.875mm-15.875mm alternating hole pattern offers greater mounting flexibility, with Numbered U	
8	<b>Material Requirements</b>	Made from steel with a thickness not less than 1.6mm and other parts not less than 1	
		Pre Treated and powder coated meeting ASTM Standard	
9	<b>Grounding Requirements</b>	Frame and door should be bonded together and to rack ground point	
		Provision to further ground to Telecom Ground bus bar System	
		UL Standards	
10	<b>Certifications, Environmental and Safety Requirements</b>	ISO9001:2015, ISO14001:2004 & OHSAS18001:2007 Certified company and should have proper EHS Policy.	
		DIN41494 and Equivalent EIA/ISO/EN /CEA Standard.	
		IP 20 rating	
		UL Certified	
11	<b>Ventilation and Thermal Management</b>	Fix Exhaust Fans / Fan Module on the top	
		Front and rear doors to provide adequate airflow required	

12	<b>Rack Power Distribution</b>	1Ph, 230V, 32A, 50/60Hz, Zero U standard with 12 X Indian Round Pin 5/15A, 16A MCB X 2 Circuits- PDU	
13	<b>Warranty and Support</b>	1 year	

➤ **15 Indoor Rack**

Sr. No.	Parameters	Description	Compliance
1	<b>General Requirements</b>	Racks should be manufactured out of steel sheet punched, formed, welded and powder coated	
		Rack should have 100% assured compatibility with all equipment's conforming to DIN 41494 (General Industrial Standard for equipment's) or Equivalent EIA /ISO / EN	
2	<b>Height</b>	15U	
3	<b>Width</b>	550	
4	<b>Depth</b>	600	
5	<b>Physical Specifications</b>	Standard for Rack configuration should be welded frame integrated with side panel and vented top cover	
7	<b>Equipment Access &amp; Installation</b>	The front door should open to allow easy access. Rack should have 1 Packet of mounting hardware, Pack of 20.	
8	<b>Material Requirements</b>	Made from steel with a thickness not less than 1.6mm and other parts not less than 1mm	
		Pre Treated and powder coated meeting ASTM Standard	
9	<b>Grounding Requirements</b>	All enclosure components i.e. frame and door should be bonded together and to rack ground point OEM to provide rack ground point, Provision to further ground to Telecom Ground bus	
		Grounding and bonding as per UL Standards Manufacture should provide Horizontal OR vertical Ground bus bar for equipment Grounding as per Customer /Tender Requirement	
10	<b>Certifications, Environmental and Safety Requirements</b>	Racks should be manufactured by ISO9001:2015, ISO14001:2004 & OHSAS18001:2007 Certified company and should have proper EHS Policy Products must be UL Certified	
		Manufacturer must certify that the products are Comply DIN41494 and Equivalent EIA/ISO/EN/CEA	

		IP 20 rating	
		The enclosure should both protect the user from mechanical hazards and generally meet the requirements for a	

		enclosure (stability, mechanical strength, aperture sizes, etc.) as defined in IEC 60950 Third Edition.	
11	<b>Ventilation and Thermal Management</b>	Fix Exhaust Fans / Fan Module on the	
		The unit should have sufficient ventilation to provide adequate airflow required by the major Network manufacturers	
12	<b>Rack Power Distribution Units</b>	Rack should have 1 no. Power Distribution Units with 6No 5A Indian Round Pin with PDU Rating 1.8KVA	
13	<b>Warranty and Support</b>	1 year	

➤ **9U Indoor Rack**

<b>Sr. No.</b>	<b>Description</b>	<b>Compliance Yes/No</b>
1	Rack should have 100% assured compatibility with all equipment's conforming to DIN 41494 (General Industrial Standard for equipment's) or Equivalent EIA	
2	The OEM must adhere to Quality Management system through ISO9001:2015 and Manufacturing facility has to be certified for the	
3	The OEM must adhere to Environmental and Occupational Health Management system through ISO14001:2004 & OHSAS18001:2007 and Manufacturing facility has to be certified for the same	
4	The OEM must adhere to Information Security Management system through ISO27000:2013 and Manufacturing facility has to be certified	
5	Standard for Rack configuration should be welded frame and integrated with side panel	
6	The Racks should be 9U in Usable height, 600mm in Overall width and 600 in Overall depth for Network application	
7	Rack should have Front Plain Metal Door with lock and key	
8	Galvanized Steel sheet with powered coated by Duel coat with primer & pure polyester Power	
9	Rack should have provision to mount racks on Wall or Pole	
10	Rack should have Adjustable mounting depth,	
11	Rack should have 2 No Adjustable, 19" verticals with Punched 9mm Square Hole and Universal 12.7mm-15.875mm-15.875mm alternating hole pattern offering greater mounting flexibility and maximizes usable	
12	Rack should have Numbered U positions,	

13	The rack should comply minimum of IP 56 rating for protection against touch, ingress of foreign bodies and ingress of water.	
14	Rack should have one Hoz. Cable Manager.	
15	Rack should have one Cantilever shelf.	

16	Rack should have Fan module Mount Provision on Bottom Cover with minimum 2 no. 90 CFM Fans and Filter Unit with Double Louvered Cover and same is mounted in Bottom of the rack	
17	Rack should have one Server /IT Rack mount power distribution unit, 1Ph, 230V, 8A, 50/60Hz, 2U standard with 6 X Indian Round Pin 5A, Inlet Plug type 6A Indian Round Pin, 8A Fuse - PDU Rating 1.8KVA/Side	
18	Rack should have provision for cable entry Exit from only Bottom	
19	Rack Should have 2 Numbers of PG Gland i.e. PG21	
20	Rack should have 1 Packet of mounting hardware, Pack of 20.	
	<b>Certifications, Environmental and Safety Requirements</b>	
21	Racks should be manufactured by ISO9001:2015, ISO14001:2004 & OHSAS18001:2007 Certified company and should	
22	Products must be UL Certified	
23	Manufacturer must certify that the products are RoHS Compliance	
24	Manufacturer must certify that the products are Comply DIN41494 and Equivalent EIA/ISO/EN/CEA Standard.	
25	The rack should comply minimum of IP 20 rating for protection against touch, ingress of foreign bodies and ingress of water.	
26	The enclosure should both protect the user from mechanical hazards and generally meet the requirements for a mechanical enclosure (stability, mechanical strength, aperture sizes, etc.) as defined in IEC 60950 Third	

➤ **9U Outdoor Rack**

Sr. No.	Parameters	Description	Compliance
1	General Requirements	Rack should be designed to provide Secure, Store, Streamline and Systemize IT Equipment	
		Rack should have 100% assured compatibility with all equipment's conforming to DIN 41494 or Equivalent EIA /ISO / EN Standard	
		The Racks should be 347mm in height with 600mm width and 500mm Depth for Network application	
2	Height	9U	
3	Width	600	
4	Depth	600	
		The Rack unit supported by casters should support a static load of at least 30Kgs	
		Rack should be associated with front metal door with Knob lock & key and should have provision to mount on Wall/Pole	



5	Physical Specifications	Rack should have PU Gasket associated with the door	
		Rack should be fully welded frame with integrated side panel	

6	Equipment Access & Installation	2No's adjustable, 19" verticals with punched 10mm square hole and Universal 12.7mm-15.875mm-15.875mm alternating hole pattern offers greater mounting	
7	Material Requirements	made from CRCA with a thickness not less than 1.5 mm, 19" equipment mounting angle should be 1.5MM and other parts not less	
		Pre Treated and powder coated meeting ASTM Standard and Out Door / IP56	
8	Grounding Requirement	Frame and door should be bonded together and to rack ground point	
9	Certifications, Environmental and Safety Requirements	Manufactured by ISO9001:2008, ISO14001:2004 & OHSAS18001:2007 Certified company	
		Manufacturer must certify that the products are RoHS Compliance	
		DIN41494 and Equivalent EIA/ISO/EN /CEA Standard.	
		IP 56rating for protection against touch, ingress offoreign bodies and ingress of	
10	Ventilation and Thermal	Fix Exhaust Fans on the bottom panel with Louvers	
11	Rack Power Distribution Units	1Ph, 230V, 16A, 50/60Hz, 2U standard with 6 X Indian Round Pin 5/15A, Inlet Plug type 16A Indian Round Pin, 16A MCB - PDU Rating 3.6KVA/Side feed-1.5Mt/ Black	
12	Cable Management	Rack should have 1U Horizontal Cable Manager Loop for cable routing	
13	Warranty and Support	1 year	

❖ **Passive Components**

➤ **Fiber Cable**

S. No	Parameter	Description	Compliance
<b>1</b>	<b>USE</b>		
		Lan backbones	
		Outdoor direct burial	
		Tunnels	
		Conduits	
<b>2</b>	<b>GENERAL</b>	<p>This specification covers an optical cable with 2 - 24 optical fibres of UNI tube construction. The cable is armoured thus making it suitable for installation outdoors in harsh environments. The armouring does also make This enhanced Singlemode fibre provides improved performance across the entire 1 260 nm to 1 625 nm wavelength spectrum due to its low attenuation in 1 282 nm the waterpeak region</p> <p>The fibre design is matched</p>	
<b>3</b>	<b>Standards</b>		
		ISO 11801 2nd edition	
		EN 50173-1:2002	
		IEC 60794-1	
<b>4</b>	<b>Construction</b>		
	Loose tube	4, 6, 12 & 24 Fibres. Ø3.0 mm jelly filled loose tube	
	Strength member	Steel Wire to provide tensile strength and anitbuckling	
		Water Swellable Tape Below Armour	
	Armouring	0.15 mm corrugated steel tape	
		RIP Cord	
	Sheath	Black Polythelene	
<b>5</b>	<b>Physical properties - IEC 60794-1</b>		
	Nominal outer diameter -	9.0 +/-0.5 mm	
	Nominal weight -	86 +/-10% kg/km	
	Tensile strength (dynamic) E1	1500N	
	Tensile strength (permanent) E1	1000N	
	Compressive strength (crush) E3	2000N	
	Impact E4	25Nm (no broken cable elements)	
	Torsion E7	5 cycles ± 1 turn	
	Kink E10	The cables do not form a kink when a loop is drawn	

	Min. Bending radius, unloaded E11	10 D	
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Min. Bending radius, loaded -	20 D	
Temperature range F1	Storage and installation: - 30°C to + 70°C	
	Operation: - 30°C to + 70°C.	
Water Penetration F5B	No Water on Free End	
<b>6 Standards and Norms</b>		
	IEC 60793-2-50 class B1.3	
	EN 60793-2-50: class B1.3	
	ITU Recommendation G.652.D - the other ITU designations A, B and C are also fulfilled	
	EN 50 173-1:2007, cat. OS2; also OS1 requirements are fulfilled	
	ISO/IEC 11801:2002 cat. OS1.	
	ISO/IEC 24702:2006, cat. OS2; also	
	IEEE 802.3 - 2002 incl. 802.3ae	
<b>7 Attenuation (of cable with fibres) - IEC 60793-1-40</b>		
1310 nm – 1625 nm	$\leq 0.39$ dB/km	
1550 nm	$\leq 0.25$ dB/km	
Inhomogeneity of refractive index for any two 1000 OTDR test meter fibre	Max. 0.1 dB/km	
<b>8 Bandwidth - IEC 60793-1-41</b>		
Group index of refraction at 1310 nm	1.467	
Group index of refraction at 1550 nm	1.468	
Group index of refraction at 1625 nm	1.468	
<b>9 Fibre properties according to IEC - IEC 60793-1</b>		
Cladding diameter IEC/EN 60793-1-20	$125 \pm 0.7$ $\mu$ m	
Cladding non-circularity IEC/EN 60793-1-20	$\leq 0.7$ %	
Core (MFD) non-circularity IEC/EN 60793-1-20	$\leq 6$ %	
Core (MFD) - cladding concentricity error IEC/EN 60793-1-20	$\leq 0.5$ $\mu$ m	
Primary coating diameter - uncoloured IEC/EN 60793-1-21	$242 \pm 7$ $\mu$ m	
Primary coating diameter - coloured IEC/EN 60793-1-21	$250 \pm 15$ $\mu$ m	
Primary coating non-circularity IEC/EN 60793-1-21	$\leq 5$ %	
Primary coating-cladding concentricity error IEC/EN 60793-1-21	$\leq 12$ $\mu$ m	
Proof stress level IEC/EN 60793-1-30	$\geq 0.7$ ( $\approx 1\%$ ) GPa	
Strip force (peak) IEC/EN 60793-1-32	$1.0 \leq F_{\text{peak.strip}} \leq 8.9$ N	
Chromatic dispersion coefficient: IEC/EN 60793-1-42		
In the interval 1285 nm – 1330 nm	$\leq 3$ ps/km • nm	
At 1550 nm	$\leq 18$ ps/km • nm	
At 1625 nm	$\leq 22$ ps/km • nm	
Zero dispersion wavelength, $\lambda_0$	$1311 \pm 11$ nm	

	Zero dispersion slope	$\leq 0.090 \text{ ps}/(\text{nm}^2 \cdot \text{km})$	
	Cut-off wavelength IEC/EN 60793-1-44 $\lambda_c$	1034 - 1330 nm	
	$\lambda_{cc}$ nm	$\leq 1260$	
	Mode field diameter at 1310 nm IEC/EN 60793-1-	$9 \pm 0.4 \mu\text{m}$	
	Mode field diameter at 1550 nm	$10.1 \pm 0.5 \mu\text{m}$	
	Macrobending loss at 1550 nm, 100 turns on a $\varnothing 60$ mm mandrel IEC/EN 60793-1-47	$\leq 0.05 \text{ dB}$	
	Polarisation mode dispersion (PMD) coefficient, cabled IEC/EN 60793-1-48	$\leq 0.5 \text{ ps}/\sqrt{\text{km}}$	
	PMDQ Link Design Value IEC/EN 60794-3	$\leq 0.2 \text{ ps}/\sqrt{\text{km}}$	

➤ **Fiber LIU**

S. No.	Parameter	Description	Compliance
<b>1</b>	<b>USE</b>	Metal 19" pre-equipped fibre optic drawers, 4 cable entries, supplied with screw fixing kit, 2 cable glands ( $\varnothing 13.5$ and $16 \text{ mm}$ ), coiling system and splicing	
		Panel and optical ports marked on dedicated marking area.	
		Sliding: end stop at a $30^\circ$ angle for easier wiring.	
		Rotating: supplied with left-to-right opening, reversible.	
<b>2</b>	<b>RANGE</b>	12 LC Single-mode Duplex	
<b>3</b>	<b>DRAWER CHARACTERISTICS</b>		
	<b>Sliding:</b>	Depth: 220 mm, height 1 U	
		Maximum capacity:	
		48 LC connectors	
		24 SC connectors	
		24 ST connectors	
<b>4</b>	<b>Supplied with screws and wiring accessories:</b>	For fixing in the 19" rack: 4 screws and nuts/4 screws	
		For the fibre optic cable: 2 cable glands (1 x PG16/1 x	
		2 accessories for coiling the fibres	
		1 drawer holder for fixing on the rack	
		1 splice holder, fitted but repositionable	
		Modular Rack Mount Fibre Patchpanel, should be of Dimensions: 19" (Width) x 1U (Height) x 238.6mm	

5	TECHNICAL CHARACTERISTICS		
	Connector characteristics	LC connector: Rectangular shape	
		Tab locking	
		Dimension: Half the size of a conventional SC	

		Single-mode SC/APC connector:	
		Rectangular shape	
		Endurance (500 insertions): maximum	
		Suitable for a large number of active devices	
		Should meet EN50173 and ISO/IEC 11801 operating	
		Protection class: IP 20	
		Impact resistance: IK 40	
6	Climate characteristics	Storage and operating temperature:	

➤ **Fiber Patch Cord**

S. No	Parameter	Description	Compliance
1	<b>DESCRIPTION</b>		
		Legrand optic fibre patchcords are suitable for low loss telecom, datacom, data centre and some critical applications	
		The patchcords provide flexible interconnection to active equipment, passive optical devices and cross-connects	
		The patchcords are terminated with ultra physical contact and angled physical contact (singlemode), zirconia ferrule connectors which are manufactured with precision factory mounting and polishing	
	OS1 (UPC) Monomode optical cords	(9/125 µm)	
	Maximum optical losses :	0.3 dB	
		Yellow sheaths	
2	<b>FEATURES / BENEFITS</b>		
		Conform to IEC, EIA-TIA, and Telecordia performance	
		Available in different fibre types	
		Available with different	
		Available in standard and custom lengths	



		RoHS, REACH & SvHC compliant	
3	<b>APPLICATIONS</b>		
		Data centre	
		CATV	

		FTTX	
		Telecommunication networks	
		LAN and WAN	
		Broadband network	
4	<b>OPTICAL PERFORMANCE</b>	Singlemode	
	IL MAX/Master (Acceptance) IEC 61300-3-4	0.15 dB	
	MAX IL/Random IEC 61300-3-34	0.30 dB	
	Ave/Master * IEC 61300-3-4	0.12 dB	
	Ave/Random * IEC 61300-3-34	0.12 dB	
	Return Loss IEC 61300-3-6	55/65 dB	
5	<b>MECHANICAL PROPERTIES</b>		
	Mechanical endurance IEC 61300-2-2	500 matings	
	Vibration IEC 61300-2-1	10-55 Hz, 0,75 amplitude	
	Drop IEC 61300-2-12	Drop height 1m, 5 drops	
	Cable retention IEC 61300-2-4	Magnitude 90 N	
	Cable torsion IEC 61300-2-5	1,5 kg - 2,5 kg for 2 mm - 3 mm cable diameter	
6	<b>CONNECTOR TYPE CONFORMANCE</b>	<b>SM DUPLEX</b>	
	LC IEC 61754-20	SM PC - Blue	
7	<b>CABLE SPECIFICATION</b>		
	Cable Material	LSZH or PVC	
	Strength Member	Aramid	
	Crush	1 000 N	
	Operating Temperature	- 20 to + 60 ° C	
	Secondary Buffer Diameter (2 mm, 2,4 mm and 3	900 ± 50 µm	
	Secondary Buffer Diameter (1,6 mm and 1,8 mm)	600 ± 50 µm	
	Minimum Bending Radius	10 D (installed) mm	
		20 D (banded) mm	

➤ **Cat 6 Cable**

S. No.	Parameter	Description	Compliance
A	Type as per ANSI/TIA 568C.2 at 250MHz	U/ UTP, Cat 6 Cable tested upto 700MHz with Third party certificate.	
	Insulation	Solid PE Ø0.96 mm	
	Conductor	23 AWG solid bare copper with a Diameter >0.56 mm	
	Separator	X shaped separator	
	Type of Sleeve	PVC / LSZH	
	Maximum Attenuation	32.8 dB per 100m	
	Min Next (dB)	38.3	
	PS NEXT	36.3	

	ACRF (dB/100m)	18.8	
	Return Loss (dB)	17.3	
<b>B</b>	<b>Electrical Specifications at 20 Deg C</b>		
	Type	Unshielded Twisted Pair, Category 6, as per IEC	

	Max linear resistance	05 Ohms per KM	
	DC dielectric strength	1KV/ 1 minute	
	Minimum Insulation Resistance	5000 Mohm.km	
	Minimum Propagation Speed	>65%	
	Characteristic Impedance from 1 to 100 MHz	100 Ohm ± 15%	
<b>C</b>	<b>Mechanical Features</b>		
	Diameter Over Insulation (mm)	1.02 ± 0.06	
	Cable Diameter (mm)	6.1 ± 0.3	
	Min. bending radius when laying (mm)	25	
<b>D</b>	<b>ENVIRONMENTAL FEATURES</b>		
	Usage Temperature	-20 to + 60 degree C	
	Transport temperature	0 to + 50 °C	
	Fire rating :	IEC 60332-1-2, EN 60332-1-2	
	EUROCLASS	EUROCLASS EN 13501-6 = Class Eca	
<b>E</b>	<b>STANDARDS AND APPROVALS</b>		
		UL Certified	
		3P Certified	
	Approvals	ETL verified to TIA / EIA Cat	
	Packing	Box of 305 meters	
	Color	Blue RAL 5015	
	Performance characteristics to be provided along	The cable NEXT, PSNEXT, FEXT, ELFEXT, PSELFEXT test result should meet & exceed the performance requirement as per as per ANSI/TIA 568C.2, ISO/IEC 11801, & EN50173-1, EN 50173-6-1, ISO/IEC 11801	
	Warranty	25-year systems warranty	

➤ **Copper Patch panel**

S. No.	Parameter	Description	Compliance
<b>A</b>	<b>CAT6 RJ45 straight patch panel</b>	<b>UTP</b>	
<b>B</b>	Standards and Approvals	Compliant with standards: ISO/IEC 11801 Edition 3.0 CENELEC EN 50173-1 2007 ANSI/EIA/TIA 568 C2-1 IEC series 60603-7,	
<b>C</b>	<b>GENERAL CHARACTERISTI</b>		

		Equipped with new-generation Soluclips for automatic fixing (screwless) on cabinet and enclosure uprights	
		Universal mounting of all cabinets or enclosures	

		The panels automatically earth each connector	
		Equipped with rear cable guide to hold cable during maintenance	
		Equipped with 4 cassettes of 6 LCS3 RJ45 Cat. 6 connectors with toolless fast connection, marked 568 A/B	
		Supplied with coloured labels	
		Conforming to standards ISO/IEC 11801 edition 3.0 (2017) and EIA/TIA 568 C2-1	
		19" panel - 1 U	
		Cassettes removed automatically by simple pressure	
		Each connector can be removed individually	
		system makes it easy to spread pairs before fitting them onto the connector.	
		Spreading the cables allows you to ensure that a pair-breakage distance of 13 mm is kept between each pair.	
		Spreading pairs at 90° to the cable ensures the best possible performance.	
	<b>POSITIONING</b>		
		The connectors are connected from the front without a special tool.	
		Connectors clip onto the panel individually	
		No need for cable ties: the cable is held in its cable guide.	
	<b>TECHNICAL CHARACTERISTICS</b>		
	Material characteristics	Panel: DC01 galvanised sheet steel	
		Contacts: gold/nickel, thickness of gold > 0.8 µm minimum	
		Metal parts: bronze, nickel, platinum, gold	
		Polycarbonate PBT	
	<b>Electrical characteristics</b>	Breakdown voltage: 1000 V	
		Contact resistance: 20 mΩ	
		Insulation resistance: 500 MΩ under 100 V DC	
		Withstand performance to a POE signal up to 50 W	
	<b>Mechanical characteristics</b>	Max. number of connections and disconnections: 5 without replacing the wire	
		Endurance: 2500 operations (plug-in/pull-out)	
		IK03	

	<b>Climatic characteristics</b>	Operating temperature: -40°C to +70°C	
		Humid heat 21-day cycle	
	<b>Dimensions</b>	Panel : 482.5(W) x 321.7(D) x 43.85(H) in MM	
		Connector: 17.5 (W) x 48.15 (D) x 20.5 (H) in MM	

	<b>TYPICAL RJ45 CONNECTION</b>	Takes the following plugs: RJ 11 (4 contacts), RJ 12 (6 contacts), RJ 45 (9 contacts).	
		EIA/TIA 568 A and B dual colour code on terminals: - UTP (8 contacts) - FTP (9 contacts)	
<b>D</b>	<b>Conductors Supported</b>		
		Single-wire: 0.5 to 0.65 mm, AWG 22 to 25	
		Multiple-wire: AWG 26	
		Polyethylene conductor insulation: max Ø with insulation 1.58 mm	
		Number of wires to be connected per connection: 1	
		RJ45 connectors are equipped with a locking nut. They do not require a special tool and can be re-wired if a	
<b>F</b>	Earthing	The panels offer automatic earthing of each connector	
<b>G</b>	Performance Warranty	The performance warranty for over all installation shall be for 25 years by manufacturer	
<b>H</b>	Capacity	Patch panel should accept 6 port Fibre cassette to connect fibre other than Copper Connectors, if required	

➤ **Cat 6 RJ45 Information Outlet**

S. No.	Parameter	Description	Compliance
<b>A</b>	<b>CAT6 RJ45 Information Outlet</b>	<b>UTP Cat 6 RJ 45 Sockets</b>	
<b>B</b>	Standards and Approvals	The electrical performance of installation outlet shall meet or exceed requirement as per - ISO/IEC 11801 Edition 2; - CENELEC EN 50173-1 2007; - ANSI/EIA/TIA 568-C.2;	
<b>C</b>	Performance characteristics to be provided for CAT6 @ 250 MHz	The information outlet NEXT, PSNEXT, FEXT, ELFEXT, PSELFEXT and return loss should be verified	
<b>D</b>	Connection of RJ 45	Should Accept RJ11 (4 contacts), RJ12 (6 contacts), RJ45 (9 contacts).	



E	Conductors Supported	Single-wire: 0.5 to 0.65 mm, AWG 22 to 25 Multiple-wire: AWG 26 Polyethylene conductor insulation: max Ø with insulation 1.58 mm	
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F	Shutter	Information outlet should have transparent shutter for protection against dust when not used	
G	Tool Less Crimping	The information outlet termination should be of self crimping type without use of 110 punching tool requirement	
H	<b>Material Specifications</b>		
1	Body	Contacts :gold/nickel, minimum thickness of gold	
2		Metal parts: bronze, nickel, platinum, gold	
3		The information outlet shall be made of high impact PBT Polycarbonate plastic	
4		For STP Products the body and spreader are made of metal alloy with a copper-nickel coating	
I	<b>Electrical Specifications</b>		
1	Break Down Voltage	Greater than or equal to 1000V	
2	Contact Resistance	Less than or equal to 20mOhms	
3	Insulation Resistance	Greater than or equal to 500 M Ohm at 100 V DC	
4	Load Testing	Connector should be tested and guaranteed under PoE restrictions, IEEE 802.3af standard and PoE+, draft standard 802.3at, up to 2500 on-load connections / disconnections. Tested with 2 simultaneous PoE+ circuits for a minimum total power of 50 W	
J	<b>Mechanical Specifications</b>		
1	Maximum no of Connections/ Re connections	5 without refreshing the wiring.	
2	Endurance	2500 movements (plug insertion/withdrawal). IK03	
3	Temperature	-40 Deg C to +70 Deg C	

➤ **Face-Plate**

S. No.	Parameter	Description	Compliance
1	Material	Polycarbonate Hi-Grade Plastic FR Grade & UV Resistant 850 degree C/ Glow Wire Test	
2	Compatibility	The face plate should be compatible for Cat5e, Cat6 and Cat6A range of RJ45 and AV	
3	Size	The face plate Size should be of minimum 86x86mm	

➤ **Cat 6 Patch Cord**

S. No.	Parameter	Description	Compliance
<b>A</b>	<b>Type: CAT6 Patch cords - 1-2 Mtr</b>	<b>U/ UTP, Cat 6 Patch Cord</b>	
	Sleeve	LSZH	
	Performance at 250MHz	Should be as per Standards - IEC 61935-2 - Ed.	
	Usage Temperature	– 20 to + 60°C	
	<b>Minimum Next (dB)</b>	Minimum NEXT (dB)	
	Length		
	1 Meter	39.5	
	2 Meter	39.5	
	<b>Return Loss (dB)</b>	Return Loss (dB)	
	Length	14	
	1 Meter	14	
	2 Meter	14	
<b>B</b>	<b>Technical and Mechanical Features</b>		
	Type	UTP	
	Diameter over Insulation (mm)	0.97	
	Cable Diameter (mm)	6±0.2	
	No of Twists	500	
	No of insertions	750	
	AWG gauge	24	
	Tensile Strength of the cord	≥ 50 N	
<b>C</b>	<b>Electrical Features</b>		
	Characteristic impedance from 1 to 250 MHz	100 Ω ± 15	
	Loop resistance	< 2 Ω	
	Contact Resistance	Less than 20 m Ohm	
	Total Resistance of the cord	Less than 5 Ohms	
	Resistance per 100m of cable with cord	Less than 14 Ohm	
	DC Dielectric Strength	1 KV/ 1 min	
<b>D</b>	<b>ENVIRONMENTAL FEATURES</b>		
	Storage and transport temperature	0 to + 50°C	
	Usage temperature	– 20 to + 60°C	
	Fire resistance	IEC 60332-1, UL VW-1	
	<b>STANDARDS AND</b>		
		EN 50173	
		ISO/IEC 60603-7	
		ISO/IEC 11801	

➤ **PVC Pipe**

Sr. No.	Parameters	Specifications	Compliance
1	APPLIED STANDARD	IS:9537: PART-3: 1983	
2	OUTSIDE DIAMETER & INSIDE DIAMETER	Normal Size=25mm	
		Outside Diameter=25mm	
4	LENGTH	STANDARD LENGTH OF CONDUIT IS 3 METERS.	
	BENDING TEST	AFTER THE TEST ON CONDITIONED SAMPLES, THE SAMPLES SHALL SHOW NO CRACKS VISIBLE TO NORMAL TO CORRECTED VISION WITHOUT MAGNIFICATION. BENDING TEST IS APPLICABLE ONLY UP TO 25MM	
6	THICKNESS	LIGHT: 1.25-1.45 (APPROX)	
		MEDIUM: 1.60-1.80 (APPROX)	
		HEAVY: 2.00-2.20 (APPROX)	
7	COMPRESSION TEST	FOR, LIGHT:25% OF COMPRESSION ALLOWED UNDER LOAD OF 320N CONDUIT AND 10%ALLOWED AFTER RELEASING THE LOAD	
		FOR, MEDIUM:25% OF COMPRESSION ALLOWED UNDER LOAD OF 750N CONDUIT AND 10% ALLOWED AFTER RELEASING THE LOAD	
		FOR, HEAVY:25% OF COMPRESSION ALLOWED UNDER LOAD OF 1250N CONDUIT AND 10% ALLOWED AFTER	
8	IMPACT TEST	AFTER THE TEST ON CONDITIONED SAMPLES, THERE SHALL BE NO SIGH OF DISINTEGRATION AND CRACK VISIBLE TO NAKED EYE IN AT LEAST NINE OUT OF TWELVE SAMPLES.	

9	COLLAPSE TEST	AFTER THE TEST ON CONDITIONED SAMPLES, THE APPROPRIATE GAUGE PASSED THROUGH THE SAMPLE CONDUIT.	
10	RESISTANCE TO HEAT	AFTER THE TEST. DIA OF IMPRESSION ON THE SAMPLE SHALL NOT EXCEED 2MM.	
11	RESISTANCE TO BURNING	FLAME SHALL DIE OUT IN LESS THAN 30 SECOND AFTER REMOVEAL OF BURNER.	
12	ELECTRICAL	DIELECTRIC STRENGTH@NO BREAKDOWN OF CONDITIONED SAMPLE SHALL OCCUR AT THE VOLTAGE OF 2000V & SOHZ FREQUENCY FOR 15 MINUTES.	
	CHARACTERISTICS	INSULATION RESISTANCE@THE INSULATION RESISTANCE ON CONDITIONED SAMPLES SHALL NOT BE I THAN 100 MEG. OHM.	

➤ **HDPE Pipe**

Sr. No.	Parameters	Specifications	Compliance
1	Colour of Duct	Red, Green, Blue, Orange, Gray, Violet, Brown, Requirement	
2	Dimensions & Tolerances		
2.1	Nominal outside Diameter	25.00±0.15	
2.2	Wall Thickness	1.50 to 1.60mm	
2.3	Thickness of Inner layer	0.17 to 0.20mm	
2.4	Lubrication	Permanently lubricated for blowing of Optical Fiber Cable	
2.5	Ovality	1.4 mm max.	
2.6	Length of each Duct	1000 ±100	
3	HDPE Raw Material		
3.1	Density	0.940 to 0.958 at 27°C	
3.2	Melt Flow Rate	0.2 to 1.10 at 190°C under 5 kg Load	
4	Visual Appearance		
4.1	Surface Finish	Satisfactory	
5	Performance Requirement		
5.1	Heat Reversion	Max.3% in longitudinal Direction	

5.2	Hydrostatic Pressure Resistance test	ACCEPTANCE Test Duration:48 hrs at 80C Induced Stress:3.8 Mpa Type Test Duration:165 hrs at	
5.3	Tensile Strength	20 Min	
5.4	Elongation	600 Min	
5.5	Environment Stress Crack Resistance with 10% legal at 50.1 deg cel.	No Crack or Split at 50 deg C for 96 hrs.	
5.6	Impact Strength	Striker weight 10 kgs	

➤ **Pole**

SL N	Parameters	Specifications	Compliance
1	Length	6Mtr, 89mm Dia, Foundation Plate = 300x300x19mm MS Plate, Galvanization thickness: 90 Micron. The Poles should be erected with proper civil works i.e., concrete foundation base of suitable depth below the ground level	
2	General	The pole and its construction can withstand wind speeds up to 150 km/h. The projected pipe should withstand at least 10 Kg of weight at	
3	General	The Poles shall be in single section, there shall not be any circumferential weld joint.	
4	General	The poles shall be hot dip galvanized as per IS2629	
5	General	The Poles shall be bolted on a foundation with a set of four foundation bolts for greater rigidity.	
6	General	The bracket shall have one coat of anticorrosion aluminum paint before dispatch to site.	
7	General	Suitable openings for running the PoE Cable, earthing wire within the Pole should be available. No cables of camera should be projected outside after installation of cameras.	

➤ **GI Pipe**

Sr. No.	Parameters	Specifications	Compliance (Yes/No)
1	Material Type	Heavy duty suitable for heavy mechanical stress, High protection	
2	Durability of Marking	Marking shall be durable & legible	
3	Material	Mass of Zinc coating(min. 360g/m <sup>2</sup> )	
4	Inside Surfac	Hot Dip Galvanised	

5	Outside	Hot Dip Galvanised	
6	Standard	3 Meters	
7	Wall Thickness	1.4 to 1.8 mm	

8	Outer Diameter	25mm(Tolerance :-0.4mm	
9	Thread	19+1mm	
10	Bending Test	Shall shown no crack & ball of appropriate gauge shall pass easily	
11	Compression Test	Difference in outside diameter after applying force of 1250 N shall not exceed by 10%	

➤ **Layer 2 Switch**

Sr. No.	General Specifications	Compliance
1	<b>Physical Interfaces</b>	
	24x1G Base-T Copper Ports, 2x1G Base-X Fiber SFP	
2	<b>Performance</b>	
	Switching fabric: 52 Gbps Line-Rate, WRR, 8K MAC Address, Priority queues: 8	
3	<b>L2 Service</b>	
	IEEE 802.1Q VLAN tagging, Broadcast, multicast, unknown unicast storm control, IEEE 802.3ad - LAGs (LACP), IEEE 802.3x (full duplex and flow control), IEEE 802.1D Spanning Tree Protocol, IEEE 802.1w Rapid Spanning Tree Protocol, IEEE 802.1s Multiple Spanning Tree Protocol, IGMP snooping (v1, v2, and v3), IGMP snooping querier, Block unknown multicast	
4	<b>Network Security</b>	
	IEEE 802.1x, Guest VLAN, RADIUS based VLAN assignment via .1x, MAC-based .1x, RADIUS Accounting, Network Storm Protection, DoS, Dynamic ARP inspection Broadcast Unicast Multicast DoS Protection	
5	<b>Management</b>	
	Web-based graphical user interface (GUI), Admin access control via Radius and TACACS+, RMON 1,2,3,9, SSL/HTTPS and TLS v1.0 for Web-based access, Ssh, Telnet (RFC 2164)	
6	<b>Environmental</b>	
	Operating Temperature: 32° to 122°F (0° to 50°C), Operating Humidity: 90% maximum relative humidity, non-condensing, Storage Temperature: – 4° to 158°F (–20° to 70°C). Storage Humidity: 95% maximum relative humidity, non-	
7	<b>Certifications</b>	
	CE mark, commercial, FCC Part 15 Class A, VCCI Class A, Class A EN 55022 (CISPR 22) Class A, Class A C-Tick, EN 50082-1, EN 55024, CCC	
8	<b>Warranty</b>	
	Industry-leading 5-year Limited Lifetime* Hardware Warranty	

➤ **Layer 2 POE Switch**



<b>Sr. No.</b>	<b>General Specifications</b>	<b>Compliance</b>
<b>1</b>	<b>Physical Interfaces</b>	
	24x1G Base-T Copper POE+ Ports, 2x1G Base-X Fiber SFP 380W Power Budget	
<b>2</b>	<b>Performance</b>	
	Switching fabric: 52 Gbps Line-Rate, WRR, 8K MAC Address, Priority queues: 8	

<b>3</b>	<b>L2 Service</b>	
	IEEE 802.1Q VLAN tagging, Broadcast, multicast, unknown unicast storm control, IEEE 802.3ad - LAGs (LACP), IEEE 802.3x (full duplex and flow control), IEEE 802.1D Spanning Tree Protocol, IEEE 802.1w Rapid Spanning Tree Protocol, IEEE 802.1s Multiple Spanning Tree Protocol, IGMP snooping (v1, v2, and v3), IGMP snooping querier, Block unknown multicast	
<b>4</b>	<b>Network Security</b>	
	IEEE 802.1x, Guest VLAN, RADIUS based VLAN assignment via .1x, MAC-based .1x, RADIUS Accounting, Network Storm Protection, DoS, Dynamic ARP inspection, Broadcast, Unicast, Multicast DoS Protection	
<b>5</b>	<b>Management</b>	
	Web-based graphical user interface (GUI), Admin access control via Radius and TACACS+, RMON 1,2,3,9, SSL/HTTPS and TLS v1.0 for Web-based access, Syslog (RFC 3164) Smart Control Center (SCC) for multi-switch management	
<b>6</b>	<b>Environmental</b>	
	Operating Temperature: 32° to 122°F (0° to 50°C), Operating Humidity: 90% maximum relative humidity, non-condensing, Storage Temperature: – 4° to 158°F (–20° to 70°C), Storage Humidity: 95% maximum relative humidity, non-	
<b>7</b>	<b>Certifications</b>	
	CE mark, commercial, FCC Part 15 Class A, VCCI Class A, Class A EN 55022 (CISPR 22) Class A, Class A C-Tick, EN 50082-1, EN 55024, CCC	
<b>8</b>	<b>Warranty</b>	
	Industry-leading 5-year Limited Lifetime* Hardware Warranty	

➤ **Layer 3 Switch**

<b>Sr. No.</b>	<b>General Specifications</b>	<b>Compliance</b>
<b>1</b>	<b>Physical Interfaces</b>	
	24 X 1G Base-T Copper Ports, 02 X 1/10G Base-T Copper Ports 02 X 1/10G Base-X	
<b>2</b>	<b>Other Ports</b>	
	Ethernet: Out-of-band 1G port (Front), Console: RJ45 RS232 (Front), Console: Mini-USB (Front), Storage: USB (Front), Full width 1 unit 1U rack mount	
<b>3</b>	<b>Performance</b>	
	Switching fabric: 128 Gbps Line-Rate (non blocking fabric), Throughput: 95.2 Mpps	
<b>4</b>	<b>Stacking</b>	
	Stack height: 8 switches	

<b>5</b>	<b>L2 Service</b>	
	VLAN, sFlow, IGMP, GARP with GVRP\GMRP, LAG, UDLD, Storm Control, RSTP, BPDU Guard	
<b>6</b>	<b>L3 Service</b>	

	IGMP & MLD Proxy, DVMRP, PIM-DM, PIM-SM, DHCP Snooping, DHCP Server, RIP, OSPF, VRRP, Diffserve- QOS, WRED, IP TOS, DoS attack protection, L2/L3/L4	
<b>7</b>	<b>Management</b>	
	Command Line Interface (CLI), Web-based graphical user interface (GUI), Admin access control via Radius and TACACS+, Telnet	
<b>8</b>	<b>Environmental</b>	
	Operating Temperature: 32° to 122°F (0° to 50°C), Operating Humidity: 90% maximum relative humidity, non-condensing, Storage Temperature: – 4° to 158°F (–20° to 70°C) Storage Humidity: 95% maximum relative humidity non-	
<b>9</b>	<b>Certifications</b>	
	CE mark, commercial, FCC Part 15 Class A, VCCI Class A, Class A EN 55022 (CISPR 22) Class A, Class A C-Tick, EN 50082-1, EN 55024, CSA certified (CSA 22.2 #950) UL listed (UL 1950)/cUL IEC 950/EN 60950	
<b>10</b>	<b>Warranty</b>	
	Limited Lifetime Hardware Warranty	

➤ **Access Point**

<b>Sr. No.</b>	<b>General Specifications</b>	<b>Compliance</b>
<b>1</b>	<b>Physical Interfaces</b>	
	One 2550 BASE-T Gigabit Ethernet (RJ-45) ports with Auto Uplink, (Auto MDI-X) supporting IEEE 802.3af or 802.3at Power over Ethernet (PoE)	
	Min. Internal 2.86/4.41/4.98 dBi (2.4GHz/5GHz L/5GHz H)	
	Power and Cloud connection; LAN speed; 2.4GHz status; 5.0GHz status	
	provision for power connector : 12V DC, 3.5A	
<b>2</b>	<b>Standards</b>	
	IEEE 802.11AX, IEEE 802.11ac, IEEE 802.11n	
	IEEE 802.11AX standard, 2.4GHz and 5GHz	
	WMM - Wireless MultiMedia Prioritization	
	WDS- Wireless Distribution System	
	Min. Power over Ethernet (PoE++) 802.3bt required.	
<b>3</b>	<b>Security</b>	
	Wi-Fi Protected Access (WPA3)	
	Wired Equivalent Privacy (WEP) 64-bit, 128-bit, and 156-bit encryption	
	Wireless access control to identify authorized wireless network devices	
	MAC address filtering with access control	
	Basic Service Set Coloring (BSS Coloring )	
	Security Socket Layer (SSL) remote management login	
<b>4</b>	<b>Network Management</b>	
	Remote configuration and management through Web browser, SNMP or Telnet	
	SNMP management supports SNMP	
<b>5</b>	<b>Manageability</b>	

	As standalone	
	remote/Cloud manageable for 5 years	
<b>6</b>	<b>Advanced Wireless Features</b>	
	Wireless Distribution System (WDS)	
	Wireless backhaul to form Mesh Network	

	Bridge mode: Point-to-multipoint wireless WDS mode	
	Adjustable Transmit Power Control (TPC) Device detection	
	AirQual feature enables spectrum analysis and interference identification	
<b>7</b>	<b>Other Specifications</b>	
	PoE power consumption should not be more than 32 Watts	
	OFDM and OFDMA both should be available	
	AX1800 (1.8Gbps) throughput	
	Target Wake Time (TWT)	
	Block SSID Broadcast	
	Ceiling mounting/ Wall mounting	
	Bidir and MU-MIMO	
	Deployment Options: Standalone, Mobile App	
<b>8</b>	<b>Warranty and Support</b>	
	5 Years of Hardware Warranty.	
	Included 5 Years of Cloud Licence	
	No repair products & replacement with New box.	
	Lifetime free latest firmware support	

➤ **Outdoor Switch**

<b>Sr. No.</b>	<b>General Specifications</b>	<b>Compliance</b>
<b>1</b>	<b>Physical Interface</b>	
	8 # 10/100/1000 Mbps Base-T auto-sensing PoE ports	
	2 # 1000 Base-x SFP uplink ports	
<b>2</b>	<b>Network Protocol and Standards</b>	
	IEEE 802.3i 10BASE-T	
	IEEE 802.3u 100BASE-TX	
	IEEE 802.3ab 1000BASE-T	
	IEEE 802.3z 1000BASE-X	
	IEEE 802.3x full-duplex flow control	
	IEEE 802.3af (DTE Power Via MDI)	
	IEEE 802.3ad Link Aggregation (manual or LACP)	
	IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)	
	IEEE 802.1s Multiple Spanning Trees Protocol (MSTP)	
	IEEE 802.1ab Link Layer Discovery Protocol (LLDP)	
	IEEE 802.1p Class of Service (CoS)	
	IEEE 802.1Q static VLAN	
<b>3</b>	<b>Performance</b>	
	Forwarding modes: Store-and-forward	
	Bandwidth: 20 Gbps full duplex	
	Buffer memory: 512 KB embedded memory per unit	
	Address database size: 4k media access control (MAC)	
	Mean time between failures (MTBF): 157,000 hours	

	Acoustic noise: 0 dB	
<b>4</b>	<b>Other Requirements</b>	
	IEEE 802.1Q static VLAN (64 groups, static)	
	Protected ports	
	Port-based QoS	

	prioritization on power	
	Dynamic Power allocation	
	DSCP-based QoS	
	PoE timer	
	DiffServ	
	LLDP-MED	
	SNMP v1, v2c, v3	
	RFC 1213 MIB II	
	RFC 1643 Ethernet Interface MIB	
	RFC 1493 Bridge MIB	
	RMON group 1, 2, 3, 9	
	Auto voice VLAN	
	DHCP Filtering	
	Auto denial-of-service (DoS) protection	
	HTTP and HTTPS	
	Ping and traceroute	
	Power saving when link down	
	RFC 2131 DHCP client	
	DHCP filtering	
	IEEE 802.1x with Guest VLAN	
	Jumbo frame support	
	Port-based security by locked MAC addresses	
	MAC and IP-based ACL	
	Storm control for broadcast, multicast and unknown unicast	
	IGMP snooping v1/v2	
	Port-based egress rate limiting	
	SNTP	
	Port mirroring support (many-to-one)	
	Web-based configuration	
	Centralised Management	
	Configuration backup/restore	
<b>5</b>	<b>Password access control</b>	
	TACACS+ and RADIUS support	
	Syslog	
	Firmware upgradeable	
<b>6</b>	<b>Power Specifications</b>	
	PoE (46 Watts of power budget)	
	Power consumption: 59.3W maximum	
	48V, 1.25A external power adapter	
<b>7</b>	<b>Environmental Specifications</b>	
	Operating temperature: 32° to 122° F (0° to 50° C)	
	Storage temperature: -4° to 158° F (-20° to 70° C)	
	Operating humidity: 90% maximum relative humidity, non-	



	Storage humidity: 95% maximum relative humidity, non-	
<b>8</b>	<b>Certifications</b>	
	CE mark, commercial	
	FCC Part 15 Class B	
	VCCI Class B	

	C-Tick	
	EN 55024	
	cUL IEC 950/EN 60950	
	CB	
<b>9</b>	<b>Status LEDs</b>	
	Per RJ45 port: Link/activity, speed, PoE status	
	Per SFP port: Link/speed	
	Per device: Power, PoE Max	
<b>10</b>	<b>Warranty and Support</b>	
	Lifetime hardware replacement warranty	
	Lifetime Chat and e-mail Technical Support	
	Lifetime free latest firmware support	
	90 Day's Remote configuration support.	

➤ **Fiber SFP Module**

Sr. No.	General Specifications	Compliance
<b>1</b>	<b>Product Specifications</b>	
	High-performance 1310 nm single-mode SFP	
	Maximum distance of up to 10 km	
	Hot-pluggable	
	Single-mode fibre	
	1000BASE-LX (IEEE 802.3z standard)	
	Duplex LC connector	
	MSA, RoHS-compliant	

❖ **EPABX system**

This Specification brings out the qualitative and quantitative requirements of “Hybrid/IP PABX System”.

The objective of this RFP in terms of architecture is unification of the voice, data and video communication infrastructures, to build-up a communication platform that is standards based.

The proposed solution would be based on Hybrid /IP technology supporting IP/SIP, Digital and Analog end points.

Proposed solution infrastructure should deliver

- Highly Secured, Scalable and high reliable communications
- feature rich telephony over all end points

## Communication System

### 1.1.1

a) The Contractor shall provide IP EPABX System, mountable in a standard 19" Network rack, that shall be

non-blocking and open standard (based on H.323/ SIP), Standalone Call server should have capacity to expand up to 112 Port. The solution shall support in-skin VoIP DSP channels at least 08 built-in from day 1

for non-blocking architecture per call server and should not consume any additional slot.

- b) The proposed communication server should provide support for:
- Media Gateways to allow TDM/SIP connectivity.
  - **ISDN PRI and BRI Interface**
  - **Hybrid Ext/IP/SIP Trunks Interface with CLI**
  - **E1 Supported**
  - **Analog Extension should support Name & Number.**
  - IP conversion and resources like conferencing, voice prompts.
  - System should Hybrid extension ports.
  - Max.128 Resources for IP Extensions / IP Trunks / Video.
  - Local or remote network management systems
  - System Should Connect 50 Location over Net with maximum features transparency.
  - System should support Built-in Voice Recording on incoming / Outgoing Extension and Trunk call.
  - System should built-in 2Hr conversation recording and expandable up to 115Hr.
  - System should built-in Conference Recording from day One.
  - System should built-in 32 (16x2) party Conference.
  - System should built-in 4 Party web video Conference, Expandable up to 32(8x4) Party's.
  - System should built-in minimum 4ch Auto Attendant and VM.
  - System should built-in Mobile Extension.
  - System should support UC function.
  - System should built-in Paging port.
  - System should built-in Relay port.
  - System should built-in minimum six sip profiles.
  - System should built-in multi-level IVR Facility.
  - System should support web base In Hotel software for 64 rooms.
  - System should support web base In Report software for Call Control.
  - System should support web base In UC software.
  - System should support web base In Guard.
- c) To ensure, complete EMPLOYERship and smooth delivery of all the functional and reliability requirements of the solution proposed, all the hardware and software must be from the same OEM. No third party products or integrated solutions are allowed.
- d) The proposed system shall be equipped to handle the required capacity to type of Hybrid / IP extensions or trunks from day one.
- e) System should evolve in the future into supporting multiple sites (Minimum 50), to ensure

distributed / centralized architecture in a multi-site environment. The system should support remote site architectures.

- f) The system must be able to inter-operate with other telephone systems and endpoints using the following standards:
  - SIP

- CTI
- TIE

**1.1.**  
**2**

- g) The system must support gateways for following external telephony interfaces and signaling protocols:
- ISDN PRI / E1
  - BRI
  - Analog Loop Start and Ground Start (with CLIP)
- h) SIP Carrier Profile – The offered system must support minimum 6 SIP carrier profiles without any extra hardware.
- i) Paging – The system should built-in dual paging port to interface with the existing PA system for paging during emergency situations.
- j) The system should support basic Unified Communication features i.e. Presence, BLF, IM and basic calling features without any external server for maximum 112 UC clients.
- k) Web Video Conference -The offered system must support maximum 32 Party's web video conference without any extra hardware.
- l) Mobile Extension -The offered system must support minimum 04 Mobile Extension without any extra hardware.
- m) The system should support Integration with SIP base Video Conference.
- n) The system should have minimum 50-department groups.
- o) The system should support multi device features.
- p) The system should support Door Phone.
- q) The system should support Door lock relay.

**1.1.1 Integrated Media Gateways:**

- a) The system should support high density media gateway to support the TDM extensions and trunks.
- b) It should support G711, G722, G726, G729a Codecs.
- c) The offered System should have minimum 128 channels VoIP resources universal slots, internal voice prompts with 16 simultaneous announcement, storage memory to accommodate 16 minutes of static prompts and 8 minutes of dynamic prompts, 4 groups of 8 party or 2 Groups of 16 Party meet me conference.

- d) The System should support Multi Site Connectivity over IP/SIP/Aspire Net.

#### 1.1.2 System features

- a) The IP PBX should support flexible numbering plan with up to 8 digits. System should allow mixed numbering scheme.

- b) Flexible Station Move: The system should give complete flexibility to dial a person his identification number from any location & thus utilize all the facilities from that point.
- c) The system should provide distinctive ringing for internal calls, junction calls, auto call back, wake up service and emergency reporting service.
- d) The proposed system should support automatic route selection (ARS) and least cost routing (LCR) features to route the calls based on priorities related to user profile, tariff, and network availability, along the most cost-effective path. This service will be transparent for users and irrespective of the physical carrier connection. It should be possible to inform the caller via voice prompt if the cheapest route is not available.
- e) The proposed system should have both live and automated attendant's features and either of the one or combination of both can be deployed to fulfill the requirement. At least 16 ports should be provided in the system.
- f) The system should support voice prompts to guide the user in all communication positions by multilingual voice guides.
- g) The System Should support Maximum 112 Proprietary IP Phones without any additional lic.
- h) The system should support 26 International languages.
- i) The system should have the following cost control features.
  - Class of service
  - Forced account code
  - Authorization code
  - Least cost routing
  - Toll restriction
  - Automatic route selection
  - Call duration timer/warning
- j) It should be possible for a user to make an external call from other sets via a PIN thus bypassing the external call barring category for that set.
- k) Hunt groups – Sequential, Cyclical or “Parallel”. The telephone sets in the group could be analog phones, Digital & IP phones or a combination of all. In case of overall occupancy, the calls will stay on hold in a waiting queue, or be redirected towards another user, station group, attendant or an external correspondent. Total no. of group should be 64. It should be possible to have up to 64 extensions in one group.
- l) **The system should support the following basic telephone features:**
  - i. Abbreviated dialing
  - ii. Appointment reminder
  - iii. Automatic call-back on busy trunk/bundle/network link
  - iv. Call forwarding unconditional on busy/no reply to extension, hunting group, Voice mail, operator, paging, etc.
  - v. Conditional external forwarding (busy or no reply)
  - v. External call forward to PSTN/ Cellular .
  - vi. Immediate forwarding



- vii.** Call pick-up
- viii.** Call parking
- ix.** Call tracing
- x.** Call waiting indication / voice prompt
- xi.** Calling line identification restriction for internal calls
- xii.** Calling party identification for internal users.(on analog phones also).
- xiii.** Camp on busy telephone/hunting group/voice mail
- xiv.** Controlled private call by Pin code and password
- xv.** Do not disturb
- xvi.** Dynamic call barring

- xvii. General night service
- xviii. Hunting group (fix head, cyclic, longest idle time, parallel)
- xix. Internal/external music on hold
- xx. Internal/external inquiry call
- xxi. Individual hold
- xxii. Instrument locking to prevent the outgoing calls.
- xxiii. Last internal/external number redial
- xxiv. Store and redial external number
- xxv. The system must support 16 party x 2 groups conference from day one.
- xxvi. The system must have minimum 32 conference resources.
- xxvii. The system must support multiple conference options. i.e. Adhoc, Meet-me, Dial-in conference with Password Protection.

**m) The system should also support the following telephone features on Digital sets in addition to above basic features:**

- Adjustable handset volume
- Call-by-name for internal and external user.
- Centralized phone book stored in communication server directory feature with spelling and syntax corrector with 1000 entries, accessible from the alphabetical keyboard of the phone.
- Caller name display
- Conditional/unconditional differentiated forwarding of multiple directory numbers
- Contextual voice prompts
- Distinctive ringing.
- Fixed function keys
- Hands-free
- Headset capability
- Individual customization
- Interactive guidance with soft keys
- Loudspeaker announcement
- Multi-line: multi-appearance and multi-numbers
- Multi-line selective forwarding
- Message waiting indication
- Calling line identification presentation/restriction (CLIP/CLIR)
- Digit by digit dialing mode
- End block dialing (digit correction possible)
- ISDN identification (CLIP) converted into name
- Malicious call identification
- Storage of unanswered calls with date, time, and callback

### 1.1.3 Network Services

- a) As this project involves multiple locations deployed with independent system and networked over PRI/E1s and IP, the network should support complete feature transparency to get the maximum benefit from the latest technologies
- b) Same set of protocols should be used for PRI/E1 and IP networking of the systems and they should provide transparent services across the network.
- c) List of network wide features to be systematically supported across the network over PRI/E1 and IP are list below:
  - Basic call

- Number and name identification
- Call/dial by name
- Call waiting indication

- Call offer
- Callback on busy links
- Callback on free or busy extensions
- Call park
- Call forwarding
- Camp on
- Individual call pick-up
- Data call
- Distinctive ringing
- Hold
- Intercom call
- Consultation call
- Broker call
- Transfer
- Conference
- Intrusion/Barge-in
- Unconditional forwarding
- Conditional forwarding
- Do not disturb
- DISA
- Transparency of rotary and DTMF dialing
- Retransmission of last number dialed (redial)
- ISDN/PSTN supplementary services
- Multi Party Conference
- Announcement/paging on speaker

- Manager/assistant filtering/screening team
- Object supervision: free, partially busy, totally busy, ringing

- Hunt groups
- Centralized Attendants and Voice messaging serving the entire network
- Video Call Support

## 1.2

### 1.1.4 Voice Messaging application

- a) Voice messaging application has to be from the same OEM as that of the IP PBX and should support unified messaging features.
- b) The offered Voice messaging application should be a single system delivering both standard voice messaging as well as unified messaging services.
- c) Voice Mail features
  - Messaging facilities
    - Direct access to the mail box (by-pass the menu greeting) from business phone set (IP or analog) and from any phone set if the phone number is declared by the user in his personal settings.
    - Internal call routing (busy and no answer)
    - Maintain a specific number of minutes of messages per user
    - Guest mailboxes
    - Mailbox escape to predefined extension
    - Future delivery
    - Automated attendant
    - The messaging application must have the ability to record live conversation through press of a button on the IP/digital phone or through the softphone application.
    - Web based interface for message consultation, play, deletion
  - Notification facilities
    - Message notification on phones, emails
    - Message waiting audible voice prompts
    - Integration with visual message waiting indicators on phones
  - Personal settings facilities
    - Password management
    - Call forwarding direct to mailbox
    - Password protected mailbox
    - Personalized voice greetings (busy, no answer)
    - Private messages
    - Announcement - only mailbox

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- Playback control
- Message header information
- Message-rewind, pause and fast-forward

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- Reply to sender
- Send a message copy
- Skip messages

#### 1.2.1

#### 1.1.5 Attendant (Operator) positions

- a) Proposed solution should be Phone Based Operator console. Phone based operator should have minimum 24 key on the set and should support add on modules.

- b) Attendant Console should support following :

- Override - The attendant can bypass forwarding or do not disturb modes on a phone
- Called Party Call Resources - When the called party is busy or does not answer, the following call resources should be available on attendant keys:
  - Callback request
  - Text message
  - Voice mail
- The attendant should be able to send mini text messages to a users with display:
  - Programmed message
  - Pre-programmed message completed by entering digit: date, hour
  - Pre-programmed message completed by any variable part (text and digits)
- Transfer on no Answer
- Transfer on Busy
- Barge-in on Busy or Partially Busy
- Three-party Conference
  - An attendant must be able to set up a three-party conference, and then transfer the conference to another user.
- Call Transfer to other Attendant
- Serial Call
- Recall
- Class of Service - The attendant console (in idle state) must be able to change the class of service for any phone.
- Public Trunk Access Restriction - The attendant console (in idle state) must be able to change the public trunk access and restriction for any phone.
- Directory access and call by name

#### 1.1.6 Hybrid Telephone terminals All phones should be from the same OEM as the PABX.

##### *a) Type 1: Entry level Terminals*



- 2-line B&W display
- Hands-free and amplified listening modes with volume control
- Dual line
- 12 programmable keys

- fixed feature keys
- Mute
- Redial
- Message lamp LED
- Directory Dial, 1000 system Numbers, 10 Personal, 50 Phone Book
  - 12 one touch programmable keys with LEDs
  - Message wait lamp LED
  - RJ11 connection
  - Should support Add on modules to add minimum 60 keys

***b) Type 2: Entry level Terminals***

- 2-line B&W display
- Hands-free and amplified listening modes with volume control
- Dual line
- 24 programmable keys
- fixed feature keys
- Mute
- Redial
- Message lamp LED
- Directory Dial, 1000 system Numbers, 10 Personal, 50 Phone Book
  - 24 one touch programmable keys with LEDs
  - Message wait lamp LED
  - RJ11 connection
  - Should support Add on modules to add minimum 60 keys

***c) Type 3: High end Proprietary SIP Phones***

- Should support following user interface features:
  - 7 in TFT LCD display 1024 x 600 with backlight, 16.7M Colours.
  - Capacitive 4 finger multi-touch window.
  - Flexible through adjustable height.
  - Good voice quality for each audio path-handset, the hands free speakerphone and blue-tooth headset
  - Full-duplex conversations, acoustic echo cancellation and background noise suppression
  - Frequency response – Wideband audio for handset, blue tooth headset and

hands-free speakerphone modes

- Dedicated RJ-9 headset port and blue-tooth support
- POE enabled
- Micro SD Card support
- USB support

- Flexible line appearance (one or more line keys can be assigned for each line extension)
- Distinctive incoming call treatment/call waiting
- Call timer and call waiting
- Call transfer, hold, divert (forward), pickup
- Called, calling, connected party information
- Should be able to participate in audio conferencing as part of the overall solution
- One-touch speed dial, redial
- Video
- RFC3261, RFC3550, RFC3711, RFC4566- SDP
- Should support following Network and provisioning features:
- SIP Protocol
- Dual Ethernet Gigabit Port with Dual switched autosensing mode.
- 10/100/1000Base-TX across LAN and PC/Laptop ports
- Manual or dynamic host configuration protocol (DHCP) network setup
- Time and date synchronization using NTP/SNTP
- QoS Support – IEEE 802.1p/Q tagging (VLAN), Layer 3 TOS, and DSCP
- Status and statistics reporting through centralized management
- Should support following Security features:
- Media encryption
- Password login

## 1.2 Security

- a) Security is currently one of the most important needs when a VoIP project should be deployed inside an enterprise. **The Tenderer must only propose an offer that conforms with adequate security standards. The quoted system should be supported with SBC from same OEM with below features:**

- SIP Trunking
- Remote worker
- SIP registration password thorough
- SIP intrusion prevention: 400+ SIP attack signature support
- DDoS / DoS attack protection
- SIP registration scan attack detection
- SIP header normalization
- SIP malformed packet protection

- Topology hiding with SIP deep packet engine
- Call security with TLS
- RTCP statistics
- T.38 Fax relay
- SIP Firewall – Should support deep packet inspection protection at Layer 7.
- VLAN and virtual IP support
- Minimum 30 concurrent channels with throughput 300Mbps
- Local security event console
- Remote system log
- Device management: Web GUI via Https & SSH CLI

### 1.2.1 Call accounting

i. CDRs should be generated for internal and external calls for incoming and outgoing calls with the following fields:

- Caller / called terminal name/ number
- Number dialed (with masking of the last four digits) / caller number
- Date, hour, and minute that the call ended
- Length of the call
- Number of cost units
- Cost for the call
- Type of call
- Log for walking class of service.
- Auth. Code
- Trunk Number

### 1.3 Environmental Conditions

The equipment offered shall be capable of maintaining its guaranteed performance when operating continuously for 24 hours a day and 365 days a year under the following environmental conditions.

- Operational temperature : 0 to 40 Degree C.
- Humidity : 10% to 90% RH (non-condensing)

## ❖ Digital PA system

### ➤ Voice Alarm Controller

The Voice Alarm Controller is the heart of the voice alarm system. It is the basis of the Voice Alarm System, and should have the essential functionality for compliance with the EN 60849 and 54-16 standards, including full system supervision, loudspeaker line impedance supervision, a supervised emergency microphone on the front panel and a supervised message manager.

A built-in 240 W amplifier provides the power for the emergency call channel and BGM. Additional Amplifiers can be added to provide two-channel operation. All amplifiers should be supervised. The audio output uses standard analog audio 100 V line switching for full compatibility with the family of public address equipment and EVAC-compliant loudspeakers.

The powerful 240 W output section has six transformer isolated 100 V constant-voltage outputs for driving 100 V loudspeakers in six separate zones. The 100 V-technique reduces line losses on longer distances and provides easy parallel connection of multiple loudspeakers. All zones may be individually selected from the front panel, and the BGM

output level in each zone can be individually set in six steps.

Six configurable volume-override output contacts are available for overriding local volume controls during priority calls. Both four-wire and three-wire schemes are supported. An LED meter monitors the output.

The controller should support upto 60 zones. Up to 255 messages can be stored in the internal 16 MB flash ROM, without a need for battery backup. Each message can have any length within the total available capacity. Messages and configurations are uploaded from a PC via USB into the memory, after which the unit operates without a PC connection.

The unit has 12 contact trigger inputs for business and emergency (EMG) calls. Each can be configured for a message consisting of a sequence of up to eight wav files. In this way some wav files may be used in various combinations with other messages, optimizing flexibility and the amount of storage space used. The Controller should also have two RS232 ports of which one should be reserved for product development and the other can be used to integrate to a third party digital device supporting RS232 protocol and can be used as a soft trigger input, in that way the number of trigger inputs (both emergency and business trigger inputs) can be increased to minimum of

150. Multiple messages can be merged to form one integrated message. The controller should have dip switches to adjust the system settings. The controller should have impedance calibration button for matching to the speaker impedance. The controller should have the VOX activation feature. A zone selection, together with this sequence can be configured for each trigger input.

Technical Specifications are as follows:

Voltage	230VAC, 50/60 Hz
Max power consumption	600 VA
Battery power supply	24 VDC, +15% / -15%
Voltage	
Outputpower (rms/maximum)	240 W / 360 W
Frequency response	60 Hz to 18 kHz
Distortion	<1% at rated output power, 1 kHz
Programmable Trigger Inputs	12
Speech filter	-3 dB at 315 Hz, high-pass, 6 dB/oct
Messages Data format	WAV-file, 16-bit PCM, mono
Memory capacity	16 MB Flash ROM
Loudspeaker outputs	12
Number of messages	255 max
Volume override outputs	6
Dimensions (H x W x D)	144 x 430 x 370 mm
Operating temperature	-10 °C to +55 °C (14 °F to +131 °F)
Storage temperature	-40 °C to +70 °C (-40 °F to +158 °F)



### ➤ **Voice Alarm Call Station**

Stylish six-zone call station for the Voice Alarm System. Six zone selection keys, all-call key and momentary.Push To Talk-key for calls. Selectable gain, speech filter, limiter, and output level for improved intelligibility. LED indications for zone selection, fault, and emergency state .Call station extension provides seven additional zone and zone group keys. Up to eight keypads can be added with each keypad adding seven zone or zone-group keys. This call station features selectable gain, a selectable speech filter, and a limiter for improved

intelligibility. The call station has a balanced line level output, making it possible to position it up to 1000 meters from the controller, using CAT-5 extension cables. With shielded cable, the call station can also be used in an EMC level 5 (heavy industry) environment.

The Call station shall be certified according to EN 60065 and Emergency according to EN 54-16 / EN 60849.

Technical Specifications are as follows:

Voltage range	24 VDC
Current consumption	<30 mA
Nominal sensitivity	85 dB SPL
Nominal output level	700 mV
Input sound level (max)	110 dB SPL
Distortion	<0.6%
Input noise level	25 dB SPLA
Frequency response	100 Hz to 16 kHz
Output impedance	200 ohm

### ➤ Power Amplifiers

The main function of the power amplifier is the amplification of audio signals for the loudspeakers. It shall be possible to select the output voltage between 100V, 70V by changing jumpers.

The system has two balanced inputs with priority control, each with a loop-through facility.

The amplifier has 70V and 100V outputs for constant voltage loudspeaker systems, and a low impedance output for 8 ohm loudspeaker loads

Technical Specifications are as follows:

RMS Power output	480W, 240W, 120W
Power Supply	230Vac
Frequency response	50 Hz to 20 kHz (+1/-3 dB @ -10 dB ref. rated output)
Battery Power Supply	24V
Voltage Output(Line)	100V / 70V
Line impedance	8 ohm

Distortion	< 3% at rated output, 1 kHz
Signal to noise ratio	>80B

➤ **Speaker**

Sr. No.	Minimum Specification	Compliance (Yes /
1	6W ceiling mount speaker with excellent speech & music	
2	Max Power: 9W, Rated Power: 6Watts, Power Tapping:	
3	Effective frequency range(-10 dB) :100 Hz to 20KHz	
4	SPL at rated power (1Khz at 1 m) 89 dB	
5	Opening Angle 1 KHz / 4 KHz (-6 dB): 180deg/180deg	
6	Speaker Diameter 88 mm(3.46in)	
7	ABS RAL 9003	

➤ **2CX1.5 Sqmm Cable Armored Cable**

Sr. No.	Parameters	Specifications	Compliance
1	Particulars		
1.1	No of Elements X Size in mm <sup>2</sup> (No X Sq.mm)	2C X 1.5	
1.2	Voltage Grade (Volts)	300/500	
2	Conductor		
2.1	Material	plain annealed high conductivity Flexible copper conductor as per Class 5 of	
2.2	Maximum d.c. resistance of conductor at 20° C (Ω/km)	13.3	
2.3	Shape of conductor	Bunched Circular	
3	Insulation		
3.1	a) Material b) Minimum Thickness (mm) c) Core Identification	Extruded pVC Type 'A' 0.44 Red & Black	
4	Collective Screen		
4.1	a) Material	Aluminium mylar tape	
4.2	b) Nominal Thickness (mm)	0.018	
4.3	c) Material of Drain Wire	Flexible ATC	
4.4	d) Size of Drain Wire (Sq.mm)	0.5 mm <sup>2</sup> (16/0.2 mm)	
5	Outer sheath		
5.1	a) Material	Extruded FR-LSH pVC Type ST1	
5.2	b) Nominal thickness (mm)	0.91	
5.3	c) Colour Of Outersheath	Blue	
5.4	Approximate Overall diameter of cable (mm)	7.4 ± 1.0	
5.5	Minimum bending radius (mm)	12 times Overall diameter	
6	Electrical Parameters		

6.1	Max. a.c. resistance of conductor at operating temperature ( $\Omega/\text{km}$ )	15.9	
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6.2	Mutual capacitance (nf/km)	<250	
6.3	Insulation resistance (MΩ/km)	10	
6.4	Inductance to resistance ratio (L/R)	<40	
6.5	Dielectric strength for 1 minute (H.V Test) (kV)	2	
7	FR-LSH PROPERTIES		
7.1	Oxygen Index	Min. 29% as per ASTM D- 2863	
7.2	b) Temperature Index	Min. 250 Deg.C as per ASTM D- 2863	
7.3	c) Smoke Density Rating	Max. 60% as per ASTM D- 2843	
7.4	d) Acid Gas Generation	Max. 20% as per IEC- 754- 1	
7.5	e) Flammability Test	As per IEC:60332-1	

❖ AV Components

86" Interactive Display			
Sr No	Parameters	Minimum Requirements	Compliance
1	Screen Size	86"	
2	Backlight Type	Direct-Type LED	
3	Brightness (Nits)	400 cd/m²	
4	Native Resolution	UHD: 3840 x 2160 HDR10	
5	Aspect Ratio	16:9	
6	Contrast Ratio (typical)	1200:1	
7	Dynamic Contrast Ratio	40000:1	
8	Life Time (typical)	50000 Hrs	
9	Response Time (typical)	8 ms	
10	Active Area (H x V)	1895 x 1066 mm	
11	Viewing Angle	178° Vert., 178° Hor. (89U/89D/89L/89R) @ CR>10	
12	Color Value	1.07 B (10-bit)	
13	Haze Level	8%	
14	Refresh Rate	60 Hz	
15	Glass Type	4 mm Tempered Anti-Glare	
16	Glass Hardness	8 Mohs	
17	Mainboard Model	MB400VS	
18	Operating System	Customized Android Pie 9.0	
19	Memory	4 GB DDR4	
20	Storage	64 GB EMMC	
21	CPU	CA55 Quad core	
22	GPU	Mali-G31 MP2	

23	Wired	10/100 Mbps Ethernet	
24	WiFi	WiFi 5 (802.11 a/b/g/n/ac) (via USB	
25	Bluetooth	BT 5.1 (via USB Dongle)	
26	Home Page	Personalized Background, Home buttons, Navigation bar, Quick	

27	Launcher	All Apps, Profile Login/Logout, Quick Settings, Tools, Source	
28	Applications	Whiteboard, ScreenShare, Web browser, File Manager, Media Player, Officesuite, AquaMail, CloudFileManager	
29	Board Management	Connected System for User Profile Management	
30	Others	Over-the-Air SW Update, Screen Freeze, Screen Lock, Dual Pen Recognition, Palm Erase, Annotate	
31	Video Input	2 x HDMI2.0 (HDCP2.2) 1 x HDMI2.0 (Daisychain Input) MicroSD (up to 1TB) OPS Interface	
32	Video Output	1 x HDMI2.0 (Daisychain Output) Headphone(Line-out)	
33	USB	1 x USB-A (2.0) 1 x USB-A (3.0) 1 x USB-C	
34	Front I/Os	USB-A (2.0 / autoswitch for Android & OPS) USB-A (3.0 / autoswitch for Android & OPS) 1 x USB-B (touch out) 1 x HDMI 2.0	
35	Console Buttons	Standby on/off Volume up Volume down Touch enable/disable Source Change,	
36	IR Receiver	Fixed on bezel	
37	Audio	2x20 W - Front Facing Speakers	
38	Pen Holder	Integrated Magnetic Tray	
39	Type of Touch	Infrared (IR) Technology	
40	Continuous Touch Points	Max. 20 touch points* *Bounded by application's limits	
41	Touch Resolution	32768 x 32768 px	
42	Sensitivity	Any touch with finger, gloved hand or	
43	Compatibility	Windows®7, Windows®8, Windows®10, Vista, XP, Mac® OS, Linux, Android	
44	Response Time	< 5 ms	
45	Touch Accuracy	+/- 1 mm (over 90% area)	
46	Pen Type	Battery-less Pen	
47	Pen Identities	2	
48	Object Sizes for Touch	2.8 & 10 mm	
49	LAN (Control)	RJ45 (LAN & Control) 3.5mm jack(RS232 Control) 2 x RJ12 (Sensor Box & service input)	
50	Vesa Mounting	800 x 600 mm - M8	
51	Bezel Width	B:66   T:15   L/R:15 mm	
52	Operating Temperature	+40°C / 0°C	



53	Operating Humidity	90%	
54	Power Supply	110 VAC - 240 VAC	
55	Typical	280 W	
56	Maximum	400 W	

57	Deep Standby		
58	Mechanical Features	Slim Bezel, User-Friendly Front Ports and Buttons, Detachable power cable, Carrying handles	
59	Safety	YES	
60	EMC	YES	
61	CE	YES	

55" Professional Display			
Sr No	Parameters	Minimum Requirements	Compliance
1	Screen Size	55"	
2	Backlight Type	Slim DLED	
3	Brightness (typical)	500 cd/m <sup>2</sup>	
4	Native Resolution	3840 x 2160 (16:9) - UHD	
5	Contrast Ratio (typical)	1200:1(typ.)	
6	Dynamic Contrast Ratio	50000:1	
7	Panel Life Time ( Min. )	50000 Hrs	
8	Response Time (typical)	8ms	
9	Active Area (H x V)	1209.6 × 680.4	
10	Viewing Angle	178° Vert., 178° Hor. (89U/89D/89L/89R) @ CR>10	
11	Color Value	1.07 G (8 bit + FRC)	
12	Screen Treatment	3H	
13	Haze Level	1%	
14	Refresh Rate	60Hz	
15	Orientation	Landscape / Portrait	
16	Operation Hours	24 / 7	
17	Area of Usage	Indoor	
18	Mainboard Model	17MB135VS	
19	RGB Input	VGA(DE-15F)	
20	RGB Output	N/A	
21	Video Input	4xHDMI2.0, 2xUSB2.0, USB2.0(Internal)	
22	Video Output	HDMI2.0	
23	Audio Input	Line In L/R	
24	Audio Output	Headphone, Optic SPDIF	
25	External Control	RS232(DE-9F), Ethernet(RJ45), Service(RJ12)	
26	External Sensor	RJ12	
27	Vesa Mounting	400 mm(W) x 400 mm(H) M6	
28	Bezel Width	9/9/9/11 mm	
29	Operating Temperature	0-40°C	
30	Operating Humidity	10-90%	
31	Power Supply	110 VAC - 240 VAC - 50/60 Hz	
32	Typical	138 W	

33	Maximum	180 W	
34	Deep Standby	$\leq 0.5$ W	

35	Main Features	Open Content Management Support, Scheduler, USB-Autoplay, Auto-Launch, HDMI-CEC, HDMI-Wakeup, Auto-switch on Failover, Panel Lock, OSD Rotation, NoSignalPowerOff, Screen Saver, Pixel shift, Scheduler, Videowall support, <del>Power Management, LAN, DVI, RS-232C, RS-485, IR, IR extender, IR receiver</del>	
36	Mechanical Features	Joystick, Rocker Switch, Detachable Power Cable, Detachable Logo, Internal Usb Cover, 30-degrees Tilting Installation Overlay Touch Kit	
37	Optional Features	SDM or OPS compatibility, Embedded IR, IR extender option	
38	Speaker	2x10 W	
39	Standard	QSG, IB, Power cord, Remote control unit, RC battery, Mounting kit, IR	
40	Safety	Yes	
41	EMC	Yes	
42	CE	Yes	

Conference Control Unit		
Sr No	Minimum Requirements	Compliance
1	The Control Unit shall have the following features and benefits:	
2	Plug-and-play functionality for quick and easy connection of Discussion Devices.	
3	Intuitive touch-buttons on the front panel for easy configuration and operation purposes.	
4	Intuitive LED indicators for clear and immediate feedback on the system settings.	
5	Web browser control – it shall be possible to use a web browser application to view and manage system settings.	
6	System control for up to 80 Discussion Devices.	
7	Hot swap of Discussion Devices, without having to power down the	
8	Plus/minus buttons and green LED indicators for setting the volume range of all connected Discussion Devices.	
9	Microphone-mode selection button and green LED indicators for selecting one of the following microphone operating modes: ‘open mode’ ‘override mode’ ‘voice activation mode’ and ‘push to talk	
10	Number of Open Microphones (NOM) button and green LED indicators for selecting the number of microphones that can be activated at the same time. It shall be possible to select up to four open microphones at	
11	Built-in digital recorder with internal memory and USB recording.	
12	Built-in loudspeaker and headphone socket for listening to recorded discussions before replaying them to the Floor, or listening to	
13	Built-in Digital Acoustic Feedback Suppression (DAFS).	
14	USB connector on front of unit for connecting a USB memory stick.	

15	Gain reduction due to number of open microphones (NOM) $1/\text{SQRT}$	
16	Sample rate 44.1kHz	
17	Nominal input (85 db SPL) <0.5%	
18	Max. input (110 db SPL) <0.5%	
19	Recorder	

20	Recording/ Playback 64,96,128,256Kbit/sec	
21	Recording/ Playback (sample frequency) 44.1kHz	
22	Monitoring loudspeaker	
23	Nominal output 72dB SPL	
24	Frequency response 200Hz-12.5kHz	

Conference Discussion Units		
Sr No	Minimum Requirement	Compliance
1	The Discussion Device shall enable participants to take part in a discussion by speaking into a microphone and listening to proceedings on a loudspeaker. The device shall have the following features and	
2	Plug-and-play functionality.	
3	Compact, attractive, ergonomic design, with LED indicator in the Discussion Device and in head of microphone.	
4	Choice of short or long fixed microphone with flexible stem.	
5	Loudspeaker integrated into front of device.	
6	Built-in headphone socket with output level control.	
7	Automatic level reduction when microphone is activated (configurable via web browser application of Control Unit): prevents acoustic feedback from headphone to microphone.	
8	Configurable as a participant or chairperson's device: changeable microphone buttons and concealed slide switch at the bottom of the device for configuration purposes	
9	GSM immunity.	
10	The device shall have the following user controls and indicators:	
11	Microphone button.	
12	Color-coded LED indicator above microphone button for showing the status of the device:	
13	- White ('Possible-To-Speak') shall indicate that the microphone will be active immediately after pressing the microphone button.	
14	- green shall indicate that the participant has pressed the microphone button and the request to speak has been added to	
15	- green flashing shall indicate that the participant is first in the waiting list,	
16	- red shall indicate that the microphone is active.	
17	Color-coded light-ring indicator in head of microphone: green shall indicate that a request-to-speak has been added to the waiting list; green flashing shall indicate that the participant is first in the waiting list; red shall indicate that the microphone is active	
18	Rotary thumbwheel on side of device for adjusting volume of connected headphones.	
19	The chairman has a separate microphone button and priority button enable the user to function as the chairperson at a conference or meeting. The chairperson's microphone shall be activated when the priority button is pressed and held in. All currently active participant microphones shall be muted, allowing the chairperson to take control of the meeting. A chime shall be sounded to announce that the	
20	Frequency response 200Hz-12.5kHz	

21	Headphones load impedance >32ohms <1kohm	
22	Loudspeaker nominal output 72dB SPL	

VC PTZ Camera		
Sr No	Minimum Requirements	Com
1	Image Sensor	1/2.8" OS, 2.14MP
2	Focal Lens	f=4.7~94.0mm
3	Zoom	Optical: 20X, Digital: 12X
4	Iris	F1.6 ~ F3.5
5	Minimal illumination	0.5 Lux (F1.8, AGC ON)
6	FOV	59.5°(H) 33°(V) / 68°(D)
7	Focus System	Auto, ual, PTZ Trigger, One Push Trigg
8	Shutter Speed	1/25 - 1/10,000s
9	Gain	Auto, ual
10	White Balance	Auto, ual, Indoor, Outdoor
11	Exposure Control	Auto, ual, Shutter Priority, Iris Priority
12	S/N	>50db
13	Pan Angle/ Speed -	170° ~ +170°, 0.2°/S ~ 100°/S
14	Tilt Angle/ Speed	-30° ~ 0°, 0.2/S - 60°/S
15	Presets	255
16	Tracking Modes	Presenter Tracking, Preset Tracking & Hybrid Tracking

6X2 4K60 4:4:4 HDR Presentation System		
Sr No	Minimum Requirements	Compliance
1	Should be 4K60 4:4:4 digital AV presentation system	
2	Should have Six HDMI® inputs with HDR10, HDR10+, and Dolby Vision® video formats support	
3	Should also have two HDBaseT inputs to connect with suitable transmitter to support a maximum resolution of 4K60 4:4:4 up to 130 ft (40 m)	
4	Should support Automatic Switching of Inputs or outing priority assigned to each input	
5	Should have two HDMI outputs with mirrored HDBaseT certified outputs	
6	Should support HDR10, HDR10+, and Dolby Vision® video formats	
7	Should have 4K60 4:4:4 video scaler for each mirrored	
8	Should support transport of audio formats like Dolby Digital®, Dolby Digital EX, Dolby Digital Plus, Dolby® TrueHD, DTS®, DTS-ES, DTS 96/24, DTS-HD High Res, DTS-HD Master	
9	Should be HDCP 2.3 compliant	
10	Should support CEC signals passthrough	
11	Should have EDID Management	
12	Should have eight mono analog audio inputs with atleast two with Mic/Line In support	



13	Should support 9-channel Audio mixing with audio embedding and de-embedding on each of the two Audio	
14	Volume and mute control should be configurable for each mirrored output independently.	
15	Should have simplified setup through the Web browser	
16	Should have push-buttons for control and LED color	

	showing signal status and power	
17	Should be working Out-of-the-Box with no programming requirement	
18	Should have a Gigabit Ethernet port	
19	Should support Enterprise-grade security like 802.1X authentication, Active Directory® credential management, PKI authentication, TLS, SSH, and HTTPS	
20	Should support Text overlay, image overlay, and background image for on-screen display	
21	Should have API (application programming interface) support for controls	
22	Should be Surface-mountable design to mount onto a wall or other flat surface.	
23	Should have universal 100-240V AC Power with IEC 60320 C14 mains power inlet; removable power cord included	
24	Should have an option of Cloud management via IoT based platform for remotely provisioning, monitoring, and managing devices across an enterprise or an entire client base by the same OEM	
25	Should be UL® Listed, IC, CE, FCC Part 15 Class B digital device compliant	

4K60 4:4:4 Transmitter for HDMI Signal Extension over CATx Cable		
Sr No	Minimum Requirements	Compliance
1	Should have minimum 1xHDMI Input or better	
2	Should have minimum 1xCatX Output or better	
3	Should enable extension of HDMI video and audio signals over a CAT5e or higher cable	
4	Should support minimum 4K and UHD at up to 130 ft or	
5	Should handle resolutions Up to 4096x2160@60Hz (DCI 4K60), 4:4:4 Video i.e. 4K60 4:4:4 Capability	
6	Should have HDR (High Dynamic Range) video support HDR10, HDR10+ or better	
7	Should support minimum HD 1080p, WUXGA, and 2K at up to 230 ft (70 m) or better	
8	Should support Dolby Vision and Deep Color Video Content	
9	Should support audio formats of Dolby Digital, Dolby Digital EX, Dolby Digital Plus, Dolby TrueHD, Dolby Atmos, DTS, DTS ES, DTS 96/24, DTS HD High Res, DTS HD Master Audio, DTS-X, LPCM up to 8 channels	
10	Should support minimum HDCP 2.3 or better	
11	Should support CEC signals	
12	Should support management of EDID	
13	Should support DVI and Dual-Mode DisplayPort Video signals or better	
14	Should be compact in size & have an option for Freestanding or surface mounting	
15	Should have power adapter supplied with the unit	

16	Should be Intertek Listed for US and Canada, CE, IC, FCC Part 15 Class B digital device compliant	
17	The switcher, Transmitter and receiver and central control system should be from the same OEM.	

<b>4K60 4:4:4 Receiver for HDMI Signal Extension over CATx Cable</b>		
<b>Sr No</b>	<b>Minimum Requirements</b>	<b>Compliance</b>
1	Should have minimum 1xHDMI output or better	
2	Should have minimum 1xCatX Input or better	
3	Should enable extension of HDMI video and audio signals over a CAT5e or higher cable	
4	Should support minimum 4K and UHD at up to 130 ft or	
5	Should handle resolutions Up to 4096x2160@60Hz (DCI 4K60). 4:4:4 Video i.e. 4K60 4:4:4 Capability	
6	Should have HDR (High Dynamic Range) video support HDR10, HDR10+ or better	
7	Should support minimum HD 1080p, WUXGA, and 2K at up to 230 ft (70 m) or better	
8	Should support Dolby Vision and Deep Color Video Content	
9	Should support audio formats of Dolby Digital, Dolby Digital EX, Dolby Digital Plus, Dolby TrueHD, Dolby Atmos, DTS, DTS ES, DTS 96/24, DTS HD High Res, DTS HD Master Audio, DTS:X, LPCM up to 8 channels	
10	Should support minimum HDCP 2.3 or better	
11	Should support CEC signals	
12	Should support management of EDID	
13	Should support DVI and Dual-Mode DisplayPort Video signals or better	
14	Should be compact in size & have an option for Freestanding or surface mounting	
15	Should have power adapter supplied with the unit	
16	Should be Intertek Listed for US and Canada, CE, IC, FCC Part 15 Class B digital device compliant	
17	The switcher, Transmitter and receiver and central control system should be from the same OEM.	

<b>1:2 HDMI Distribution Amplifier</b>		
<b>Sr No</b>	<b>Minimum Requirements</b>	<b>Compliance</b>
1	Should split one HDMI source into minimum two outputs	
2	Should handle resolutions Up to 4096x2160@60Hz (DCI 4K60). 4:4:4 Video	
3	Should handle HDMI w/HDR10, Deep Color, 3D	
4	Should be fully compatible with HD 1080p, UHD 4K, and DCI 4K sources and displays	
5	Should handle 3D video and Deep Color	
6	Should have selection option for HDCP 2.2, HDCP 1.4 or HDCP disabled	
7	Should have EDID management options	
8	Should handle Dolby TrueHD, Dolby Atmos, DTS HD, DTS:X, and uncompressed 7.1 linear PCM audio	

9	Should supports audio formats of Dolby Digital, Dolby Digital EX, Dolby Digital Plus, Dolby TrueHD, Dolby Atmos, DTS, DTS-ES, DTS 96/24, DTS HD High Res, DTS HD Master Audio, DTS-X, LPCM up to 8 channels	
10	Should have presence indication option for input and output video with status LED	

11	Should not require any Programming or control system	
12	Should be surface, shelf, or single rack rail mountable	
13	Should be supplied with power adapter	
14	Should have CE, IC, FCC part 15 Class B digital device compliance	

Wireless Presentation System with Wi-Fi Network Connectivity		
Sr No	Minimum Requirements	Compliance
1	Should be ideal for conference rooms, huddle rooms, lounges, lobbies, or almost any space to establish a <del>productive meeting environment</del>	
2	Should support secure wired and wireless presentation	
3	Should have an HDMI output supporting resolution up to 4K, and <del>multiple USB interfaces touch interactivity display</del>	
4	Should have dedicated LAN port for Corporate & Guest network, also the device should be able to generate its own built in Wi-Fi® network for guest content sharing, or a <del>suitable external Wi-Fi Router unit to be provided</del>	
5	Should have option for user to present content from Mac, desktop or laptop computers using client software or airplay, extension for the Google Chrome™ web browser, or Miracast® screen mirroring technology (Windows® 10 computers only). Present content from Android™ and iOS® <del>mobile devices with the app/Screen mirroring</del>	
6	Should have balanced audio output for de-embedding audio.	
7	Should support two sources on a single screen simultaneously and should have possibility to extend up to nine sources, layout should be configured automatically <del>based on the number of active sources the type of sources</del>	
8	Should be able to display a customizable welcome screen on the room display with simple instructions for <del>connecting and presenting when no source is connected</del>	
9	Should have integration with Appspace digital signage software platform for content display when system is not in use, or a <del>suitable external hardware unit to be provided</del>	
10	Should have built-in native integration with Microsoft 365, Outlook, Google Calendar, and other calendaring applications for Displaying space availability, meeting details, and other messaging on screen, or a suitable <del>external room scheduling unit to be provided</del>	
11	Should periodically indicate the time left in the meeting on Display if the calendar integration is incorporated, or a <del>suitable external room scheduling unit to be provided</del>	
12	Should have customizable welcome screen provides clear instructions for presenters, displaying space availability, <del>meeting details and other messages onscreen</del>	
13	Should comply to standard network security protocols such as 802.1x network access control, Active Directory® authentication, AES content encryption	

14	Should support minimum 100/1000 Mbps, auto-switching, autonegotiating, autodiscovery, full/half duplex, TCP/IP, UDP/IP, DHCP, SSL, TLS, SSH, SETP	
15	Should have minimum 1xRS-232 and 2xIR control ports	
16	Should support display device control via CEC, IR, or RS-	

17	Should supports an option for management of HDCP and	
18	Should support HTTPS web browser setup	
19	Should support Wi-Fi Dual-band 802.11a/b/g/n (2.4 GHz & 5 GHz), Up to 100 ft (30 m) range at 80 Mbps, subject to	
20	Should support HDCP 2.2	
21	Should be capable of Powered via PoE+ compliant Ethernet switch or a PoE+ Injector	
22	Should be UL Listed for US and Canada, CE, IC, FCC Part 15 Class B digital device compliant	
23	Should have an option of Cloud management via IoT based platform for remotely provisioning, monitoring, and managing devices across an enterprise or an entire client base by the same OEM	

4" 2-way surface-mount loudspeaker		
Sr No	Minimum Requirements	Compliance
1	Frequency Response 65Hz - 20kHz	
2	Power Handling 200W Cont. Prog./400W Peak	
3	Sensitivity 89 dB, 1W/1m	
4	Impedance 8 ohms	
5	Max SPL 113 Db	
6	Horizontal Coverage 120°	
7	Vertical Coverage 80°	
8	Crossover Frequency 2.2 Khz	
9	LF Transducer 2 x 4"	
10	HF Transducer 1"	
11	Swing x Rotation 100° x 90°	
12	Wattage Taps 70V: 3.75 W 70V/100V: 7.5W, 15W, 30W,	

Mixer Amplifier		
Sr No	Minimum Requirements	Compliance
1	Max. / rated - 360 W / 240 W	
2	output 4 ohm 31 V (240 W)	
3	Frequency response 80 Hz to 18 kHz (+1/-3 dB @-10 dB ref. rated output)	
4	Distortion <1% @ rated output power, 1 kHz	
5	Bass Control Max. ± 8 dB	
6	Treble Control Max. ± 8 dB	
7	Connector Cinch, stereo converted to mono	
8	Sensitivity 200 mV to 300 mV	
9	Impedance 22 kohm	



10	S/N (flat at max. volume) $\geq 70$ dB	
11	Headroom $> 25$ dB	

6 ft HDMI Interface Cable		
Sr No	Minimum Requirements	Compliance
1	Should be 6ft Male to Male High-speed Category 2 HDMI	
2	Should be 24k gold-plated 19-pin Type A connector	
3	Should have High-flex CL3-rated jacket	
4	Should Support 4K60 4:4:4 video	
5	Should support 18 Gbps bandwidth	
6	Should be RoHS compliant	

Automation Control Processor		
Sr No	Minimum Requirement	Compliance
1	Should have minimum 1 Bidirectional RS-232/422/485 or more	
2	Should have minimum 2 Bidirectional RS-232 or a suitable control port expansion module to be provided separately	
3	Should have minimum 8 IR/1-way Serial ports or a suitable control port expansion module to be provided separately	
4	Should have minimum 8 Low Voltage Relay Ports or a suitable control port expansion module to be provided	
5	Relay Port should be Rated minimum 1 Amp, 30 Volts AC/DC	
6	Should have minimum 8 I/O Versiport or a suitable control port expansion module to be provided separately	
7	Should have Onboard SDRAM minimum 2GB or more	
8	Should have minimum 8 GB Flash memory or more	
9	Should have memory card slot support SD/SDHC cards up to 32 GB or more	
10	Should support Expandable storage up to 1TB or more	
11	Should have minimum 1xHigh-speed USB 2.0 host port to support Mass Storage	
12	Should support ethernet with 100/1000 Mbps, auto-switching, auto-negotiating, auto-discovery, full/half-duplex, industry-standard TCP/IP stack, UDP/IP, CIP, DHCP, SSL, TLS, SSH, SETP (SSH File Transfer Protocol), EIDS 140.2	
13	It should support IEEE 802.1x Active Directory service authentication to ensure reliability and compliance with your organization's IT policies	
14	It should have Built-in SNMP support	
15	Should have Enterprise-class network security and authentication with SNMP V3 remote IT management	
16	It should support web servers like HTTP/HTTPS & SMTP email client	
17	Should have IPv4 & IPv6 Support	
18	Should have Native BACnet/IP support or a suitable external interface to be provided	
19	Should have a network bus control port for communicating and controlling with other devices of the	

20	Should have Customizable user interface, capable of real-time feedback and Metadata	
21	Should support minimum 10 programs to run simultaneously	
22	Should be 1U rack-mountable with rack ears provided	
23	Should be controllable thru PC thru application file	

24	Should be able to be controlled thru Mobile Devices like I-pad, I-phone, Android without the need of any	
25	Should be UL Listed for US & Canada, CE, IC, FCC Part 15 Class B digital device compliant	
26	Should have an option of Cloud management via IoT based platform for remotely provisioning, monitoring, and managing devices across an enterprise or an entire client base by the same	
27	Appropriate power supply for the controller should be included in the BOO	

7 in. Tabletop Touch Screen		
Sr No	Minimum Requirements	Compliance
1	Should have TFT active matrix Colour LCD, 7in. Diagonal	
2	Should have widescreen active-matrix color display and 1280 x 800 display resolution	
3	Should control Custom-programmable virtual control buttons	
4	Should supports HTML5 and Smart Graphics for custom user projects	
5	Should have minimum 1280 x 800 pixels resolution or better	
6	Should have minimum aspect ratio of 16:10 WUXGA or better	
7	Should have minimum contrast of 850:1 or better	
8	Should have minimum brightness of 350 nits or better	
9	Should have viewing angle of $\pm 80^\circ$ horizontal, $\pm 80^\circ$ vertical or better	
10	Should have Edge-lit LED with auto brightness control	
11	Should have the minimum project storage of 600 mb or better	
12	Should have 2 GB LPDDR3 RAM	
13	Should support 100 Mbps, auto switching, auto negotiating, auto discovery, full/half duplex, TCP/IP, UDP/IP, CIP, DHCP, SSL, TLS, SSH, SFTP (SSH File Transfer	
14	Should employ advanced security features and protocols like IEEE 802.1X, SNMP, IPv4 or IPv6, Active Directory® service authentication HTTPS web browser setup IEEE	
15	Should support Wi-Fi communication with IEEE 802.11a/b/g/n/ac Wi-Fi	
16	Should have built-in microphone and speakers	
17	Should support onboard Voice Recognition	
18	Should have SIP Intercom integration feature	
19	Should support H.265, H.264, or MJPEG formats streaming	
20	Should support RTSP	
21	should support streaming input resolution up to	
22	Should have Capacitive touch screen display with 5-point multitouch capable	
23	Should have Web, cloud, or device-based configuration	
24	Should support native apps for Zoom Rooms conferencing control, Microsoft Teams online meeting solution, and various room scheduling services	

25	Should have Enterprise grade security and authentication with 64 and 128-bit WEP, WPA and WPA2-PSK with TKIP and AES or better	
26	Should have the built-in Bluetooth communications beacon	

27	Should be powered via Single wire Ethernet connection with Poe or PoE+ only. should not have separate power supply	
28	Should have built-in Table Top Docking Station	
29	Should be available in Black color	
30	Should be IC, CE, FCC Part 15 Class B digital device	
31	Should have an option of Cloud management via IoT based platform for remotely provisioning, monitoring, and managing devices across an enterprise or an entire client base by the same	

Table mount Modular Multi-connection Cable Manager		
Sr No	Minimum Requirements	Compliance
1	Should have an easy openable retractable lid which disappears with a single tap of a button	
2	Should have minimum 1xUniversal power supply	
3	Should have 6 module slots arranged in single row or better	
4	Should have adjustable plates to accommodate a variety of cables with different connector shapes and sizes	
5	Should have Swiveling dog mounting system accommodates surfaces up to 1-3/4 inch (44 mm) thick	
6	should Fits a 3-1/4 x 7 inch (83 x 178 mm) size	
7	Should be Square in shape	
8	Should have pass-thru cable for 1x18Gbps HDMI to HDMI with 4K resolution support	
9	Should have pass-thru Cable USB-A to USB-B, USB 2.0	
10	Should have front module connectors with engraved Symbol for different types of Cables & Connector	
11	Should have USB charging capability which enables Rapid charging of minimum two USB devices up to 12 watts at 2.4 amps through two USB Type-A charging ports	
12	Should have 10xRJ-45 I/O modules for LAN connectivity through the Cable Manager	

Tabletop Open platform Video Conference System		
Sr No	Minimum Requirements	Compliance
1	Should support minimum 7 inches diagonal capacitive touch screen or better	
2	Should have Multi-Touch TFT active matrix color LCD with resolution of 1280 x 800 pixels, or an external 7" Touch Panel to be provided	
3	Should have built-in AEC, automatic mic mixing, automatic gain control, and dynamic noise reduction	
4	Should be minimum full-duplex IEEE 1329 Type 1 compliant or better	
5	Should have Full range speaker with minimum 11 Watts amplifier power or a suitable External amplifier to be	
6	Should have minimum 95 dB SPL at 0.5m or better	

7	Should have frequency response of minimum 90 Hz to 22 kHz or better	
8	Should have 360° tri/quad element mic array or better	
9	Should have minimum 20 ft radial pickup range or better	
10	Should support minimum two additional optional mic or better	

11	Should have an inbuilt transmitter to send HDMI and USB single to be carried to a distance of 70mtrs. over a single cat6 cable or a separate Transmitter and receiver to be supplied	
12	Should be supplied with compatible receiver and power adapter	
13	Should have minimum 1xHDMI Input or better	
14	Should be supplied with UC Camera with minimum Resolution HD 1080p @ 30 fps or better	
15	Should have minimum 4x digital Zoom or better	
16	The camera should support atleast the auto/genius framing feature or better	
17	Should have minimum horizontal FOV: $\pm 120^\circ$ & Vertical FOV:	
18	Should have 4K image sensor & minimum aperture of f/2.8 or better	
19	Should have USB Type-C connectivity with UVC 1.1 plug-and-play compatible	
20	Should support content Input Resolution of minimum 1920x1080@60Hz or higher	
21	Should be minimum HDCP 2.2 compliant or better	
22	Should support the EDID & CEC Passthrough	
23	Should support Integration with SIP compliant phone systems	
24	Should support Built-in Occupancy Sensor activates touch screen and the room display device, or an external occupancy sensor to be provided to turn on the Display	
25	Should support minimum 100 Mbps ethernet port along with LDAP, Kerberos, SSL, TLS, SSH, SFTP (SSH File Transfer Protocol), SRTP	
26	Should support enterprise-grade security	
27	Should have device management including IEEE 802.1X, Active Directory authentication, password login, HTTPS secure provisioning	
28	Should support cloud-based device deployment and	
29	Should have built-in Bluetooth to Transfer Active call over Bluetooth device pairing, or an external Bluetooth device to be provided	
30	Should have USB 2.0 micro Type B device port to support UAC & UVC for plug & play compatible audio/speakerphone interface and camera video output to a USB host computer running web conferencing or other software	
31	Should supports UVC for camera video input	
32	Should have minimum 1xRS-232 & 1xIR Port or better for display device control or an external controller to be provided	
33	Should support Built-In wireless presentation and Device Mirroring shares the full screen from an Apple iOS, Android, macOS, or Windows device, or a suitable external wireless Presentation device to be provided	
34	Should support secure wired and wireless presentation	
35	Should have a option for wireless presentation from laptops, smartphones, and tablet devices using the existing Wi-Fi wireless network for BYOD connectivity	



36	Should be compatible with Apple® iOS®(Airplay), Android™, Windows®, macOS®, Chrome OS™ devices	
37	Should have Miracast option for Android devices & Windows® 10 devices which allows users to wirelessly share content from a Microsoft Windows 10 device, even if a Wi- Fi® network is not available	

38	Should have built-in native integration with Microsoft 365 & MS Exchange applications for Displaying space availability, meeting details, and other messaging on screen, or a suitable external room scheduling unit to be provided	
39	Should not require any automation controller, programming or software installation	
40	Should support Web browser setup	
41	Should supply with all the additional accessories like HDMI cables, CATx Cables, USB Cable, Camera Mounting Bracket	
42	Should have an option of Cloud management via IoT based platform for remotely provisioning, monitoring, and managing devices across an enterprise or an entire client base by the same	
43	Appropriate power supply for the device should be included in the BOO	

## ❖ Fire Alarm System

Active Repeater Panel		
Sr N	Description	Compliance
1	LPCB Certification No.	
2	Display Full colour 800 x 480 LCD with resistive touch screen and automatic backlight dimming	
3	Network Interface Card	
4	USB host port USB type A	
5	USB device port USB type B	
6	Input Supply -24VDC	
7	Network- IP , RS232 /RS485	
8	RS485 fire panel network Up to 128 panel nodes	
9	IP rating -30	

Addressable Multidetector		
Sr N	Description	Compliance
1	Electronic addressing Dual bi-color LED indication for 360° viewing angle	Yes
2	3 User selectable modes	Yes
3	Variable sensitivity 1% to 4.5% or better	1% to 5%
4	Electronically Addressed	Yes
5	Operating Voltage 17 – 41 V dc	Yes
6	Low Power Mode (typ) 120 µA	Yes
7	Quiescent Current (typ) 400 µA	Yes
8	Variable sensitivity 1% to 4.5% or better	1% to 5%

9	Alarm Current	9.1 mA (excluding remote)
10	Removable Chamber	Yes
11	Dual Heat Elements	Yes
12	Stainless Steel smoke chamber mesh	Yes
13	Heat Sensing limit 0 to 88 Degree C	Yes

14	LPCB Certified	Yes
15	VDS Approved	Yes

Addressable Heat detector		
Sr N	Description	Compliance
1	Electronic addressing Dual bi-color LED indication for 360° viewing angle	
2	3 User selectable modes	
3	Variable sensitivity 1% to 4.5% or better	
4	Electronically Addressed	
5	Operating Voltage 17 – 41 V dc	
6	Low Power Mode (typ) 110 µA	
7	Quiescent Current (typ) 350 µA	
8	Alarm Current 9.1 mA (excluding remote indicator)	
9	Removable Chamber	
10	Dual Heat Elements	
11	Heat Sensing limit 0 to 88 Degree C	
12	LPCB Certified	
13	VDS Approved	
14	IP Rating : IP 67 or Higher	

Input Module		
Sr N	Description	Compliance
1	Electronic addressing	
2	1 no. Monitored Input	
3	Electronic Programming	
4	Operating voltage 17 - 41Vd.c.	
5	Quiescent Current / Alarm Current 150µA (at 41V) max	
6	LPCB Certified	
7	VDS Approved	

Output Module		
Sr N	Description	Compliance
1	Electronic addressing	
2	1 no. Monitored Output	
3	Electronic Programming	
4	Operating voltage 17 - 41Vd.c.	
5	Quiescent Current / Alarm Current 150µA (at 41V) max	
6	LPCB Certified	

Resettable Manual Call Point
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<b>Sr N</b>	<b>Description</b>	<b>Compliance</b>
1	Electronic addressing    Blinking LED for visual supervision	
2	Two wire communication	
3	In-Built Short Circuit Isolator	

4	Operating Voltage 17 - 41V dc	
5	Low Power Mode 180µA (max), 100µA (typ)	
6	Quiescent Current 350µA (max), 250µA (typ)	
7	Alarm Current 10.0mA (max), 5mA (typ)	
8	Resistance in positive 100mΩ when closed (max), 100kΩ when open (min)	
9	Short-circuit threshold (typ) 430Ω	
10	LPCB Certified	

Wall Sounder		
Sr N	Description	Compliance
1	Electronic addressing	
2	Variable Sound Output 90 ~ 102 dB(A) (±2 dB(A)) output at 1 metre	
3	51 User-Selectable Tones (all tones EN54-3 compatible)	
4	Minimum 13 volume setting	
5	360° Harmonic sound output	
6	Auto-Shutdown feature prevents noise-pollution	
7	Operating Voltage 17 ~ 41 Vdc	
8	Quiescent Current (typ) 200 µA	
9	Sounding Current (typ) 2 mA (90 dB(A) (±2 dB(A)) @ 1 m) ~ 8 mA (102	
10	Tone Frequency Range 300 Hz ~ 2850 Hz	
11	LPCB Certified	
12	VDS Approved	

## ❖ Access Control System

## ➤ Wire Free Reader

Sr N	Description	Compliance
1	Wire free reader should be Stainless steel construction and battery operated.	
2	Reader must operate on maximum of 3 AAA batteries (LR03 1,5V) and that should last long till 40000 - 60.000 door opening	
3	Wire free reader must have Multiple Opening mode like... Standard Office mode Timed office Automatic opening Automatic opening + office	

4	Installation of Wire free reader should be Simple & it should be ready to install on any type of door, including those with narrow frames	
5	Reader must support MIFARE® (DESFire EV2, Plus, Ultralight C, Classic - ISO/IEC 14443) Bluetooth SMART (BLE) NFC technologies	

6	Wire free reader must be able to operate on Data on card technology and should have the capacity to store atleast of 2250 logs in standlaone mode.	
7	Wire free reader should be compatible with European electro mechanical mortise locks and cylinders.	
8	Reader should have the provision for mechanical-key as well along with the Privacy control mechanism.	
9	Wire free reader should always be opened from the inside (single action panic feature works in conjunction with the relevant mortise lock)	
10	Wire free reader should not be more than of 285mm x 42mm x 19,5mm and it should not be more than 1.5 KG	
11	Wire free reader should Covers door thicknesses: From 32mm up to 120mm.	
12	Wire free reader should be of Clutch mechanism and when it's in unWire free reader ed position then handle moves freely.	
13	Handle of Wire free reader must be Reversible handle left or right	
14	Wire free reader muts be available in multiple colour finishes.. IM Satin stainless steel IP Bright stainless steel PP PVD bright brass type PM PVD satin brass type NE Black chromium BC BioCote anti-	
15	Reader muts be available in Black and white colour.	
16	Reader must perform well in +5 °C / +50 °C Environmental conditions Outdoor and it should be IP53.	
17	Reader Must be CE, FCC/IC, RCM, EAC, BIS , IMDA , EN1906, EN 179, EN 1634-1 (Ei60, E260, E90) certified.	



➤ **Portable Programming Device**

Sr N	Description	Compliance
1	A multilingual Portable device must be there to configure the Wirefree readers.	
2	Programmable device should work on Battery which should not be more than : 3 alkaline batteries - LR03 - AAA 1,5V	
3	Portable device must be ready to work over NFC or USB or on RS232	
4	Portable Device must have the functionality to perform several activity like.. Initialise wirefree readers Collecting the audit trail. Update locks (door profile & internal clock). Door diagnostic.	
5	Portable Device must have the functionality to open the Wirefree readers in case of emergency.	
6	Portable device must have the provision to provide the power to the wirefree readers in case of Battery down.	
7	Portable device must be EN 55022 (1994), Class B, EN 50082 (1997) certified.	
8	Device Must perform seamlessly even in operating temperatures: .0°C	

➤ **Ncoder**

Sr N	Description	Compliance
1	Card Ncoding device compatible with a wide range of RFID cards and compatible with BLE mobile keys.	
2	Ncoding device must not be more than 95,5 x 141 x 30,5mm Dimensions and should not be more than 174	
3		
4	Power consumption of Ncoding device should be : 5V and must have the provision of USB or Ethernet connectivity to connect with the PC	
5	USB Interface of the device should be USB 2.0 Type-B and Ethernet Interface: 10BASE-T/100BASE-TX	
6	Ncoding device supports card types... MIFARE® (DESFire EV2, Plus, Ultralight C, Classic-ISO/IEC 14443), HID ICLASS®, Bluetooth SMART (BLE), NFC.	

7	It should be CE, FCC/IC, RCM certified.	
8	LED indication must be there as Red+Green+Blue	
9	Ncodign device muts perform seamlessly in Temperature: Min 0°C to Max 50 °C	
10	Non condensing Humidity: lever must be atleast of Min 0 to 95%	

➤ **Gateway**

Sr N	Description	Parameters	Compliance
1	Frequency range	2400-2483,5 Mhz	
2	RF standard	Bluetooth Low Energy	
3	Indoor radio range	10/15m	
4	Max output power	8dBm	
5	Power	PoE IEEE802.3af, 12V power adapter	
6	DHCP / Static IP	DHCP by default	
7	Ethernet	10 BASE-T/100BASE- TX	
8	Operation Temperatur	0 to 60 °C	
9	Operation Humidity	35 to 85 %	
10	LED	Multi colour led to notify the status of the	
11	Certifications	CE, FCC/IC, RCM, SRRC, EAC	

➤ **Node**

Sr N	Description	Parameters	Compliance
1	Frequency range	2400-2483,5 Mhz	
2	RF standard	Bluetooth Low Energy	
3	Indoor radio range	10/15m	
4	Max output power	8dBm	
5	Power	12V power adapter	
6	Connectivity	BUS485	
7	Operation Temperatur	-0 to +70 °C	
8	Operation Humidity	35 to 85 %	
9	LED	Multi colour led to notify the status of the	
10	Certifications	CE, FCC/IC, RCM, SRRC	

➤ **Proaccess Space**

Sr N	Description	Compliance
1	Web Based multi lingual access control software that enables users to programme access-time zones for each user, manage different company calendars and obtain audit trails from each door to see who has passed through it.	
2	Software must be user friendly to use both PC and Tablet device.	
3	Access control software must run on MSSQL database.	
4	Software should be Multiplatform compatible: so that there is No risk of database corruption	
5	Access control Software must include special functions such as automatic door status changes, anti pass back and relay management (for example in elevator control)	
6	Software must have at least of user capacity of Up to 4 million users	
7	Access software should support at least of Up to 64,000 doors &	
8	Software should have 256 Calendars., 1024 Time periods & 1024 Time zones.	
9	Access software should support unlimited number of Access	
10	Software must have the functionality to monitor the live events coming from the Wirefree readers.	
11	Software must have the functionality to open or close the doors(Including the Wirefree readers) directly from the software.	
12	Event Stream and Automatic key assignment option must be available in software.	
13	Database synchronization must be available .	
14	Access control Must be ready to integrate with other application over SHIP communication.	
15	Elevator configuration, Hotel Module and Mobile Guest Key option must be the default part of the access control application.	
16	Access control software must have the functionality for Graphics mapping.	
17	Model Name	
18	Software should be ready to integrate with other applications over API or database level.	
19	Software should have the functionality such as ... Anti Pass back occupancy control Visitor management	

➤ **Time & Attendance**

Sr N	Description	Parameters	Compliance
1	Biometric	Face, RFID	
2	RF Option	125kHz EM, HID Prox & 13.56MHz MIFARE, MIFARE Plus, DESFire EV1/EV21), FeliCa, iCLASS	
3	RF Read Range2)	EM/HID iCLASS/MIFARE: 30 mm, HID Prox/DESFire: 25 mm, FeliCa: 15 mm	
4	Mobile	NFC, BLE	
5	Barcode and QR	Supported	
6	CPU	1.5GHz Quad Core	
7	Memory	32GB Flash + 4GB RAM	
8	Crypto Chip	Supported	
9	LCD Type	5.5" IPS color LCD	
10	LCD Resolution	720 x 1280 pixels	
11	Sound	16bit	
12	Operating Temperatur	-20°C ~ 50°C (-4°F ~ 122°F)	
13	Operating Humidity	0%~80%, non-condensing	
14	Camera	2MP x 2EA (Visual, IR)	
15	Dimension (W x H x D)	82.5mm x 171mm x 23.4mm	
16	Ingress Protection (IP)	IP65	
17	Vandal Proof (IK)	IK06	
18	Certificates	KC, CE, UKCA, FCC, RCM (Compliance: RoHS, REACH, WEEE)	
19	Recognition	0.6 ~ 1.0 m (23.6"~39")	
20	Recognition Height	1.4 ~ 1.9 m (55.1"~74.8")	
21	Matching Speed	Less than 0.3 sec	
22	Live Face Detection (Anti-	Supported	
23	Max. User	1,00,000	
24	Max. Credential	Face: 50,000	
25	Max. Credential	Face: 100,000 / Card: 100,000 / PIN: 100,000	
26	Max. Text Log	50,00,000	
27	Max. Image Log	50,000	
28	Ethernet	Supported (10/100/1000 Mbps, automatic	
29	Wi-Fi	Supported (802.11 b/g/n 2.4GHz)	
30	RS-485	1ch Host or Slave (Selectable)	
31	Wiegand	1ch Input and 1ch Output	
32	TTL Input	3ch Inputs	
33	Relay	1 Relay	
34	PoE+	Supported (IEEE 802.3 at compliant)	
35	Intercom	Supported	

36	USB	USB 2.0 (Host)	
37	Extended USB	Supported	
38	Tamper	Supported	
39	Power	DC 12 V 2.5A, DC 24 V 1.2A	

❖ **Make List :-**

Sr. No.	Item	Approved Make
1	CCTV Surveillance	Tyco / Mobotix / Avigilon
2	Hard Disk	WD/Seagate/Toshiba
3	Outdoor Access Point P2P	Digisol/Tp-link/D-link
4	Work Station	Dell/HP/Lenovo
5	Network Rack	Netrack/Rittal/Emerson
6	Passive Networking	Commscope/ Panduit /Legrand
7	Active Networking	Aruba/ Cisco /Netgear
8	PVC Pipe	Varni/YGP/Precision
9	HDPE Pipe	Varni/YGP/Precisions
10	GI Pipe	BEC/AKG/Precision
11	Pole	Yamuna/Fab/Impressi on Equipment
12	Fire Alarm System	BOSCH /HOCHIKI /ESSER
13	PA System	BOSCH/TOA/EV
14	Fire Cable	Polycab/RR/Caliplast
15	Speaker cable	Polycab/RR/Caliplast
16	EPABX Sytem	Cisco / Avaya / NEC
17	86" Interactive Display	Samsung/Panasonic/Vestel
18	55" Professional	Samsung/Panasonic/Vestel
19	Conference System	Bosch/Toa/Televic
20	PTZ Camera	A&T/Aver/Sony
21	AV Switcher	Crestron / Extron / Lightware
ss22	Transmitter & Receiver	Crestron / Extron / Lightware
23	HDMI Splitter	Crestron / Extron / Lightware
24	Wireless presentation	Crestron / Extron / Lightware
25	Speaker	EV/Bosch/Crestron
26	Amplifier	EV/Bosch/TOA
27	HDMI Cable small	Crestron / Extron / Lightware
28	Control processor	Crestron / Extron / Lightware
29	Touch Panel	Crestron / Extron / Lightware
30	Cable Manager	Crestron / Extron / Lightware
31	Video Conference	Crestron / Poly / AMX
32	Time Attendance	Suprema / Invixium / Bosch
33	Access Control System	Salto/Aperio/Dormakaba

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Part C

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**Electrical Works**

Section I General Instructions

Section II Electrical Specification and  
List of Make

Section III Item Specification

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Section III Item  
Specifications

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## Section II: Electrical Works - Item Specifications Contents

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## E1 Internal Wiring

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### E-1 to E-13 Point wiring

#### 1 Material

Shall confirm to E – 1.

#### 2 Workmanship

#### p Installation

A) The size of conduit shall be selected in accordance with the number of wires permitted under table given below. The minimum size of the conduit shall be 25 mm. diameter unless otherwise indicated or approved. Size of wires shall not be less than 1.5 sq.mm. copper or 2.5 sq.mm. aluminium.

Nominal Dia of (mm)	Nominal Cross sec. (mm <sup>2</sup> )	<u>20</u> <u>mm</u>		<u>25</u> <u>mm</u>		<u>32</u> <u>mm</u>		<u>38</u> <u>mm</u>	
		S	B	S	B	S	B	S	B
1/2.40	1.50	4	3	8	6	15	9	--	--
1/1.80	2.50	4	2	6	4	10	8	--	--
1/2.24	4.00	2	2	4	3	8	6	--	--
1/2.80	6.00	1	--	4	3	6	6	--	--
1/3.55	10.00	1	--	3	2	5	4	6	5

**S** - runs of conduits which have distance not exceeding 4.25 m. between draw boxes & which do not deflect from the straight by an angle more than 15 degree.

**B** - runs of conduits which deflect from the straight by more than 15°.

B) Conduits shall be kept at a minimum distance of 100 mm. from the pipes of other non-electrical services. And maintain minimum 300 mm distance between telephone, TV & Computer piping.

C) Separate conduits/raceways shall be used for :

1. Normal lights and 5 A 3 pin sockets on lighting circuit.
2. Separate conduit shall be laid from D.B. to switch board or point.
3. Power outlets - 15 A 3 pin 20 A/30 A, 2 pin scraping earth metal clad sockets.
4. Emergency lighting.
5. Telephones.
6. Fire alarm system.
7. Public address system & Music system.
8. For all other voltages higher or lower than 230 V.
9. T.V. Antenna.

10. Water level guard.

11. Computer Wiring

D) Call bell wiring layout of conduits shall be generally as indicated on drawings and the layout shall be supplemented and complemented by contractor on site with the approval of the Engineer.

E) Wiring for short extensions to outlets in hung ceiling or to vibrating equipments, motors etc., shall be installed in flexible conduits. Otherwise rigid conduits shall be used. No flexible extension shall exceed 1.25 m.

F) Conduits run on surfaces shall be supported on GI 12 mm. thick pressure saddles which in turn are properly screwed to the wall or ceiling. Saddles shall be at intervals of not more than 500 mm. Fixing screws shall be with round or cheese head and of rust-proof materials. Exposed conduits shall be neatly run parallel or at right angles to the walls of the building. Unseemly conduit bends and offsets shall be avoided by using fabricated mild steel junction/pull through boxes for better appearances. No cross-over of conduits shall be allowed unless it is necessary and entire conduit installation shall be clean and neat in appearance.

G) Conduits embedded into the walls shall be fixed by means of staples at not more than 500 mm. intervals. Chases in the walls shall be neatly made and refilled after laying the conduit and brought to the finish of the wall but final finish will be done by the building contractor.

H) Conduits buried in concrete structure shall be put in position and securely fastened to the reinforcement and got approved by the Engineer, before the concrete is poured. Proper care shall be taken to ensure that the conduits are neither dislocated nor choked at the time of pouring the concrete suitable fish wires shall be drawn in all conduits before they are embedded.

Where conduit passes through expansion joints in the building, adequate expansion fittings shall be used to take care of any relative movement.

I) Inspection boxes shall be provided for periodical inspection to facilitate withdrawal and removal of wires. Such inspection boxes shall be flush with the wall or ceiling in the case of concealed conduits. Inspection boxes shall be spaced at not more than 12 meters apart or two 90° solid bends or equal. All junction and switch boxes shall be covered by 6 mm. clear perspex plate truly cut and fixed with cadmium plated brass screws. These junction boxes shall form part of point wiring or conduit wiring as the case may be including the cost of removing the perspex cover for painting and re-fixing. No separate charges shall be allowed except where specially mentioned.

J) Conduits shall be free from sharp edges and burrs and the threading free from grease or oil. The entire system of conduits must be completely installed and rendered electrically continuous before the conductors are pulled in. Conduits should terminate in junction boxes of not less than 32 mm. deep.

K) An insulated earth wire of copper rated capacity shall be run in each conduit.

## **2) Lighting & Power Wiring :**

A) All final branch circuits for lighting and appliances shall be flexible copper wire of appropriate size run inside conduits. The conduit shall be properly connected or jointed into sockets, bends, junction boxes.

B) Branch circuit conductor sizes shall be as shown in the schedule of quantities and or drawings.

C) All circuits shall preferably be kept in a separate conduit upto the Distribution Board. No other wiring shall be bunched in the same conduit except those belonging to the same phase. Each lighting branch circuit shall not have more than ten outlets or 800 watts whichever is lower. Each conduit shall not hold more than three branch circuits, of the same phase.

D) Flexible cords for connection to appliances, fans and pendants shall be 650/1100 V grade (three or four cores i.e with insulated neutral wire of same size) with tinned stranded copper wires, insulated, twisted and sheathed with strengthening cord. Colour of sheath shall be subject to the Engineer's approval.

E) Looping system of wiring shall be used. Wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors. No such joints shall be made unless the length of the sub-circuit, sub-main or main is more than the length of the standard coil.

F) Control switches shall be connected in the phase conductors only and shall be 'ON' when knob is down. Switches shall be fixed in 3 mm. thick painted or galvanized steel boxes with cover plates as specified. Cadmium plated brass screws shall be used.

G) Power wiring shall be distinctly separate from lighting wiring. Conduits not less than 25 mm. and wires not less than 2.5 sq.mm. copper shall be used.

H) Every conductor shall be provided with identification ferrules at both ends matching the drawings.

### **3) Testing**

The entire installation shall be tested for :

- a) Insulation resistance.
- b) Earth continuity.
- c) Polarity of single pole switches.

### **General**

All the wiring switch board, outlet points shall be done in a concealed manner in wall & slab in PVC conduit of minimum 25 mm dia. (medium guage) when laid in ground the PVC pipe will be Heavy gauge & with 650v / 1100v grade PVC insulated flexible copper condutor wire. The switches should be modular with moulded cover plates, blank plates for outlet boxes. The accessories, connectors, sockets, should be fixed with brass crome / cadmium plated machine screw. For fan points the rates should be inclusive of 300 W regulators as required to complete the point wiring. The wiring shall be as per IS: 732 and IS: 4648. The wiring shall be done in a looping manner so as to avoid junction boxes at any place. All the looping shall be done only in the switch board and outlet points. The size of the wire shall be as per the specification. Colour code shall be strictly followed. Heavy guage PVC pipe shall be laid for ground.

The size of wires shall as follow : 10

Amp. metal clad points:

Phase / Neutral	2.5 mm <sup>2</sup>
Earth	1.5 mm <sup>2</sup>

6 Amp. out let points :

Phase / Neutral	1.5 mm <sup>2</sup>
Earth	1.5 mm <sup>2</sup>

Two nos. of 16 Amp. socket out let connected in parallel from DB to first outlet

Phase / Neutral	4.0 mm <sup>2</sup>
Earth	2.5 mm <sup>2</sup>

Two nos. of 16 Amp. socket out let connected in parallel from first outlet to second outlet.

Phase / Neutral	2.5 mm <sup>2</sup>
Earth	1.5 mm <sup>2</sup>

Light, fans, exhaust fan, 5 Amp. plug point, two way light point, bell point etc.

Distribution Board to SB

Phase / Neutral	2.5 mm <sup>2</sup>
Earth	1.5 mm <sup>2</sup>
SB to outlet (P/N/E)	1.5 mm <sup>2</sup>

15/20 Amp. Socket outlet for appliances / AC (Single Phase/Three Phase) / Geyser

Phase / Neutral	4.0 mm <sup>2</sup>
Earth	2.5 mm <sup>2</sup>

Separate pipes shall be laid for off wires and circuit mains.

Circuit mains of same phase shall be drawn in one pipe with prior permission/discussion with the consultant.

Separate phase, neutral and earthing wire of sizes recommended by consultant shall be drawn for each and every circuit mains.

All wires shall have proper size Cu. Lugs when connected to any MCB, Plug etc...

### **CONDUIT WORKS :**

#### **CEILING / WALL OUTLET BOXES FOR LIGHTS / FANS :**

Outlet boxes shall be of steel with cover and so installed as to maintain continuity throughout. These shall be protected at the time of laying by filling with jute / earth / cotton etc. so that no cement mortar finds its way inside during concreting or plastering etc. In beams conduit socket shall be provided in place of outlet boxes. The same shall be used for installation of luminaries.

For fixing light fixtures / brackets, outlet boxes complete with knock out for holding conduits shall be used. For lighting fixture suitable for 40/20 watts fluorescent tubes / incandescent lamps / mercury vapour lamps, only one outlet box is required.

For fixing ceiling fans, circular outlet boxes, 100 mm. diameter, complete with 12 mm. dia. Mild Steel rod 300 mm. long, for holding 12 mm. dia. Mild Steel cover 125 mm. dia. at bottom shall be used.

#### **DRAW OUT JUNCTION BOXES :**

Steel drawout boxes at angle dimensions shall be provided at a convenient points on walls / ceilings to facilitate pulling of long runs of cables / wires. The location of these boxes is to be decided prior to fixing, as per site requirement and following should be treated as general guidance for deciding the location of these :

- (a) These should be provided at a place where these are not in direct view. Recommended place is 400 / 450 mm. below ceiling, if conduits are running vertically.

- (b) Junction box in the offset of bottom of RCC beam and vertical wall should not be provided.
- (c) If junction boxes are coming side by side for two or more conduits, one common M.S. box of proper size can be used to act as junction box.
- (d) If junction box is to be provided in ceiling, its position should be so located that it is in line with other light / fan points.
- (e) Junction boxes should never be used for splitting one conduit into two or more. Junction box for such functions is avoidable and for this, number of conduits to be connected to one switch board should be calculated correctly as per drawing before laying conduits in ceiling.
- (f) Locating junction boxes on outer surface of exterior walls of building should be avoided as these are in direct view and are also exposed to weather.

#### SWITCH BOXES :

Steel boxes of required sizes, shall be provided to house speed regulators of fans, switches for lights, fans, plug sockets etc. as per requirement of drawings. These should be so designed that accessories on sheet.

could be mounted with tapped holes and brass machine screws, leaving ample space at the back and on the sides for accommodating wires and check nuts at conduit entries. These shall be attached to conduits by means of check nuts on all walls of the boxes through which the conduits are entering. These shall be completely connected leaving edges flush with finished wall surfaces. Cover should be fixed to these switch boxes by means of brass chrome plated machine screws and cup washers. Utmost care shall be taken by contractor to ensure that all switch boxes are in line and level.

Inside each switch box, one bolt shall be welded to receive earthing wire.

#### SWITCH AND SOCKET :

Switches shall be installed at 900 mm above finished floor level unless otherwise indicated on the drawings.

The switch controlling the light point or fan shall be connect on to the phase wire of the circuit and neutral shall be continuous, having no fuse or switch installed in the line except at the D.B. All fan regulators shall be fixed inside the switch boxes

The cover plates to the switch box shall be fixed by means of sunk head brass cadmium screws.

Where two or more switches and fan regulators are installed together, they shall be provided with one gang cover plate with knockouts to accommodate required number of switches, sockets and regulators.

The switch controlling the socket outlet shall be on the phase wire of the circuit. The third pin of the socket shall be connected to the earth continuity conductor of the circuit

The switch boxes, installed back-to-back in the same wall shall be offset from each other, 150 mm horizontally, to preclude noise transmission.

#### CLEANING AND PROTECTION OF CONDUIT SYSTEM :

The entire conduit system including outlet boxes, junction boxes and switch boxes shall be thoroughly cleaned after completion of erection and tested for not blockage by air / sound or steel wire prior to finishing of building by air / sound or steel wire prior to finishing of building and before drawing in of cables / wires to safeguard conduit system against filling up with the plaster / cement slurry / water etc.

all the outlet and switch boxes will have to be provided with temporary jute / cotton filling, covers and plugs etc.. Within tendered cost which shall be replaced later on by hylem / sheet cover after wiring as required.

#### TESTING OF INSTALLATION :

Before a completed installation is put into service, the following tests shall be complied with:

##### (a) INSULATION RESISTANCE :

The insulation resistance shall be measured by applying 500 volt megger with all fuses in places, circuit breaker and all switches closed.

The insulation resistance in megohms of an installation, measured shall not be less than 50 megohms divided by the number of points on the circuit.

The insulation resistance shall be measured between EARTH  
TO PHASE  
EARTH TO NEUTRAL PHASE  
TO NEUTRAL PHASE TO  
PHASE

(b) EARTH CONTINUITY PATH : The earth continuity conductors shall be tested for electrical continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance or earth leakage circuit-breaker, measured from the connection, with the earth electrode to any point in the earth continuity conductor in the completed installation and shall not exceed one ohm.

##### (c) POLARITY OF SINGLE POLE SWITCHES :

A test shall be made to verify that every no-linked, single pole switch is connected to one of the phase of the supply system.

##### (d) COMPLETION CERTIFICATES :

All the above tests shall be carried out in presence of client and the results shall be recorded in a prescribed forms. Any default during the testing shall be immediately rectified and that section of the installation shall be re tested. The completed test result from shall be submitted to the client for approval.

On completion of an electric installation a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electric supply authority.

### 3 Mode of measurement

The unit rate shall include:

1) Making zari in the wall & semi finishing the surface.



- 2) Ball and socket joints where ever required
- 3) Earthing of fittings
- 4) Electrical connection to the fixtures from the outlet point/ ceiling rose
- 5) Supply and Installation and interconnection of electronic regulators for ceiling fan
- 6) Rate for the point shall consist of wiring from the out let point to the switch board as required with a connector/ plate/ ceiling rose fan box with hook socket with switch. The point rate shall include in addition to phase and neutral wire a PVC insulated earth continuity wire from switch to outlet. The unit rate for the point shall consist of the circuit wiring form SB to outlet point through switch and/or socket, switch board as required and including the outlet points with connector, fan hook box or sockets. A point shall include in addition to phase and neutral wire a PVC insulated Earth continuity wire from SB to the final termination at outlet points.

**E-14 to E-18 MAINS :**

**A) The mains is considered from the Distribution Boards to the individual Switch Boards.**

**1 Material :**

As per item 1.1 above

**2 Workmanship**

As per item no 1.1 above

**3 Mode of measurement**

The mains shall be paid on per mtr basis which shall include cost of wires, pipe, bends and junction and accessories for mounting and jarri work. The length shall be certified by the engineer in charge from Clients side.

## **E2            Distribution Board**

---

**Supplying, assembling, grouting, leveling, Connecting & testing D.B of specified**

**make : E-19 VTPN Distribution Board :**

**Supplying, assembling, grouting, leveling, Connecting & testing various types of Three phase and neutral distribution boards of desired ways of specified make :**

### **1 Material**

Should conform to E – 2

### **2 Workmanship :**

- 1) All the D.B. should have adequate Capacity three phase busbar with main neutral links.
- 2) The D.B. should be provided with 2 separate insulated earth links.
- 2) The D.B. should be concealed type having sheet metal enclosure with double door unless or otherwise specified..
- 4) The D.B. should be Powder coated.
- 5) The D.B. shall have top and bottom plates openable.
- 6) The D.B. Shall be provided with necessary cable end junction box

### **3 Mode of measurement**

The rate shall be for one unit of D.B.

## **E-20 to E-21    TPN Distribution Board :**

**Supplying, assembling, grouting, leveling, Connecting & testing various types of Three phase and neutral distribution boards of desired ways of specified make :**

### **1 Material**

Should conform to E – 2

### **2 Workmanship :**

- 1) All the D.B. should have separate neutral link per phase with main neutral link i.e. four neutral link of appropriate nos. of way.
- 3) The D.B. should be provided with 2 separate insulated earth links.
- 4) The D.B. should be concealed type having Thermoplastic enclosure with double door unless or otherwise specified..
- 5) The D.B. shall have top and bottom plates openable.
- 6) The D.B. Shall be provided with necessary cable junction box

### **3 Mode of measurement**

The rate shall be for one unit of D.B.

**E-21 to E-23 S.P. Distribution Board**

**Supplying, assembling, grouting, leveling, Connecting & testing various types of Single phase and neutral distribution boards of desired ways of specified make :**

**1 Material**

As per item no 2.2 above

**2 Workmanship**

As per item no 2.2 above.

**2 Mode of measurement**

As per item no 2.2 above.

**E-25 to E-46 M.C.B. :**

**Supplying, Assembling, levelling, connecting & testing**

**MCBs/ELCBs/ELMCBs/Isolators of various rating in boards as specified 297 to 304.**

**1 Material**

Should Conform to E – 2

**2 Workmanship**

Should mount all the MCBs/ELCBs/ELMCBs/Isolators and other accessories in the D.B. as per the MCB chart furnished by consultant and also do the necessary connections. Should check for any faulty connections and reconnect the same. Also check for the loading once complete installation of fixtures and other equipments is completed.

**3 Mode of measurement**

As per item 2.1 but for MCBs/ELCBs/ELMCBs/Isolators and accessories.

## E-47

**Making trench in soft soil of suitable width of 90 cms deep for  
g the fault all over the run and backfilling the same and making  
roviding and erecting iron clad cable route marker duly marked  
ize 23 cms.X 12 cms. Flushed with ground in cement foundation  
er in charge. The width shall be as per requirement**

## 1 Material :

All the tools and tackels required for the excavation shall be provided by the contractor. Cable markers shall be provided.

## 2 Workmanship

Excavation shall be done as per the route specified in the plan of the consultant. Also the depth as specified in the item shall be strictly maintained. Cable markers shall be installed at length specified in the item.

### 3 Mode of measurement :

The item shall be paid in running Mtr. and the measurement shall be certified by the engineer in charge from the Clients side.

## E-48

**Covering of cable with second class bricks laid cover the cable crosswise & also on both sides with covering of 7.5 Cms. layer of sand above & below cable (cable shall be laid in 0.9mtr.deep & 0.4 Mtr.wide trench). Where there are more than one cable in the trench on either side of the cable, 5 Cms. over lapping of bricks shall be provided.**

## 1 Material :

All the tools and tackels required for the spreading fine sand and back filling shall be provided by the contractor. Bricks of 2<sup>nd</sup> class or higher quality shall be used.

## 2 Workmanship

Bricks shall be laid on all the three sides of the cable as per the drawing of the consultant. Proper thickness for the fine sand as specified in the item shall be strictly maintained. After back filling proper levelling shall be done and lumps of soil should not be visible. The trench should give a levelled look.

### 3 Mode of measurement :

The item shall be paid in running Mtr. and the measurement shall be certified by the engineer in charge from the Clients side.

## **E4 Cable Tray**

---

**E-56 to E-58 Providing and fixing approved make Ladder type cable tray. Made from M.S sheet. The cable tray should be bended as per IS 2062/1079 shall be fabricated of double bended channel section longitudinal members with single bended Channel section. Rungs of members welded to the base of the longitudinal members at 250 mm c/c spacing . as per IS and shall be coated with hot dip galvanizing as per IS 2629/4759. with coupler plate / Fish plate and GI hardware like nut - bolt and washers etc. erected on existing support as per Specification and as per instruction of engineer in charge..**

**1) Material**

Should conform to E – 4

**2) Workmanship**

Shall mount on the m.s. fabricated support as per design & use bends, T- Junctions, reducers etc.. accessories as per requirements.

**3) Mode of measurement :**

Shall be measured on per meter basis.

**E-59 to E-62 C type cable trays, Made from CR sheet steel. The cable tray should be single or double bended as per required and as per IS 2062/1079 and shall be coated with hot dip galvanizing as per IS 2629/4759. with coupler plate / Fish plate and GI hardware like nut - bolt and washers etc. erected on existing support as per Specification and as per instruction of engineer in charge..**

**1) Material**

Should conform to E – 4

**2) Workmanship**

Shall mount on the m.s. fabricated support as per design & use bends, T- Junctions, reducers etc.. accessories as per requirements.

**3) Mode of measurement :**

Shall be measured on per meter basis.

**E-63        MS race way / junction boxes/clamps/hangers for Cable Tray, Light Fixture made out of 14 gauge sheet/Angle/Flat/rod/ channel etc with all necessary accessories like bend, junction boxes, coupler, Anchor fastener, Bolt Nuts, etc.. & work from MS structure for other work with anchor fastener of Hilti make and necessary hardware with necessary welding has to be done to complete the job from ISA / ISMC / PLATE. The job also includes to paint the structure with two coats of red oxide and two coats color of enamel paint as approved and recommended by consultant. Complete in all respect**

**1) Material**

Should conform to E – 4

**2) Workmanship**

Shall conform to E-338, 339 to 341

**3) Mode of measurement :**

Shall be measured on per Kg. basis.

## **E5      Cables**

---

**E-64 to E-77    1100 volt grade XLPE insulated PVC sheathed aluminium / Copper conductor armoured cables as per specification in trenches, cable trays, ducts, over bed of sand, clamped to wall with suitable clamps including, saddles fixing bolts, connecting testing and commissioning with identification tags at every 10 mtr. & Both ends. with All the fixing accessories, excavation Back filling & Cable protection with Bricks as per the drawing ( If required )..**

### **1    Material**

Should conform to E – 5

### **2    Workmanship**

#### **Installation**

A) Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the contractor shall mark it out on the drawings and also on the site and obtain the approval of the Architect/Consultant before laying the cable. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.

B) Cables, running indoors shall be laid on walls, ceiling, inside shafts or trenches. Single cables laid shall be laid in GI/PVC pipe and not to fix on wall slab directly or drawn through GI / PVC pipes fixed on wall or ceiling and supported at not more than 500 mm. Where number of cables are run, necessary perforated cable trays shall be provided wherever shown. Perforated trays shall be mild steel or Aluminum as specified in the schedule of work and supported on mild steel frame work as shown on drawings or as approved. Cables laid in built-up trenches shall be on steel supports. Plastic / Aluminum identification tags shall be provided at every 30 m. All cables laid shall be properly dressed and atleast 50 mm space shall be kept between the cables.

C) Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer's recommendations whichever is higher.

D) In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc. Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles on all the three sides as shown on drawings. Width of excavated trenches shall be as per drawings. Back fill over buried cables shall be with a minimum earth cover of 750 mm to 1000 mm. The cables shall be provided with cables markers at every 20 meters and at all loop points.

E) The general arrangement of cable laying is shown on drawings. All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end termination indicating the feeder number and the Panel/Distribution board from where it is being laid. cable termination for conductors upto 4 sq.mm. may be insertion type and all higher sizes shall have tinned copper compression lugs. Cable termination shall have necessary brass glands. The end



termination shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armoring shall be earthed at both ends.

F) In case of cables entering the buildings. It would be done duly only through pipes. The pipes shall be laid in slant position. So, that no rain water may enter the building. After the cables are tested. The pipes shall be sealed with M. seal & then tarpaulin, shall be wrapped around the cable for making the entry of water light.

G) All cables shall be provided with stainless steel/Aluminum cable identification tags at a maximum distance of 10 m.

H) All cables to be laid should be properly dress and atleast 50 mm space should be kept between the calbes.

## **INSTALLATION OF CABLE NETWORK :**

Cable network shall include power, control and lighting cables which shall be laid in underground trenches, cable trays, G.I. pipes, or on building structures as detailed in the relevant drawings, cable schedules or as per the client / consultant's instructions. Supply & installation of cable trays, G.I. pipes / conduits, cable glands and sockets of both end isolators, junction boxes, remote push button stations, etc. shall be under the scope of the contractor.

### **(a) General requirements for handling cables :**

Before laying cables, this shall be tested for physical damage, continuity, absence of cross phasing, insulation resistance to earth and between conductors. Insulation resistance tests shall be carried out with 500 / 1000 V megger.

The cables shall be supplied at site, wound on wooden drums as far as possible. For smaller length and sizes, cables in properly coiled form can be accepted. The cables shall be laid by mounting the drum of the cable on drum carriage. Where the carriage is not available, the drum shall be mounted on a properly supported axle, and the cable laid out from the top of the drum. In no case the cable will be rolled on as it produces kinks which may damage the conductor.

Sharp bending of cable shall be avoided. The bending radius for PVC insulated and sheathed, armoured cable shall not be less than 10 D, where "D" is overall diameter of the cable.

While drawing cables through G.I. pipes, conduits, RCC pipes, ensure that size of pipe is such that, after drawing cables, 40% area is free. After drawing cables, the end of pipe shall be sealed with cotton / bituminous compound.

High voltage (11 kV and above), medium voltage (240 V and above) and other control cables shall be separated from each other by adequate spacing or running through independent pipes / trays.

Armoured cables shall never be concealed in walls / floors / roads without G.I. pipes, conduits or RCC pipes.

Joints in the cable throughout its length of laying shall be avoided as far as possible and if unavoidable, prior approval of site engineer shall be taken. If allowed, proper straight through epoxy resin tight joint shall be made, without any additional cost.

A minimum loop of 3 mtr. shall be provided on both ends of the cable, and on both ends of straight through cable joint. This additional length shall be used for fresh termination in future. Cable for this loop shall be paid for supply and laying.

Cable shall be neatly arranged in the trenches / trays in such manner so that criss-crossing is avoided and final take off to the motor / switchgear is facilitated. Arrangement of cable within the trenches / trays shall be the responsibility of the contractor.

All cable routes shall be carefully measured and cable cut to the required lengths and undue wastage of cables to be avoided. The routes indicated in the drawings is indicative only and the same may be rechecked with the client / consultant before cutting of cables. While selecting cable routes interference with structures, foundations, pipelines, future expansion of buildings etc. should be avoided.

All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be taped with an approved PVC or

rubber insulating tapes. Use of friction type or other fabric type tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.

Wherever cable rises from underground / concrete / masonry trenches to motors / switchgears / push buttons, these shall be taken in G.I. pipes of suitable size, for mechanical protection upto 300 mm. distance of concerned cable gland or as instructed by the client / consultant.

The cable pass through foundation / walls of other underground structures, the necessary ducts for opening will be provided in advance for the same. However, should it become necessary to cut holes in existing foundation of structures the electrical contractor shall determine the location and obtain approval of the client / consultant before cutting is done.

#### (b) LAYING OF CABLES (UNDERGROUND SYSTEM)

- Cables shall be so laid in trench that this will not interfere with other underground structure. All water pipes, sewage lines or other structures which become exposed by excavation shall be properly supported and protected from injury until the filling has been rammed solidly in places under and around them. Any telephone or other cables coming in the way are to be properly shielded / diverted as directed by the EMPLOYER / consultant.
- Cable shall be laid at minimum depth of 750 mm. in case of L.T. and 1200 mm. in case of H.T. from ground level. Excavation will be generally in ordinary soil. The width of trench shall be sufficient for laying of required no. of cables.
- Sand bedding 75 mm. thick shall be made below and above the cables. Layer of bricks (full size) shall be laid above sand bedding on the sides and above the cables to cover cables completely. More than one cable can be laid in the same trench. However, the relative location of cables in trench shall be maintained till termination. The surface of the ground after back filling the earth shall be made good so as to conform in all respects to the surrounded ground and to the entire satisfaction of the client / consultant.
- For all underground cables, route markers should be used :
  - a) Separate route markers should be used for LT, HT and telephone cables.
  - b) Route markers should be grounded in ground with 1:2:4 cement concrete pedestal size 230 x 230 x 300 mm..
  - c) Cable markers should be installed at an interval not exceeding 30 mtr. along the straight routes of cables at a distance of 0.5 mtr. away from centre of cable with the arrow marked on the cable marker plate indicating the location of cable. Cable markers should also be used to identify change in direction of cable route and for location of every joint in underground cable.
- RCC Hume pipe for crossing road in cable laying shall be provided by employer. No deduction shall be made for cable laying in Hume pipe for not providing bricks, sand and excavation. RCC hump pipe at the ends shall be sealed by bituminous compound after laying and testing of cables by electrical contractor without any extra charge.

(c) LAYING OF CABLE IN MASONRY TRENCHES

Masonry / concrete trenches for laying of cables shall be provided by employer. However, steel members such as M.S. angles / flats etc. shall be provided and grouted by electrical contractor to support the cables without any extra charge. Cables shall be clamped to these supports with minimum saddles / clamps. More than one tier of cables can be provided in the same trench if the no. of cables are more.

Entry of cables in trenches shall be sealed with bituminous MASTIC compound to stop entry of water in trenches.

**(d) LAYING OF CABLES IN CABLE TRAYS**

Cable trays and steel members such as M.S. angle / channel / flats etc. shall be provided and fixed by the contractor.

Cable shall be fixed in cable trays in single tier formation and cables shall be clamped with flat clamps and galvanised bolts / nuts.

Earthing flat / wire can also be laid in cable tray alongwith

cables. After laying of cables, minimum 20% area shall be spare.

**(e) TESTING OF CABLES :**

- i. Before energising, the insulation resistance of every circuit shall be measured from phase to ground. This requires 3 measurements if one side is grounded and 6 measurements for 3 phase circuits.
- ii. Where splices or terminations are required in circuits rated above 650 volts, measure insulation resistance of each length of cable before splicing and/or terminating. Repeat measurements after splices and/or terminations are complete.
- iii. DC high voltage test shall be made after installation on the following :
  - a) All 1100 volts grade cables in which straight through joints have been made.
  - b) All cables above 1100 V grade.

For record purpose test data shall include the measured values of leakage current versus time. The DC high voltage test shall be performed as detailed below :

Cables shall be installed in final position with all the straight through joints complete.

Terminations shall be kept unfinished so that motors, switchgear, transformer etc. are not subjected to test voltage.

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

**iv. PROFORMA FOR TESTING CABLES :**

<b><u>DATE OF TEST</u></b>			
a)	Drum No. from which cable taken.		
b)	Cable from to		
c)	Length of run of this cable meter		
D)	<b>Insulation resistance test</b>		
i)	between core-1 to earth mega-	iii)	ohm
	ohm		between core-3 to earth
ii)	between core-2 to earth mega-	iv)	mega-ohm
			between core-1 to core-
			2 mega-ohm



- v) between core-2 to core-3 mega-ohm
  - vi) between core-3 to core-1 mega-ohm
  - vii) duration used : 1 kV
  - e) High voltage test
- Voltage Duration
- i) between core an earth.
  - ii) between individual cores

[This proforma shall be jointly signed by the CLIENT / CONSULTANT and the contractor in duplicate].

All test readings shall be recorded and shall form part of the completion documentation.

### 3 Mode of measurement

The cable shall be measured in per mt. Basis and the rates shall include ;

- 1) Cables and clamps
- 2) Installation, Commissioning and testing
- 3) Cable marking and all the accessories for the cable if at all to be installed on walls. Cable length shall be certified by engineer in charge from Clients side.



**E-78 to E-91 Supplying & fixing heavy gauge compression type Brass glands & making joint with necessary crimping socket of long neck type connecting the same to various equipment like section pillar, switch, starter, motor etc. sizes of cables specified in BOQ CUPAL washers shall be provided for copper busbars to aluminum connection:**

**1 Material**

Should conform to E – 5

**2 Workmanship**

Cable joints shall be done as per regular practice and check shall be carried out for loose connections and leakages. Insulation cutting shall be done properly taking care that no area of the conductor remains exposed. Crimping shall be done with the help of hydraulic tool.

**TERMINATION AND JOINTING OF CABLES :**

- i. a) For HT cables suitable size of push on type termination kit shall be
- b) Use of glands :

All PVC cables upto 1.1 kV grade, armoured or Unarmoured shall be terminated at the equipment / junction box / isolators / push buttons / control accessories, etc. by means of suitable size single compression type cable glands. Armour of cable shall be connected to earth point. The contractor shall drill holes for fixing glands wherever necessary. Wherever threaded cable gland is to be screwed into threaded opening of different size, suitable galvanised threaded reducing bushing shall be used of approved type.

In case of termination of cables at the bottom of the panel over a cable trench having no access from the bottom, a close fit holes should be drilled in the bottom plate for all the cables in one line, then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables with glands, it shall be sealed with cold sealing compound.

**ii. USE OF LUGS / SOCKETS :**

All cable leads shall be terminated at the equipment terminals, by means of crimped type solderless connectors unless the terminals at the equipment ends are suitable for direct jointing without lugs / sockets.

The following is the recommended procedure for crimped joints and the same shall be followed :

- a) Strip off the insulation of the cable and with every precaution, not to damage any strand. All insulation's to be removed from the stripped portion of the conductor and ends of the insulation should be clean and square.
- b) The cable should be kept clean as far as possible before assembling it with the terminal / socket. For preventing the ingress of moisture and possibility of re-oxidation after crimping of the aluminium conductors, the socket should be filled with corrosion inhibiting compound. This compound should also be applied over the stripped portion of the conductor and the palm surface of socket.

- c) Correct size and type of socket / ferrule / lug should be selected depending on size of conductor, and type of connection to be made.
- d) Make the crimped joint by suitable crimping tool.
- e) If after crimping the conductor in socket / lug, some portion of the conductor remains without insulation the same should be covered sufficiently with PVC tape.
- f) For HT cable the manufacturer's recommendation should be followed.

iii) DRESSING OF CABLE INSIDE THE EQUIPMENT :

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

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

Cables inside the equipment shall be measured and paid for on lug to lug basis.

iv) IDENTIFICATION OF CABLES / WIRES / CORES :

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

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

### **3 Mode of measurement**

Rate shall be considered for 1 nos of joint.

**E7 Mv Switch Gear & Power Panels**


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**E-92 to 96      Supplying, unloading at site, shifting to site, assembling, leveling, grouting, erecting, Testing,**

**& Commissioning main L.T. panel board, fabricated from M.S. sheet & folded channel totally enclosed cubical type compartmentalized.**

**1 Material**

Should Conform to E – 7

**2 Workmanship :**

- 1) Main busbar should be electrolytic tin copper type.
- 2) All internal wiring and all connection shall be with copper wires and strips as required. Use copper flexible wire for below 100 Amps and copper strips for over 100 Amps.
- 3) All component, frame etc shall be earthed. A common internal earth bar with two separate earthing leads to be provided.
- 4) Powder coating to be done on all sheet metal works as required.
- 5) Panel should have MS base frame for floor mounting unless otherwise specified.
- 6) The board should be front operated and extensible type.
- 7) Compression type brass glands and crimping lugs for incomer and outgoing ends.
- 8) All ammeters to be provided with C.T.'s and selector switch and voltmeter with selector switch and control fuses.
- 9) Panel components shall be as specified
- 10) The design and location of all panels to be approved by the architect/consultant before fabrication and installment.
- 11) All panels should be dust and vermin proof.
- 12) All panels should be fabricated out of 14 gauge sheet The door should be made from 14 gauge (2 mm) and the other parts should be made from 14 gauge sheet metal.
- 13) All meters should be digital type only unless and otherwise specified.
- 14) The metering on main panels shall be LOAD MANAGER type unless and otherwise specified.
- 15) The board should meet with the requirement of IS2147/1962. Internal wiring, busbar making etc. shall conform to IS 375/1963.
- 16) All the Switches used should be capable of withstanding the AC23 duty for motor operation. The Switches should have quick make quick break. The contacts should be silver plated double break type. The switch should conform to IEC 947-III.
- 17) Main LT Panel, Emergency Panel, Bus coupler and APFCR panel should be fabricated in the approximate length of 1 meter and depth of 1 meter compartment.
- 18) The board should withstand the system prospective fault current

- 19) The switches shall conform to IS : 4047. the fuses shall conform to IS : 220. the fuses shall be of HRC type.
- 20) Engraved plastic labels shall be provided indicating the feeder details, capacity, cable size, load in KW and danger signs.
- 21) The entire panel board should be with adequate height width & depth as per relevant prevailing I.S. code and Installation include foundation bolts of suitable size as per requirement.

- 22) All compartment doors should be concealed hinged type & handles of feeders to be interlocked mechanically with the doors such that door cannot be opened when the switch is in 'ON' position & switch cannot be 'ON' when the door is in open position.

**(a) ERECTION :**

Electrical panels his own arrangement for safe transportation of all the items to the erection site and also carry out complete loading / unloading during transportation. The contractor shall be responsible for final assembly and interconnection of busbars / wiring. Foundation channel shall be delivered in convenient shipping section by the manufacturer. The contractor shall make shall be grouted in the flooring by the contractor. Switchgear shall be aligned and levelled on their base channels and bolted to them as per the instructions of the client / consultant. The earth bus shall be made continuous throughout the length. Loosely supplied relays and instruments shall be mounted and connected on the switchgear. The contacts of the drawout circuit breaker shall be checked for proper alignment and inter changeability.

After erection, the switchboard shall be inspected for dust and vermin proof. Any hole which might allow dust or vermin etc. to enter the panel shall be plugged suitably at no extra cost. If the instrument transformers are supplied separately, they shall be erected as per the direction of the client / consultant. The contractor shall fix the cable glands after drilling the bottom / top plates of all switchboards with suitable holes at no extra cost.

Range of overload relays / timers etc. shall be checked with requirement of motor actually to be connected at site and if the same is undersized / oversized, it shall be brought to the notice of the client / consultant, who shall arrange procurement of corrected components. However, the contractor shall not charge anything extra for labour for such replacements.

**(b) TESTING :**

Before electrical panel is energised, the insulation resistance of each bus shall be measured from phase to ground. Measurement shall be repeated with circuit breakers in operating positions and contacts open.

Before switchgear is energised, the insulation resistance of all control circuits shall be measured from line to ground.

The following tests shall be performed on all circuit breakers during erection.

- Contact alignment and wipe shall be checked and adjustment where necessary in accordance with the breaker manufacturer's instructions.
  - Each circuit breaker shall be drawn out of its cubicles, closed manually and its insulation resistance measured from phase to phase and phase to ground.
  - All adjustable direct acting trip devices shall be set using values given by the consultant/ manufacturer.
  - The dielectric strength of insulating oil wherever applicable, shall be checked.
- Before switchgear is energised, the following tests shall be performed on each circuit breaker in its test position.

- Close and trip the circuit breaker from its local control switch push button or operating handle. Switchgear control bus may be energised to permit test operation of circuit breaker with A.C. closing with prior permission of the client / consultant.
- Test tripping of the electrically operated circuit breaker by operating mechanical trip device.
- Test proper operation of circuit breakers latch, check carriage limit switch if provided. Test proper operation of lockout device in the closing circuit. Wherever provided by simulating conditions which would cause a lockout to occur.
- Trip breaker either manually or by applying current or voltage to each of its associated protective release.

- Before switchgear is energised, the tests covered above shall be repeated with each breaker in its normal operating position.
- Capacitor banks shall be tested as per manufacturer's instructions. In addition, test for output and/or capacitance, insulation resistance test and test for efficiency of discharge device shall be carried out.
- All electrical equipment alarms shall be tested for proper operation by causing alarms to sound under simulated abnormal conditions.

**(c) PROFORMA FOR PCC, MCC, DB, CONTROL PANEL TEST :**

- Circuit breaker or contactor module designation / bus no.
- Insulation resistance test (contacts open, breaker racked in position)
  - a) between each phase of bus : Mega ohm
  - b) between each phase and earth : Mega ohm
  - c) DC and AC control and auxiliary circuits : Mega ohm
  - d) between each phase of CT / PT and between CT  
& PT circuit if any : Mega ohm
- CT checks :
  - a) CT ratio
  - b) CT secondary resistance
  - c) CT polarity check
- Check for contact alignment and wipe.
- Check / test all releases / relays.
- Check mechanical interlocks.
- Check electrical interlocks.
- Check switchgear / control panel wiring.
- Check breaker / contactor circuit for :
  - a) Closing - local & remote (wherever applicable)
  - b) Tripping - local & remote (wherever applicable)
- Opening time of breaker / contactor.
- Closing time of breaker / contactor.

[This proforma shall be jointly signed by the CLIENT / CONSULTANT and the contractor in duplicate].

**3 Mode of measurement :**

The rate shall be for one unit of panel.



**E-97 to E- 104 Supply, Installing, Testing , commissioning of Light fixtures of various types and of specified make:**

**1    Material**

Should conform to E – 8

**2    Workmanship**

The fixture shall be installed on wall / ceiling as directed and as per manufacturer's instruction, with necessary accessories for surface, concealed, suspended from ceiling, bracket mounting etc. The job also includes connection of fixture with respective outlet point with heat resistant wires through heat resistance sleeve and PVC connector. The exhaust fan shall be installed complete with M.S. angle iron mounting frame/ ring, G.I. louvers, wire mesh and plug at the end of the cord including wiring & earthing etc. Proper earthing shall be provided to the fixtures

**INSTALLATION OF LIGHTING FIXTURES / FANS :**

**i)    INSTALLATION OF LIGHTING FIXTURES :**

Scope of work under this item shall start from light point, with 3 nos. 1.5 mm.<sup>2</sup> PVC insulated wires from connector to the connector inside the lighting fixture, connections, fixing of lighting fixture complete with all accessories, lamps on wall / roof / steel truss etc. testing the lighting fixture and commissioning. If wire length of light point is enough to reach connector of light fitting, connector in light point can be deleted.

**iii)    INSTALLATION OF EXTERNAL LIGHT FIXTURES :**

Street lighting installation shall be carried out as per details shown in the drawing.

The poles shall be erected in perfect plumb with concrete foundation at a location shown in the drawing. The foundation shall be designed to withstand the static load as well as wind velocity and bending moment of the pole and shall be approved by the client prior to execution.

The junction box shall then be clamped to the erected pole as per details shown in the drawing. The luminaires shall also be installed on the pole and be electrically wired to the respective junction box. The cable lay out shall follow the tentative route as shown in the drawing. In case of any constraint on the cable route the same shall be brought to notice of the client. The cable lay out shall be carried out in an underground manner and the said installation complete with electric connections.

Earthing installation shall follow the details for the same shown in the drawing.

The earthing station ( coil type ) and the earthing grid installation shall be carried out as per the specification for the said works given in section under title “Earthing” of this tender document.

On completion of the installation, the street light poles shall be painted with two coats of metal primer ( Red Oxide ) followed by two coats of Synthetic enamel of the shade as approved by the Engineer-in- charge.

The brackets shall be made of 38 mm. NB MS class “B” pipe approx. 1.8 mtr. long bent at the

centre at an angle 120° C. with necessary holding brackets, hold fasts etc. with special reducer at the end to accommodate type of street light fitting to be fixed. Bracket shall have 1 coat of anti-corrosion paint before despatch to site and 2 coats of approved make and shade of aluminium paint. This bracket shall also be provided with one M.S. water tight box complete with the connector, neutral link, rewirable fuse etc.. See enclosed drawings of street light poles.

Installation of poles shall be done as per enclosed drawings of street light poles. The depth of pole to be buried in ground shall be  $\frac{1}{5}^{\text{th}}$  of the total pole length or as specified in drawing, whichever is more. Special care shall be taken in erecting poles so that these are not strained or damaged during erection and are firmly stayed till the foundation are secured. The pole shall be grouted inside ground pit (cross-section 600 x 600 mm.) with cement concrete 1:2:4. Before the placement of concrete around pole in the pit, necessary conduit pipes (not less than 25 mm. dia.) shall be placed for facilitating drawing of cables. Separate conduit shall be provided for incoming and outgoing cables. The cement concrete shall be protected from premature drying by curing for atleast 7 days after pouring. All concrete surface from 150 mm. below ground level to top shall be finished smooth with cement mortar 1:4.

This includes fixing of street light fittings complete with accessories and lamps at the end of the pole / bracket, connecting it with 3 x 2.5 mm.<sup>2</sup> aluminium conductor, PVC insulated cable from water tight

M.S. box, testing, commissioning. Third core shall be connected with earthing point of light fitting at one end and earthing point of marshalling box at the other end.

### **3 Mode of measurement**

The unit rate shall be considered for Supplying and fixing one fixture. The rate shall include following

- a) All fixing accessories, mounting bracket, ballast condensers and control gear wherever applicable.
- b) Supplying and fixing Ball and socket joints wherever required.
- c) Earthing of fittings.
- d) Electrical connections to fittings/fans from the junction box/ceiling rose.
- e) Installation and interconnection of Electronic regulators for ceiling fans.

Per Unit for Supplying, assembling, installing, connecting ,testing and commissioning of fluorescent/ incandescent luminaries fixture, ceiling fan, exhaust fan etc.

Refer General Instruction for Electrical work – Basic Rates for Light Fixtures also.

## **E-105 to 106 Supply, Installing, Testing , commissioning of Exhaust fans of various types and of specified make:**

### **1) Material :**

Should conform to E – 8

### **2) Workmanship :**

As per item no 8.1 above

#### **i. INSTALLATION OF EXHAUST FANS :**

Scope of work under this system shall start from exhaust fan point, with a ceiling rose, 2 core 2.5 mm.<sup>2</sup> PVC insulated wire from ceiling rose to connector of exhaust fan, connections, making fan opening in walls including repair / finishing fixing of exhaust fan complete with accessories and louvers on walls with hold-fasts, testing the exhaust fans and commissioning.

### **3) Mode of measurement :**

As per item no E-101 to 107 above E8

**E-107 to E-108 Supply, Installing, Testing , commissioning of ceiling fan of various types and of specified make:**

**1) Material :**

Should conform to E – 8

**2) Workmanship :**

As per item no E-101 to 107 above

**3) Mode of measurement :**

As per item no E-101 to 107 above

**E9      Uninterruptable Power Supply**

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**E-112      SITC of Varous size I/p-3 ph, O/p-3 ph. On line UPS with In built isolation transformer & Battery back up as per specification & 15 minute. battery backup.**

**1    Material**

Should conform to E – 12

**2    Workmanship**

Shall be erected as per the drawing and necessary battery for back up of 15 minute shall done.

**3    Mode of measurement**

The rate shall be for one unit of UPS with Battery pack.

## **Lightning protection system**

### **1.1 SCOPE:**

The scope of work under this section covers the Engineering / Design, supply, installation, connection, testing and commissioning of lightning protection system. The lightning protection system shall be designed and installed as per IS / IEC 62305 and additional requirements (if any) of this specification. The designing of LPS shall be done by using CDEGS software. General arrangement of the protection system shall be as indicated in the drawings and consisting of the following:

- 1.1.1 Air termination network.
- 1.1.2 Down conductors.
- 1.1.3 Joint and Bonds.
- 1.1.4 Conductor Holders
- 1.1.6 Expansion Piece
- 1.1.6 Testing Links.
- 1.1.7 Earth termination network.

### **2.0 CODES AND STANDARDS:**

The Component and accessories covered by this specification shall be designed, manufactured and tested in compliance with the latest relevant standards published by the Indian Standards institution wherever available in order that specific aspects under Indian conditions are taken care of.

The Component and accessories for which Indian Standards are not available shall be designed, manufactured and tested in accordance with the latest and relevant IEC.

The component and installation shall also conform to the latest Indian Electricity Rules and requirement of Indian Electricity Act. Nothing in this specification shall be constructed to relieve the Contractor of his responsibilities.

Generally, the Lightning protection system shall conform to IS/IEC: 62305 unless otherwise stated.

Following standards shall also be applicable:-

- i. IS/IEC: 62305-1 Protection against lightning – General Principles.
- ii. IS/IEC: 62305-2 Protection against lightning – Risk Management.
- iii. IS/IEC: 62305-3 Protection against lightning – Physical Damage to the structure and life hazard.
- iv. IS/IEC: 62305-4 Protection against lightning – Electrical and electronic system within structure.
- v. IEC: 62561-1 Lightning Protection components – Requirements for connection components.
- vi. IEC: 62561-2 Lightning Protection components – Requirements for conductors and earth electrodes.
- vii. IEC: 62561-3 Lightning Protection components – Requirements for isolating spark-gaps.
- viii. IEC: 62561-4 Lightning Protection components – Requirements for conductor fasteners.
- ix. IEC: 62561-5 Lightning Protection components – Requirements for Earth electrode inspection housing and earth electrode seals.
- x. IEC: 62561-6 Lightning Protection components – Requirements for Lightning strike counters.
- xi. IEC: 62561-7 Lightning Protection components – Requirements for Earth enhancement compounds.
- xii. NBC – 2016 National Building Code 2016

### 3.0 **EXTERNAL LIGHTNING PROTECTION SYSTEM:**

- a) The external lightning protection system shall be installed as indicated in the drawings.
- b) As air terminals shall be installed on the highest roof of the building, the air terminals shall be joined to horizontal roof conductor by means of proper clamps & connectors.
- c) Roof conductor shall be laid horizontally on the roof as indicated on the drawing.
- d) Down conductor shall be installed on the vertical surface of the building. The down conductor shall be joined with roof conductors in the method as prescribed by the code.
- e) The down conductor shall be joined with earth termination network or to the earthing station as indicated on the drawing.
- f) At every 1 mtr, the roof conductor holder for mesh and wall conductor holder for down conductor should be used.
- g) At every 20 mtr, an expansion piece should be connected in order to avoid unnecessary contraction and expansion of conductor due to change in weather conditions.
- h) At the connection of the earth-termination, a test joint should be fitted on each down conductor.
- i) A test joint shall be provided in the down conductor 1000 mm above the ground level at a place which is easily accessible for testing.

### **COMPONENT / PARTS:**

#### 4.1 **Air Termination Network/ Vertical Air Terminals/ Air Finial/ Spike/ Franklin Rod/ Single Rod**

The probability of structure penetration by a lightning current is considerably decreased by the presence of a properly designed air-termination system as per IS/IEC 62305 and NBC 2016.

Air termination systems can be composed of any combination of the following elements-

- a) Rods (including free-standing masts)
- b) Catenary Wires
- c) Meshed Conductors

The individual air-terminations rods should be connected together at roof level to ensure current division.

Vertical air terminals shall be provided for the Air Termination network, at the highest points, corners, and edges and at connection to down conductor, as per approved drawing. The Contractor shall co-ordinate the installation detail to allow for bonding of the network with the external façade elements, to comply with the requirement of IS/IEC 62305-3. All fixing accessories, installation materials etc. as required, shall be included in the Contract. Roof mounted electrical/electronic equipment (for example, chillers, antennas, cameras etc.) need vertical air-termination to avoid direct flashover.

All metallic projections, chimneys, ducts, vent pipe, railings, gutters etc., on or above the main surface of the roof of the structure shall be bonded to and form part of the air termination network.

#### 4.2 **Roof Conductor/Horizontal Conductor/ Mesh Conductor**

The air terminals shall be in compliance with the IEC 62561-2. The conductors shall be solid rod of

Aluminium, 8mm dia. (min.).

The conductors shall be installed at locations in compliance with the code requirement and as per approved Drawings. The conductor and Air terminals shall be securely fixed in place with suitable clamps and hardware, to the building structure. The clamps / hardware used for jointing Air terminal to the roof conductor and for fixing of roof conductor to the metallic / Masonry / glass surface of facade, shall be according to the relevant part of IS/IEC 62305.

Wherever possible, the horizontal conductors shall be of continuous lengths. Where saddled to masonry the fixing screws shall be set in expansion type plugs contained in properly formed holes. All roof conductors are to be secured by roof conductor holders at intervals from 500mm to 1000mm.

The Drawings showing the various roof levels of the building, indicating the general arrangement and layout of the air termination system. The Contractor shall ensure that air termination system, installed over its total route of the roof shall maintain absolute electrical continuity. Provision shall be made with suitable fittings to allow for expansion and contraction of the horizontal conductors at every 20 meter.

#### **4.3 Down Conductor:**

The Down Conductors shall be in compliance with the IEC 62561-2. The conductors shall be solid rod of aluminium, 8mm dia. (min.).

The down conductor shall be distributed around the outside wall / façade of the structure. Minimum Spacing between the down-conductors shall be as per designed level of protection and as per IS/IEC 62305-3. Down-Conductors are to be secured at intervals from 500mm to 1000mm.

Any external metal running vertically through the structure shall be bonded to the down conductors. A down conductor shall follow the most direct path possible between the air terminals and the earth termination. Separation distance needs to be calculated and maintained from live parts/services while routing the down-conductors.

At the structures, which cannot be punctured for holding the down-conductors, like tin roofs, glass façade etc., the down-conductors should be supported with adhesive type clamps tested for weather durability, wind speed and for withstanding lightning currents as per designed Lightning Protection Level.

#### **4.4 Joints and Bonds/Connectors**

- a) The lightning protection system shall have minimum joints as possible. Joints and bonds shall be mechanically and electrically effective. Joints exposed to the atmosphere/open air can be clamped, screwed, bolted, riveted or exothermically welded joints. Joints and bonds made below earth and in concrete shall be through exothermic welding only.
- b) With overlapping joint, the length of overlapping shall not be less than 25mm for all types of conductor. Contact surfaces shall be first cleaned, and then inhibited from oxidation with a suitable non-corrosive compound. Joints of dissimilar metals shall be protected from moisture by an inert, tenacious material.

#### **4.5 Fixing Accessories/Conductor Holders**

Suitable fixing accessories to be considered to support Roof conductor as well as down conductor at every 1 meter as per IS/IEC 62305-3.

#### **4.6 Test Clamp**

Each down conductor shall be provided with a testing joint in such a position that, it is convenient for testing (about 1000 mm above Ground level). It shall be made of copper and shall be connected at every down conductor for connection and disconnection purpose.

#### 4.7 **MAINTENANCE FREE EARTHING SYSTEM**

The Maintenance Free Earthing System shall include:

1. An earth pits with solid copper coated/bonded steel rods for uniform dissipation of fault current.
2. An earth enhancement material to offer better performance.

The earth electrode/rod is the main component of the earthing system which is in direct contact with the ground and thus provides a means of releasing or collecting any earth leakage currents. The material should have good electrical conductivity and should not corrode in a variety of soil conditions. For an effective earthing system, Copper Bonded Steel Rod can be used as described here:

High tensile-low carbon steel rod complying UL467, IEC 62561-2 & IS 3043, NBC 2016 molecularly bonded by 99.9% pure high conductivity copper on the outer surface with copper coating thickness 250 micron or more, Length 10 feet or more as per requirement. The copper bonded steel rod shall be UL Listed and the manufacturer shall provide approval certifications at the time of inspection.

The resistance from any part of the lightning protection system to earth shall not exceed 10 Ohm before any bonding has been affected to metal in or on a structure or to services below ground. If the value obtained exceeds the specified 10 Ohm it shall be reduced by adding to the number of earth electrode.

**An earth termination network shall consist of vertical and horizontal conductor comprising of ring earthing/foundation earthing, at a min. distance of 3.0 mtr from the structure.**

#### **E11 Miscellaneous**

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**E-183 Providing & Erecting conventional type CO2 based fire extinguishers Approved make of 4.5 Kg.**

**1) Material**

Should conform to E – 16

**2) Workmanship**

Shall mount the fire extinguishers at the desired location and shall check for leakage if any.

**3) Mode of measurement :**

Shall be measured on unit basis.

**E-184 Supplying rubber matting of following thickness as per IS : 15652/IEC61111 4mm**

**1) Material**

Should conform to E – 16

**2) Workmanship**

Should check for the defects and shall mount the same at locations specified by consultant.

**3) Mode of measurement :**

Shall be measured in Sq. mtr. basis.

**E-185 Providing & Erecting danger notice board of 150 x 150 mm.**



1) **Material**

Should conform to E – 16

2) **Workmanship**

Should check for the defects and shall erect the same at locations specified by site consultant.

3) **Mode of measurement :**

Shall be measured on unit basis.

**E-186 Providing printed instruction chart both in English & REGIONAL LANGUAGE & duly framed out on glass for treatment of person suffering from Electric shock, or should be laminated.**

1) **Material**

Material shall conform to E – 16

2) **Workmanship**

The chart shall be mounted at a height which makes it visible properly using screws with plugs where ever necessary. The chart shall be aligned properly.

3) **Mode of measurement**

The quantity shall be measured on the unit basis

**E-187 to 190 Providing the Various size Colour print of the Final Plan / SLD duly framed out on Glass for Electrical room & BMS Room.**

**1) Material**

Paper should be Photo quality, Glossy paper more than 90 GSM paper.

**2) Workmanship**

The chart shall be mounted at a height which makes it visible properly using screws with plugs where ever necessary. The chart shall be aligned properly.

**3) Mode of measurement**

The quantity shall be measured on the unit basis

**E-191 to E-193 Providing & laying, Double walled corrugated pipes (DWC) of polyethylene (conforming to IS 14930 II) Anti Rodent type with necessary connecting accessories of same material at required depth for laying of cable below ground / road surface for enclosing cable and backfilling the same to make ground as per original. (a) 50mm, (b) 90mm, (c) 120mm, (c) 200mm**

**1) Material**

Should be as per E-1.

**2) Workmanship**

Shall be as per 1.1 above

**3) Mode of measurement**

The quantity shall be measured on the meter basis

## **EXTENT OF WORK**

The scope of work for the total package of plumbing system as described in the tender and includes the detail engineering, supply of all material at site, construction / fabrication, installation, inspection, testing and commissioning in accordance with the drawing, specification and data sheet enclosed herewith to meet the guideline of NBC./ IS-Codes/ Standards.

The scope of works mainly involves as described below, but not limited to the following:

- 1.1 Plumbing & Drainage System Comprises of:
- 1.2 Water supply & distribution (hot, cold & drinking) system including, external water piping, valves with valve chambers, tank dewatering piping systems
- 1.3 Internal plumbing (hot & cold) system with risers within the building, air vents, internal plumbing piping, insulation, CP fittings.
- 1.4 external sewage collection & disposal system with pipe, manhole, inspection chamber, Gully traps.
- 1.5 internal waste & soil water drainage with down takes, vent, vent cowls, floor traps, nahni traps.
- 1.6 external storm water collection & disposal system with pipe/channel, catchments pits, grating.
- 1.7 internal roof / terrace water drainage with down takes, channels, drainage system with pumps, etc. complete.
- 1.8 RCC Hume pipe for services at road crossing & sleeves for building ceiling, wall
- 1.9 necessary instruments like meters, indicators, gauges, switches, etc. & bellows
- 1.10 required electrical starters, cable, wiring, junction boxes, cable trays, trench, earthling, etc. Complete for the plumbing & drainage equipments
- 1.11 Excavation, dewatering, bedding, trenching, backfilling, removal of surplus soil, necessary civil work to lay the water & drainage piping
- 1.12 Core cutting of floors for suspended plumbing.
- 1.13 Sewage Treatment Plants & Percolation wells.
- 1.14 Necessary foundation, supports, thrust blocks, hangers, anchors, etc. required for equipment's, valves & piping
- 1.15 Connection of site sewage & storm water network with the external sewer & drain with necessary chamber, pipe & special required at the single/multiple points (As per BOQ)
- 1.16 All civil work, equipment, piping, accessories, etc. required for complete erection of Plumbing & Drainage system. (As per BOQ)
- 1.17 Painting of the equipments, structures, supports, piping, etc.
- 1.18 Providing all documents, shop drawings, foundation & installation detail, catalogues, O & M manuals.
- 1.19 As built Drawings.
- 1.20 Supply and installation of RCC pipe supports for above ground piping.
- 1.21 Excavation & backfilling for underground pipe at road crossing.
- 1.22 Training of Clients personnel in operation and maintenance of Plumbing Pumps, Equipments, Fixtures, STP, WTP, R.O.plants, Heat pump, Solar heater etc, including mock drill.
- 1.23 Approval of water, drain, connections system from any agency nominated by government authority.

- 1.24 Quantity can varying, EMPLOYER has right to Change/Delete any Tender for plumbing System
- 1.25 Any other civil work and structural work required/directed by EMPLOYER/ Consultant Civil work like making / opening in wall/ceiling and regularization the same shall be done by contractor

- 1.26 Any other work required for the functional and operation completion of the work but not specifically mentioned in the scope of work shall be in contractor's scope of work and shall be carried out as per instruction of EMPLOYER / Consultant.
- 1.27 Quantity can varying, EMPLOYER has right to Change/Delete any Tender for Plumbing System as Quantity / specified in the Tender;
- 1.28 Any other civil work and structural work required/directed by EMPLOYER/ Consultant Civil work like making opening in wall/ceiling and regularisation the same shall be done by contractor;
- 1.29 Any other required for the functional and operation completion of the work but not specifically mentioned in the scope of work shall be in contractor's scope of work and shall be carried out as per instruction of EMPLOYER / Consultant.
- 1.30 Any extra item shall be calculated on the rate analysis basis approved by EMPLOYER

## 6.1 PLUMBING System Comprises of :

- 6.1.1 internal as well as external Water supply & Distribution system including domestic water, hot water & drinking water system with all pumps, hydro pneumatic systems, piping & fittings, valves, treatment units, instruments & gauges with all required accessories
- 6.1.2 Drainage (Sewage) system including internal & external system with piping, gully chambers, grease traps, sewer traps, pumps (if called for in BOQ) inspection chambers, manholes, etc. complete
- 6.1.3 Construction, fabrication, erection, testing, commissioning entire system
- 6.1.4 Connection to the city sewer/city drain/water source
- 6.1.5 Excavation, dewatering, trenching, bedding, refilling, etc. with necessary civil work for laying of water supply / drainage pipe with good practice. RCC hume pipes for all road crossings.
- 6.1.6 Collection of sewage, treatment of sewage & ultimate disposal, Storm water collection, percolation, ultimate disposal

## 7.0 ABBREVIATIONS:

The following abbreviations have been used in the accompanying specifications, drawings and Bill of quantity:

SR NO	ABBREVIATION	MEANING
1	SV	Sluice Valve
2	NRV	Non Return Valve
3	HP	Hydro pneumatic System
4	WTP	Water Treatment Plant
5	R.O.	Reverse Osmosis
6	MH	Man hole Chamber
7	IC	Inspection Chamber
8	GT	Gully Trap
9	DP	Drain Pump
10	AV	Air Vessel
11	ARV	Air Release valve
12	SP	Soil pipe
13	WP	Waste Pipe
14	NT	Nahni Trap
15	FT	Floor Trap

16	CP	Catchment pit
17	WS	Water Supply
18	BV	Ball Valve
19	BFV	Butterfly Valve
20	PG	Pressure Gauge
21	PS	Pressure Switch

SR NO	ABBREVIATION	MEANING
33	VFD	Variable Frequency Drive

## 8.0 REGULATIONS AND STANDARDS:

The design shall follow guidelines appearing in the following Standards :

27 – 1992/2002	Specifications for Pig Lead
269- 1989 /2004	Specifications for 33 grade Ordinary Portland Cement
407- 1981 / 2001	Brass tubes for General purposes
456- 2000	Code of practice for Plain & Reinforced concrete.
458- 2003	Specifications for Concrete Pipes.
554- 1999	Dimensions for pipe thread where pressure tight joints are required.
638- 1979 / 2003	Sheet rubber jointing & rubber insertion jointing
651- 1992 / 2003	Specifications for Salt glazed stoneware pipes & fittings.
771 (Pt. I & VII)	Glazed Fire Clay Sanitary Appliances.
771- 1979 / 2003	General requirements
771- 1985 (Pt. II) / 2003	Specific requirements of kitchen & laboratory sinks
771- 1979 (Pt. III/ Sec 1) / 2003	Specific requirements of urinals ( section 1- Slab urinals)
771- 1985 (Pt. III/ Sec2) / 2000	Specific requirements of urinals ( section 2- Stall urinals)
771- 1979 (Pt. IV) / 2003.	Specific requirements of postmortem slabs.
771- 1979 (Pt. V) / 2003	Specific requirements of shower trays
771- 1979 (Pt. VI) / 2003	Specific requirements of bed pan sinks
771- 1981 (Pt. VII) / 2003	Specific requirements of slop sinks
774- 1984 / 2000 .	Flushing cistern for water closet and urinals.
775- 1970 / 2000	Cast iron brackets and supports for wash basin and sink.
778- 1984 / 2000	Specifications for copper alloy gate & Globe check valves for water works
779- 1994 / 2004	Water meters (domestic type)
781- 1984 / 2001	Specifications for cast copper alloy screw down bib taps & stop cocks for water services
782- 1978 / 2003	Specification for Caulking lead.
783- 1985 / 2001	Code of practice for laying concrete pipes.
784- 2001 / 2002	Pre-stressed concrete pipes.
1172- 1993/ 2002	Code of basic requirements for water supply, drainage and sanitation
1200-1979 (Pt. 16) / 2002	Method of measurements for Laying of water and sewer
1200-1981 (Pt. 19) / 2002	Method of measurements for Water supply, plumbing and drains.
1230	Specifications for CI Rain Water pipes



1239- 2004 (Pt I)	Specifications for Mild steel tubes
1239- 1992 ( Pt. II) / 2002	Specifications for Mild steel Tubular & other wrought steel pipe fittings
1300- 1994 / 2000	Phenolic moulding material specification
1536- 2001	Specifications for Centrifugally cast iron (spun) pressure pipes for water, gas, sewage

1537- 1976 / 2000	Specifications for Vertically cast iron pressure pipes water, gas and sewage
1538- 1993 / 1999	Cast iron fittings for pressure pipes for water, gas and
1700- 1973 / 2003	Drinking fountains
1701- 1960 / 2003	Combination valve , mixing valves
1703- 2000	Ball valve (horizontal plunger type) including floats for water supply.
1711- 1984 / 2000	Self closing taps.
1726- 1991 / 2003	Cast iron manhole covers and Frames.
1729- 2002	Cast /ductile iron drainage pipes & fittings for over ground NP pipeline S/S series.
1742- 1983 / 2002	Code of practice for building drainage
1795- 1982 / 2000	Pillar taps for water supply purposes
1879	Malleable Cast Iron Pipe Fittings
1978- 1982/2002	Specification for line pipe (M S Seamless )
1979- 1985 / 2002	Specification for high test line pipe
2065- 1983 / 2001	Code of practice for water supply in buildings.
2097 - 1983 / 2000	Specification for foam making branch pipe.
2104- 1981 / 2003	Water meter boxes (domestic type)
2326- 1987 / 2003	Automatic flushing cistern for urinals
2373	Specification for Water Meter (Bulk type)
2379- 1990 / 2000	Colour code for identification of pipe lines.
2401- 1973 /2003	Code of practice for selection, installation & maintenance of domestic water meters
2470 (Pt. I to II)	Code of practice for installation of septic tanks
2470- 1985 (Pt. I) / 2001	Design criteria & construction
2470- 1985 (Pt. II) / 2001	Secondary Treatment & disposal of septic tank effluent
2527- 1984 / 2000	Code of practice for fixing rain water gutters and down pipes for roof drainage.
2548- 1996(Pt. I) / 2002	Plastic water closet seats and covers.
2548- 1996(Pt. II) / 2002	Plastic water closet seats and covers.
2556 (Pt. 1 to XV)	Specification for Vitreous (Vitreous China) sanitary appliances.
2556- 1994 (Pt.1) / 2004	General requirements
2556- 2004 (Pt. 4)	Specific requirements of wash basins
2556- 1994 (Pt.5) / 2004	Specific requirements of laboratory sinks
2556- 1995(Pt.6) / 2003	Specific requirements of urinals & partition plate
2556- 1995 (Pt.7) / 2003	Specific requirements of accessories for sanitary
2800- 1991 (Pt. I)	Construction of tube well

2800- 1979 (Pt. II)	Testing of tube well
2951- 1965 (Pt. I) / 2003	Head loss in straight pipes due to frictional resistance
2951- 1965 (Pt. II) / 2003	Head loss in valves & fittings.
3006- 1979 / 2003	Specification for Chemically resistant glazed S.W. pipes and Fitting
3076- 1985 / 2003	Low density polyethylene pipes for potable water supply
3114- 1994 / 2004	Code of practice for laying of Cast Iron pipes.
3486- 1966 / 2000	Specification for Cast iron spigot and socket drain pipes
3589- 2001	Specifications for steel pipes for water & sewage

	2540 mm outside dia.)
3597- 1998	Method of test for concrete pipes.
3950- 1979 / 2003	Specification for Surface boxes for sluice valve.
3989- 1984 / 2000	Centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes, fittings & accessories
4038- 1986 / 2000	Foot valves for water works purposes.
4111- 1985 (Pt. II) / 2001	Flushing tanks
4111- 1985 (Pt. III) / 2001	Inverted syphon
4736- 1986 / 2001	Specification for hot –dip zinc coating on mild steel tubes.
4984- 1995 / 2002	Specifications for HDPE pipes for water supply
4985- 2000	Specifications for unplasticised PVC pipes for potable water supplies
5312 (Pt. I)	Swing check type reflux (non return ) valves
5312- 1984 (Pt. I)/ 2000	Reflux (non return ) valves – single door pattern
5382- 1985 / 2003	Specifications for rubber sealing rings for water, gas & sewer mains
5455- 1969 / 2003	Cast iron steps for manholes
5600- 2002	Specifications for Sewage and drainage pumps
5611- 1987 / 2002	Code of Practice for waste stabilization ponds (Facultative type)
5822- 1994 / 2004	Code of Practice for laying of welded steel pipes for water supply
5961- 1970 / 2003	Specifications for Cast Iron grating for drainage purposes
6295- 1986 / 2001	COP for water supply & drainage in high altitude & / or sub- zero region
6392- 1971 /1998	Steel pipe flanges
6411- 1985 / 2000	Specifications for gel coated glass fiber reinforced polyester resin bath tubs
6418- 1971/2000	Cast Iron & malleable flanges for general engg. Purpose
6494- 1988 / 2000	COP for water proofing of under ground water tanks & swimming pools
6587- 1987 / 2003	Specifications for Spun hemp yarn

7181- 1986 / 2000	Horizontally Cast Iron Double Flanged pipe for water, gas & sewage.
7231- 1994 / 2004	Specifications for Plastic Flushing Cisterns for w.c. &
7558- 1974 / 2001	Code of Practice for domestic hot water installations
7634 (Pt. I to III)	Code of Practice for Plastic pipe work for potable water supplies
7634- 1975 (Pt. II) / 2002	Laying & jointing polyethylene (PE) pipes
7634- 2003 (Pt. III)	Laying & jointing unplasticised PVC pipes
7740- 1985 / 2001	Code of Practice for road gullies
8727- 1978 / 2000	Specifications for vitreous enameled steel kitchen sinks
8835- 1978 / 1999	Guideline for planning and design of surface drains.
8931- 1993 / 2003 p	Specifications for copper alloys Fancy single taps, combination tap
9338- 1984 / 2000	Specifications for Cast Iron screw down stop valves and stop
9739- 1981/ 2003	Specifications for Pressure reducing valves for Domestic water supply system.

9758- 1981 /2003	Flush valves and Fittings for water closets and urinals
9762- 1994 / 2004	Specifications for polyethylene floats for float valves
10500- 1991 / 2003	Specification of Drinking water
12231 - 1987 / 2003	UPVC pipes for section & delivery lines of agricultural pumps–Specification.
12235 - 1986 / 1998	Method of test for UPVC pipe for potable water supply
12288 - 1987 / 2002	Code of practice for use and laying of Ductile Iron pipes.
12469 - 1988 / 2002	Specifications for pumps
12592- 2002	Precast concrete frame & cover ( SFRC frame & cover )
12701-1996 / 2002	Specifications for rotational moulded polyethylene water storage tanks
12820 - 1989 / 1999	Dimensional Requirements of Rubber Gaskets for Mechanical Joints & push in joints for use with CI pipe & fittings for carrying water, gas, sewage
13095 - 1991 / 2003	Butterfly valves for general purposes
13114 - 1991 / 2003	Spn. For forged brass gate, globe & check valves for water works purposes
13382-2004	Cast Iron specials for mechanical & push-on flexible joints for pressure pipeline for water, gas & sewage
13592- 1992 / 2002	Specifications for PVC soil, waste & rain water (SWR) including ventilation pipes
13593 - 1992 / 2002	UPVC pipes fittings for use with section and delivery lines for agriculture pumps
13983-1994 / 2004	Specifications for stainless steel kitchen sinks & drain boards for domestic purpose
14333-1996 / 2001	Specification for HDPE pipes for sewerage system.
14735-1999 / 2004	UPVC injection moulded fittings for UPVC – SWR pipes – Specifications.
14845- 2000 / 2004	Resilient seated cast iron air relief valves for water works purposes – Spn

14846- 2000	Specifications for sluice valve for water works purposes (50 to 1200 mm size )
15328 – 2003	15328 – 2003 -- UPVC non pressure pipes for use in underground drainage and sewerage system spec.
15450- 2004	Polyethylene/Aluminium/Polyethylene composite pressure pipes for hot & cold water supply

Codes for Motors, Cabling, wiring and accessories shall be as per relevant Indian / international codes and standards.

## **9.0 FEES, PERMITS AND TESTS:**

The Contractor shall pay for any and all fees and obtain permits required for the installation work. On completion of the work the contractor shall obtain and deliver to the EMPLOYER, certificates of final inspection and approval by the local authority.

## **10.0 UTILITY SUPPLY:**

The location of receipt of incoming utilities supply (Hook up Points) like LT power supply, It is the responsibility of the contractor to co-ordinate with various utility agencies, the exact location of such Hook up Point and mode of connection. Further the contractor shall co-ordinate with such utility agencies to provide necessary drawings, documents, get their approval, make the necessary arrangement for the payments and arrange the utilities supply at no extra cost.

## **11.0 ACTUAL ROUTE OF PIPING:**

The location of the pumps, tanks, water supply & distribution piping, drinking water tap, soil & waste water piping, storm water piping, etc. are indicative only, therefore, the actual route of piping and the location may differ from the plans according to the details of the building construction and the conditions of executions of the installations.

The contractor shall supply and install at his expense all secondary materials and special fittings found necessary to overcome the interference and to supply the modifications on the route of ref. piping that are found necessary during the work, to the complete satisfaction of the EMPLOYER's representative.

## **12.0 MATERIAL AND EQUIPMENT:**

All material and equipment shall conform to the relevant standards and shall be of the approved make and design. The materials and equipment shall conform to relevant Indian Standards. The Contractor shall be responsible for the safe custody of all the materials and shall insure them against theft, damage by fire, earthquake etc. A list of items of materials and equipment, together with sample of each shall be submitted to the EMPLOYER within 10 days of the award of the contract. Any item which is proposed as a substitute, shall be accompanied by all technical detail giving sizes, particulars of materials and the manufacturer's name and shall be submitted along with the tender or bid offer. At the time of the submission of proposed substitute the Contractor shall state the credit, if any due to the EMPLOYER. In the event the substitution is approved, all changes and substitutions shall be requested in writing and approvals obtained in writing from EMPLOYER. EMPLOYER's decision in the matter shall be final.

All materials of the same kind of service shall be identical and made by the same manufacturers. Any deviation to this rule shall be approved by the Consultant. Top priority shall be given to the products that have a permanent agent providing spare parts and maintenance facilities in the same city where the project is situated.

Make of plumbing & drainage equipments, components, accessories, etc. has been mentioned in order of priorities. The tenderer has to quote for the first priority as mentioned above after ascertaining that the first preference materials are available. If at a later stage during executing the work, material of the first preference make are not available, the contractor has to get approval from the EMPLOYER to use other make of material prior to procurement. Any rate difference for the first preference make and the one approved will be passed on to the EMPLOYER.

### **13.0 MANUFACTURERS :**

Where manufacturers have furnished specific instructions relating to the materials used in this job, covering points not specifically mentioned in these documents, these instructions shall be followed in all cases.

Where manufacturer's names and/or catalogue numbers are given, this is an indication of the quality, standards and performance required.

When interfacing occurs, equipment shall be mutually compatible in all respects.

### **14.1 RATING:**

Rating of all items shall be appropriate for the conditions on the particular site on which the items will be used. All the equipment shall be fit for continuous work under the worst conditions of site and shall be rated for the following ambient condition.

- ◆ Outdoor temperature 45 deg. cel.
- ◆ Temperature under shed 40 deg. cel.
- ◆ Salty, dusty and humid

### **15.0 INSPECTION AND TESTING:**

EMPLOYER'S representative reserves the right to request inspection and testing at manufacturer's works at all reasonable times during manufacture of items for this contract. Tests on site of completed works shall demonstrate, among other things:

- 15.1 That the equipment installed complies with specification in all particulars and is of the correct rating for the duty and site conditions.
- 15.2 That all items operate efficiently and quietly to meet the specified requirements.
- 15.3 That all the features performed at its best and loading \_unloading of the system.
- 15.4 That all the accessories used in low side work are of specified make only. And any deviation in the same needs written approval from our technical consultant.

The contractor shall provide all necessary instruments and labor for testing, shall make adequate records of test procedures and readings, shall repeat any tests requested by the EMPLOYER and shall provide test certificates signed by a properly authorized person. Such test certificates shall cover all works.

If tests fail to demonstrate the satisfactory nature of the installation or any part thereof then no claims for the extra cost of modifications, replacements or re testing will be considered. EMPLOYER's decision as to what constitutes a satisfactory test shall be final.

The above general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere.

#### **16.0 PRICE DETAILS:**

At anytime and at the request of EMPLOYER, the contract shall provide details or breakdown of costs and prices of any part or parts of the works.

#### **17.0 TEST CERTIFICATES:**

The contractor shall submit test certificates for all the High side PLUMBING system installed. These shall be issued by an Engineer in charge certifying that all equipment, materials, construction and functions are in agreement with the requirements of these specifications, ISI and when ISI is not applicable other approved certifying agencies.

#### **18.0 INSTRUCTION MANUAL:**

The contractor shall prepare and produce instruction, operation and maintenance manuals in English for the use, operation and maintenance of the supplied equipment and installations, and submit 3 sets to EMPLOYER, at the time of handing over.

#### **19.0 SAMPLES AND CATALOGUES:**

Before ordering the material necessary for these installations, the contractor shall submit to EMPLOYER for approval, a sample of every kind of material such as valve, pipe, etc., along with the catalogues.

For big items such as pumps, hydro pneumatic systems, panels, WTP, hot water generator, the submission of catalogues shall be enough. Prior to ordering any plumbing & drainage equipment/material/system, the contractor shall submit to EMPLOYER, the catalogues, along with the samples, at least from three different manufacturers. After the selection of manufacturer by EMPLOYER, the contractor shall arrange inspection and testing at the manufacturer's factory or assembly shop for final approval. No material shall be procured prior to the approval of the EMPLOYER.

#### **20.0 VENDOR AND SHOP DRAWINGS:**

The contractor shall prepare and submit to EMPLOYER, for his approval, Six sets of vendor detailed drawings of PLUMBING Plant Room Equipments, Water Piping & drainage Route Proposed, and equipment to be fabricated by the contractor, or other vendor within 10 days of signing of the contract.

Before starting the work, the contractor shall submit to EMPLOYER for his approval in the prescribed manner, the shop/execution drawings for the entire installation, specially the main connections and junctions, the route of water & drainage piping, and any other information

required by EMPLOYER. EMPLOYER reserves the right to alter or modify these drawings if they are found to be insufficient or not complying with the established technical standards or if they do not offer the most satisfactory performance or accessibility for maintenance.

#### **21.0 AS BUILT DRAWINGS:**

At the completion of work and before issuance of certificate of virtual completion the contractor shall submit to EMPLOYER, three sets of layout drawing drawn at appropriate scale indicating the complete wiring system "as installed". These drawings must provide (in plan, folded elevation and section)

21.1 Location and specification details of all Plumbing Pumps, WTP, hydro pneumatic system

21.2 Location of all water piping routes and Valve Locations.

21.3 Route and particulars of soil + waste piping & other components.

21.4 Route and particulars of storm water piping & other components.

21.5 All Kitchen and Toilet drainage system

21.6 Basement drainage System

21.7 GA Drawing of all major PLUMBING Equipment

22.1 Any defective work or material supplied by the contractor.

22.2 Any material or equipment damaged or destroyed as a result of defective workmanship by the contractor

#### **23.0 SAFETY OF MATERIALS:**

The contractor shall provide proper and adequate, storage facilities to protect all the materials and equipment including those issued by EMPLOYER against damage from any cause whatsoever.

#### **24.0 COMPLETION CERTIFICATE:**

On completion of the PLUMBING SITC (or an extension to an installation) a certificate shall be furnished by the contractor countersigned by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local supply authority. The contractor shall be responsible for getting the Plumbing & Drainage installation inspected and approved by the local concerned authorities.

#### **25.0 DEFECTS LIABILITY:**

Defects liability period shall mean 12 calendar months after EMPLOYER have issued certificate of completion of the whole work. The certificate of completion shall be issued after the necessary tests have been carried out to the satisfaction of EMPLOYER and the required drawings are submitted.

The contractor shall make good at his own cost and to the satisfaction of EMPLOYER, all defects or other faults arising in the opinion of EMPLOYER out of bad workmanship or faulty materials not in accordance with the drawings, Indian Standard, NBC & local rules & regulations under which it may appear within twelve months after completion of the work.

**26.0 SITE ENGINEER AND TRAINING :**

The contractor shall employ a competent fully licensed qualified, full time Civil engineer to direct the work of PLUMBING & DRAINAGE installation in accordance with the drawings and specifications. The engineer shall be available all times at site to receive instructions from EMPLOYER, in the day to day activities throughout the duration of contract. The engineer shall correlate the progress of the work in conjunction with all the relevant requirements of the supply authority. The engineer coordinates with other services contractor and PMC for any coordination site issues.

Contractor shall give training to technical staff of client for Operating, Control and Basic maintenance for easy operation.

**27.0 RESTATING & FINISHING OF CIVIL DAMAGES:**

For erection of equipment / Piping etc., if any civil structure is required to be broken, the same shall be done, restated and finished as original by the tenderer without any extra cost.

**28.0 COLOUR CODES:-**

The following colour codes are recommended for pipes {see also accepted standard [9-1(20)]}: as per NBC recommendation can be follow.

<i>Sl No.</i> (1)	<i>Particulars</i> (2)	<i>Ground Colour</i> (3)	<i>First Colour Band</i> (4)	<i>Second Colour Band</i> (5)
i)	Cooling water	Sea green	French blue	—
ii)	Boiler feed water	Sea green	Gulf red	—
iii)	Condensate water	Sea green	Light brown	—
iv)	Drinking	Sea green	French blue	Signal red
v)	Treated	Sea green	Light orange	—
vi)	Fire water	Fire red	Crimson red	—
vii)	Water with central heating below 60°C	Sea green	Canary yellow	—
viii)	Water with central heating between 60 to 100°C	Sea green	Dark violet	—
ix)	Water with central heating above 100°C	Sea green	Dark violet	Signal red
x)	Cold water from storage tanks	Sea green	French blue	Canary yellow
xi)	Domestic, hot water	Sea green	Light grey	—
xii)	Hydraulic power water	Sea green	Black	—
xiii)	Untreated sea/river water	Sea green	white	—
xiv)	Filtered water	Sea green	Light brown	—
xv)	Soft water	Sea green	Light brown	Signal red
xvi)	Warm water	Sea green	Light grey	Canary yellow
xvii)	Chilled water	Sea green	Black	Canary yellow
xviii)	Sprinkler and hydrant water	Sea green	White	Signal red
xix)	Waste water	Sea green	Canary yellow	Signal red



**VOLUME –I\_ TECHNICAL SPECIFICATION FOR INTERNAL PLUMBING WORKS**  
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## GENERAL TECHNICAL SPECIFICATION FOR PLUMBING WORK

### 1.0 GENERAL:

- 1.1 The work shall be carried out in the accordance with the drawings and design as would be issued to the Contractor by the Design Consultant duly signed and stamped by him. The Contractor shall not take cognizance of any drawings, designs, specifications etc. not bearing Design Consultant signature and stamp. Similarly the Contractor shall not take cognizance of instructions given by any other Authority except the instructions given by the Client's Representative in writing.
- 1.2 The work shall be executed and measured as per metric dimensions given in the Bill of Quantities, drawings etc.
- 1.3 The Contractor shall acquaint himself fully with the partial provisions for supports that may or may not be available in the structure and if are available then utilize them to the extent possible. In any case the Contractor shall provide all the supports regardless of provisions that they have been already made. Nothing extra shall be payable for situations where insert plates (for supports) are not available or are not useful.
- 1.4 Shop coats of paint that may be damaged during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.
- 1.5 The Contractor shall protect / handle the material carefully and if any damage occurs while handling by the Contractor then the sole responsibility shall be of the Contractor. Such damages shall be rectified/recovered by the Contractor at no extra cost whatsoever.
- 1.6 The Contractor shall, within twenty one (21) days of receipt of the Notice of Award for the Project, where applicable, complete the submission of shop drawings to the Client's Representative for approval by the Design Consultants in order to conform to the contract schedule.

### 1.7 MEASUREMENTS:

All measurements shall be taken in accordance with relevant IS codes, unless otherwise specified.

### 2.0 APPLICABLE CODES AND STANDARDS:

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practice given below as amended up to the date of submission of Tender. All equipment and material being supplied shall meet the requirements of BIS and other relevant standard and codes.

#### Plumbing Works:

Vitreous Chinaware	-	IS: 2556 - 1974 (Part - I)
	-	IS: 2556 - 1981 (Part - II)
	-	IS: 2556 - 2556 (Part - III)
Ball Valve	-	IS: 1703 - 1977
Cistern Brackets	-	IS: 775 - 1970
Toilet Seat Cover	-	IS: 2548 - 1983
Vitreous China Cistern	-	IS: 2326 - 1987
Sand Cast Iron Pipes and Fittings	-	IS: 1729 - 1979

Spun Cast Iron Pipes and Fittings	-	IS: 3989 - 1984
GI Pipes	-	IS: 1239 - 1979
Galvanizing for GI Pipes	-	IS: 4736 - 1986
Pipe Threads	-	IS: 554 - 1985
Milleable Iron Fittings	-	IS: 1879 - 1987
Cast Iron Sluice Valves	-	IS: 780 - 1984
Full Way Valves	-	IS: 778 - 1984
Brass Ferrule	-	IS: 2692 - 1978
Stone Ware Gully Trap	-	IS: 651 - 1980
RCC Pipes	-	IS: 458 - 1971
Cast Iron Class LA Pipes	-	IS: 1536 - 1989
Cast (Spun) Iron Fittings	-	IS: 1538 - 1976
Pig Lead	-	IS: 782 - 1966
Induction Motors	-	IS: 4691
Code for Measurements	-	IS: 1200
UPVC Pipes and Fittings	-	IS: 4984
Specification for Caulking Lead	-	IS: 782
Code of Practice for laying of concrete	-	IS: 783

#### **COLOUR CODE FOR WATER SUPPLY PIPES:-**

Color code for water supply pipes shall be as per IS 2379. Details are as mentioned below

SL NO	DESCPRITION	GROUND COLO U R	FIRST COLOUR BAND	SECOND COLOU R
1	Cooling	Sea green	French Blue	
2	Boiler feed	Sea green	Gulf red	
3	Condensate	Sea green	Light Brown	
4	Drinking	Sea green	French blue	Signal red
5	Treated	Sea green	Light Orange	
6	Cold water from storage	Sea green	French Blue	Canary Yellow
7	Warm water	Sea green	Light grey	Canary Yellow
8	Soft water	Sea green	Light Brown	Signal red
9	Waste water	Sea green	Canary yellow	Signal red

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### **3.0 QUALITY ASSURANCE AND QUALITY CONTROL:**

- 3.1 The work shall conform to high standard of design and workmanship, shall be structurally sound and aesthetically pleasing. Quality standards prescribed shall form the backbone for the quality assurance and quality control system.
- 3.2 At the site, the Contractor shall arrange the materials and their stacking/ storage in appropriate manner to ensure the quality. Contractor shall provide equipment and manpower to test continuously the quality of material, assemblies etc. as directed by the Client's Representative. The test shall be conducted continuously and the result of tests maintained. In addition the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of surface.

- 3.3 The Client's Representative shall be free to carry out such tests as may be decided by him at this sole direction, from time to time, in addition to those specified in this Document. The Contractor shall provide the samples and labour for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.
- 3.4 The test shall be conducted at Standard Laboratory selected by Client's Representative. Contractor shall keep the necessary testing equipment such as hydraulic testing machine, smoke testing machine, gauges and other necessary equipment required.
- 3.5 The Client's Representative shall transport the samples to the laboratory.
- 3.6 Testing charges shall be borne by the Client's Representative.
- 3.7 Testing may be witnessed by the Contractor or his Authorised Representative. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

#### **4.1 SANITARY FIXTURES & C.P. FITTINGS:**

#### **4.2 SCOPE**

- 4.2.1 Work under this section shall consist of transportation, furnishing, installation, testing and commissioning and all labour as necessary as required to completely install all sanitary fixtures, brass and chromium plated fittings and accessories as required by the drawings and specified hereinafter or given in the Bill of Quantities.

#### **4.3 GENERAL REQUIREMENTS**

- 4.3.1 All fixtures and fittings shall be fixed with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Bill of Quantities, specifications, drawings or not.
- 4.3.2 All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per architectural design requirements. Wherever necessary the fittings shall be centered to dimensions and pattern desired.
- 4.3.3 Fixing screws shall be half round head chromium plated brass with C.P. washers wherever required as per directions of Client's Representative.
- 4.3.4 All fittings and fixtures shall be fixed in a neat workmanlike manner true to levels and heights shown on the drawings & in accordance with the manufacturer's recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, wall or ceiling surfaces shall be made good at Contractors cost.
- 4.3.5 All fixtures of the similar materials shall be by the same manufacturers.
- 4.3.6 All fitting shall be of the chromium plated materials.
- 4.3.7 Without restricting to the generally of the foregoing the sanitary fixtures shall include all sanitary fixtures, C.P. fittings and accessories etc. necessary and required for the building.

4.7.8 Whether specifically mentioned or not all fixtures and appliances shall be provided with approved fixing devices, nuts, bolts, screws, and hangers as required. These supports shall have the necessary adjustment to allow for irregularities in the building area construction.

4.7.9 For the installation of the CP fittings, Teflon tape shall be used.

#### **4.3 EUROPEAN W.C.**

4.3.1 European W.C. of glazed vitreous china shall be wash down, single or double symphonic type, floor or wall mounted set, flushed by means of flush valve as specified in Bill of Quantities. Flush pipe / bend shall be connected to the W.C. by means of suitable rubber adopter. Wall hung W.C. shall be supported by C.I. floor mounted chair.

4.3.2 Each W.C. seat cover shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C. Seat cover shall be of white solid plastic, elongated open front with heavy duty hinges. Exposed fixture trims shall be Chrome plated, and trims of similar function shall be by the same manufacturer.

4.3.3 Flush valves shall be of the best approved quality procurable with C.P. control valve and C.P. flush pipe.

4.3.4 The flush pipe/bend shall be connected to the WC by means of a suitable rubber adopter.

4.3.5 Alternatively if flushing cistern to be used shall conform to the requirements of IS: 774-1971. High level cisterns shall be of cast iron unless otherwise specified. Low level cistern shall be of the same material as the water closet or as instructed by the EMPLOYER/Architect/ Consultant. The cisterns shall be mosquito proof & shall fulfill the requirements of the local Authority.

4.3.6 The levels of the WC should be checked by placing spirit level on the W.C. W.C. should be tested on completion of fixing by putting small paper balls and flushing out. If all the paper balls are not flushed out. The fixing will have to be rectified / re-aligned.

#### **4.4 KITCHEN / PANTRY SINKS**

4.4.1 Sinks shall be of stainless steel material as specified in the Bill of Quantities/Drawings.

4.4.2 Each sink shall be provided with R. S. brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable angle iron clips or brackets as recommended by the manufacturer. Each sink shall be provided with 40 mm dia Chromium Plated waste with chain and plug or P.V.C. waste with Escutcheon plates. Fixing shall be done as directed by Client's Representative.

4.4.3 Supply fittings for sinks shall be mixing fittings or C.P. taps, angle cocks etc. all as specified in the Bill of Quantities/Drawings.

#### **4.5 WASH BASINS**

4.5.1 Wash basin shall be of white vitreous china of best quality manufactured by an approved firm and sizes as specified in the Bill of Quantities.

4.5.2 Wash basin shall be of under counter drop in type shall be supported on a pair of rolled steel brackets of approved design and shall be mounted on a countertop. So that rim and basin bowl is exposed from top.

4.5.3 Wash basin shall be provided with single lever mixer with chain and rubber plug, chromium plated brass bottle trap of approved quality, design and make where hot water required. Single tap where hot water is not required.

4.5.4 Wash basin shall be fixed at proper location and height and truly horizontal as shown on drawing or as directed by Client's Representative.

#### **4.6 HOSE BIBB'S**

4.6.1 Hose Bib of Chromium Plate tap is draw off tap with horizontal inlet and free outlet knurling on outer face to fix the hose pipe. Hose bib shall be of specified size and shall be of screw down type and shall conform to IS: 781-1984. The closing device shall work by means of a disc carrying a renewable non-metallic washer which shuts against the water pressure on a seating at right angle to the axis of the threaded spindle which operate it. The handle shall be either crutch or butterfly type securely

#### **4.7 URINALS**

Half stall wall hung urinals of glazed vitreous china shall be provided with 15mm dia, C.P. brass spreader, 32mm dia C.P. domical waste and C.P. cast brass bottle trap with pipe and wall flange and shall fixed to wall by one C.I. bracket and two C.I. clips as recommended by manufacturers complete as directed by the Client's Representative.

Urinals shall be flushed by means of "NO-TOUCH" infrared operated flush valves.

Waste pipes for urinals shall be any one of the given material as directed by the Client's Representative:

- a) G.I. Pipes
- b) Rigid PVC/High density polyethylene.

Waste pipes may be exposed on wall or concealed in chase as directed by the Client's Representative.

#### **4.8 BATH TUB**

Bath tub & panel shall be white enameled cast iron or pressed steel as specified in the Bill of Quantities of guaranteed quality and specifications.

Each bath tub shall be provided with 40mm dia CP brass waste with 32mm C.P. brass overflow, 40mm dia cast brass overflow-cum-waste trap with pop-up waste assembly.

Bath tub shall be provided with four Nos. C.P. brass concealed stop cocks, bath spout and overhead shower or as specified in the Bill of Quantities.

Bath tubs shall be fixed true to level firmly fixed to another or supports provided by the manufacturer. Edges touching the wall shall be slightly recessed in the wall finishing so as ensuring water tightness. The fixing shall be perfectly done so that the wall behind does not tend to get damp or patchy.

Contractor shall during the entire period of installation and afterwards protect the bathtub by



providing suitable cover or any other protection so as to absolutely prevent any damage to the bathtub until handing over.

#### **4.9 DIVETOR, SHOWER , MIXER, SPOUT**

Single lever divertore, over head shower , spout in the shower area as specified in the Bill of Quantities of guaranteed quality and specifications Concealed body for single lever concealed diverter system consisting of 40 mm cartridge with button Assembly, Cartridge Sleeve (but without operating lever, wall flange and tip ton knob).  
Over head Shower shall be provided with 5” dia ( 3 flow) type operation function assembly as specified in the Bill of Quantities.

#### **4.10 TOILET PAPER HOLDER:-**

Toilet paper holder shall be of Stainless Steel. The make and model shall be as specified in the BOQ.

#### **4.11 TOWEL RING:-**

These shall be of CP/ sanitary ware. The make and model shall be as specified in the BOQ. These shall be fixed by means of C.P. brass counter sunk screws to wooden / plastic cleats firmly embedded in the wall.

#### **4.12 LIQUID SOAP DISPENSER: -**

The Soap dispenser shall be of approved type as specified in the BOQ. It shall be made up of ABS plastic / CP material.

#### **4.13 FLOOR TRAPS FRAME AND GRATING: -**

The floor trap frame and grating shall be of approved material as specified in the BOQ. The trap shall be fitted with anti- cockroach grating. A minimum of 70mm depth of water seal shall be provided in the trap.

#### **4.14 HEALTH FAUCET: -**

These shall be of CP / sanitary ware. The make and model shall be as specified in the BOQ. These shall be fixed by means of stainless-steel counter sunk screws to wooden/ plastic cleats firmly embedded in the wall. 15 mm CP health faucet with 1.0m long flexible tube with end nuts & Hook. 1 No 15mm CP brass angular stop cock with wall flange Hook with CP brass counter sunk screws.

#### **4.15 PUSH COCK: -**

These shall be of CP / sanitary ware. The make and model shall be as specified in the BOQ. These shall be fixed by means of stainless-steel screws to wooden / plastic cleats firmly embedded in the wall.

#### **5.1 WATER SUPPLY:**

#### **5.2 SCOPE**

5.2.1 Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the bill of quantities.

5.2.2 Without restricting to the generality of the foregoing, the water supply system shall include the following:-

- i. Pipe protection & painting.

- ii. Connections to all plumbing fixtures, tanks, pump etc.
- iii. Providing hot water pipe lines and supply point with isolation valves, wherever required.
- iv. Control valves, masonry chambers and other appurtenances.
- v. Connections to all plumbing fixtures, tanks and appliances.
- vi. Excavation and refilling of pipe trenches, wherever necessary.
- vii. Internal galvanized water supply piping inside the toilets shaft/plant room/terrace.
- viii. Testing all line and fixtures as specified.

### **5.3 GENERAL REQUIREMENTS:**

5.3.1 All materials shall be new of the best quality and shall be furnished, delivered, erected, connected and finished in every detail conforming to specifications and subject to the approval of Client's Representative.

5.3.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

5.3.3 Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.

As far as possible all bends shall be formed by means of hydraulic pipe bending machine for pipes up to 65mm dia.

5.3.4 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc. and shall be selected and arranged so as to fit properly into the allocated building space.

5.3.5 Pipes shall be securely fixed to walls by suitable clamps at intervals specified.

5.3.6 Valves and other appurtenances shall be located to provide easy accessibility for operation, maintenance and repairs.

5.3.7 Connection between dissimilar materials.

5.3.8 All G.I. pipes jointing shall be with white lead and spun yarn.

5.3.9 Drawings illustrating block out and penetration of pipes in the wall/floor/slab.

5.3.10 UNIONS:

Contractor shall provide adequate no. of unions on all pipes to enable dismantling later and for servicing. Union shall be provided near each gunmetal valve.

## **5.4 INTERNAL WORKS**

5.4.1 **MATERIALS:**

5.3.1.1 G.I. PIPES

- i. The pipes shall be galvanised mild steel threaded pipes conforming to the requirement of IS: 1239 Part-I for heavy grade upto 150mm dia and IS: 3589 for pipes above 150mm dia. They shall be of the dia (nominal bore) specified in the description of the item. Galvanising shall confirm to IS: 4736.
- ii. The pipes shall be clearly finished, well galvanised in and out and free from cracks, surface flow, laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with axis of the tube.
- iii. All screw tubes shall have pipe threads conforming to the requirements of IS: 544-1955 (or revised).

5.3.1.2 G.I. FITTINGS

- i. All fittings shall be conforming to IS: 1239 Part II (or as revised). All fittings shall have manufacturer's trade mark stamped on it. Fittings in G.I. pipe lines shall include elbows, tees, bends, reducers, nipples, union, G.I. Clamps / Steel structural supports of approved design, nuts, bolts, washers, etc. All fittings shall be tested at manufacturer's works. Contractors may be required to produce certificate to this effect from the manufacturers.
- ii. The fittings shall have screw threads at the ends conforming to the requirements of IS: 544-1955 (or revised). Female threads on fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered.

5.3.1.3 CUTTING AND JOINTING:

- i) The pipes and fittings shall be inspected at site before use to ascertain that they conform the specification given in para no. 5.3.1.1 above. The defective pipes shall be rejected. Where the pipes have to be cut or re-threaded, the ends shall be carefully filled out so that no obstruction to bore is offered. The end of the pipes shall then be threaded conforming to the requirements of IS: 544-1955 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening screw threads which have become bend or damaged and shall not be used for turning of the threads so as to make them slack, as the later procedure may not result in water tight joint.
- ii) The screw threads of pipes and fittings shall be protected from damage until they are fitted.

- iii) The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped round the screwed end of the pipe. The end shall then be screwed in the socket. Care should be taken that all pipes and fitting are properly jointed so as to make the joints completely water tight and pipes are kept at all times free dust and dirt during the fixing. Burr from the joint shall be removed after laying. The open ends of the pipes shall be temporarily plugged to prevent access of water, solid or any other foreign matter.

### 5.3.2 INSTALLATION OF G.I.:

Tender drawings indicate schematically the size and location of pipes. The Contractor on the award of the work, shall prepare detailed coordinated with other trades working drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and control valves, drain valves and all pipe support, structural supports. He must keep in view the specific openings in buildings and other structures through which pipes are designed to pass.

- i. Piping shall be properly supported on or suspended from connection clamps, hangers as specified and as required. Install pipes in a manner to avoid strain on equipments connections. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers, and be responsible for their structural sufficiency.
- ii. Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated back. Where pipe and clamps are of dissimilar materials a dielectric fitting shall be provided in between. Spacing of pipe supports shall not exceed the following:

Pipe Size	Spacing between Supports
Upto 12 mm	1.5 meter
15 to 25 mm	2.0 meter
32 to 150 mm	2.0 meter
150 mm and over	2.5 meter

- iii. Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars steel structural supports attached to pipe and with a 15 mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Risers shall have a suitable clean out at the lowest point and air vent at the highest point.
- iv. Pipe sleeves, 50 mm larger diameter than pipes, and 50mm above F.F.L. Shall be provided wherever pipes pass through walls and slabs, and annular space filled with fire proof materials like putty, fire seal etc.
- v. All pipe work shall be carried out in workmen like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized in consultation also coordinated with other Contractors work so that particular area work shall be carried out in one stretch.
- vi. Cut outs in the floor slab for installing the various pipes are indicated in the drawings. Contractor shall carefully examine the cut outs provided and clearly point out wherever the cut outs shown in the drawings, do not meet with the requirements.

- vii. The Contractor shall make sure that the clamps, steel structural supports, brackets, clamp saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes, and include expansion joints where required.
- viii. All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.
- ix. All buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint, then wrapped with bitumen faced hesian.
- x. In case the pipe is embedded in walls or floors, it should be painted with two coats of anti corrosive bitumastic paint of approved quality, covered with one layer of fiberglass tissue and finally painted with one coat of bitumen paint. The pipe should not come in contact with cement mortar or cement concrete as the pipe will be affected by cement. Under the floors, the pipes shall be laid in layer of filling under concrete floors.
- xi. For pipes 15mm to 25mm dia, the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick work or concrete. However, for bigger dimension pipes the holes shall be carefully made of the smallest size as directed by the Client's Representative. After fixing the pipes the holes shall be made good with cement mortar 1:3 (1 cement: 3 coarse sand) properly finished to match the adjacent surface.
  - xii. All pipes above ground shall be painted with one coat of red lead and two coats of synthetic enamel paint of approved shade and quality. Pipes shall be painted to standard colour code/or as specified by the Client's Representative.
  - xiii. Springing or forcing pipe into place will not be permitted. Protect piping at all times from dirt and moisture. During storage at construction site, keep end plugged to prevent dirt and moisture entering.
  - xiv. Carefully grade all pipes to eliminate traps and pockets. Where air pockets or water traps can not be avoided provide means of drainage with valved hose connection for water traps and valved automatic air vents for air pockets.
  - xv. Below grade piping shall be installed in such a manner that it does not appear directly on ground.
  - xvi. Any location where pipes/valves through or closed to basement walls shall be protected from direct contact of concrete block.
  - xvii. Pipes passing through building walls shall be protect by cast iron sleeves large enough to permit changes size eccentric fittings shall be used except where branch pipes connect into mains and in domestic system.

### **5.3.3 INSULATION:**

#### **Pipe Insulation for Hot Water Pipes:**

Hot Water Pipes fixed in wall chase shall be insulated by using 9mm thick rubberised insulation sleeve of material shall be closed cell Elastomeric Nitrile Rubber or closed cell cross linked polyethylene foam.

Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.038 W/mOK or 0.0313 K.Cal/M.hr OC at an average temperature of 30OC. Density of the material shall not be less than 0.06 gm/cm<sup>3</sup>.

- All the Hot Water supply & Hot Water return pipe shall be insulated in the manner specified hereinafter.
- Insulating material shall be rigid performed sections of mineral/rock wool with a “K” value of not more than 0.036 W/MK at 100 Deg. C mean temperature and of density 140 Kg/Cu.m
- No insulation shall be applied until the pipe is satisfactorily pressure tested.
- Pipes shall be insulated with rigid performed pipe sections of the following thickness:

<b>Pipe Diameter (mm)</b>	<b>Thickness (Mineral Wool) mm</b>
80-150	50

- Pipe insulation shall be applied as follows:
- Pipe shall be thoroughly cleaned with wire brush and rendered free from all rust and grease and applied with two coats of anti-rust paint.
- Pipes in Shaft:
  - i) Fix rigid performed sections of insulation with adhesive between all points (transverse and circumferential).
  - ii) The insulation shall be tied with GI chicken wire mesh.
  - iii) The insulation shall be provided with 24 gauge aluminium cladding screwed at the joints with cadmium coated self tapping screws. Joints shall be overlapped minimum 12mm wide.
- Pipes exposed to weather:
  - i) Same as (b) (i) to (ii)
  - ii) Provide polythene based hessian (500 gauges) overlapping 100mm on all joints (transverse and circumferential) and stitched at the joints.
  - iii) The hessian shall be covered with 15mm x 20mm hexagonal chicken wire mesh.
  - iv) Over the wire mesh the surface shall be covered with two layers of tarfelt grade-II and type-II with bitumen between layer overlapping 100mm on all joints (transverse & circumferential).
  - v) Over the second layer of tarfelt final coat of hot bitumen not less than 6mm thick shall be applied.

- vi) Over the final layer of tarfelt and hot bitumen coat aluminium cladding shall be provided with 24 gauge aluminium shut screwed at the joints with cadmium coated self-tappings screws. Joints shall be overlapped minimum 25mm wide.
- d) Pipes Buried Underground:
  - i) Rigid pipe sections of insulation shall be fixed tightly to the surface taking care to seal all joints with 50mm wide aluminium adhesive tape (transverse and circumferential).
  - ii) The insulation shall be tied with aluminium band not less than 6mm width and 24 gauge 4 bands per meter or equivalent plastic band using G.I. sheet clamp crimped at the joints.
  - iii) Wrap the insulation with polythene sheet 400 gauges. Polythene sheet shall be tied with 6mm, 24 gauge, aluminium band 4 bands per meter or equivalent plastic tape using GI sheet clamp crimped at the joint.
- iv) The polythene surface shall be covered with two layers of tarfelt grade – II, type – II with bitumen between layers overlapped 100mm on all joints (transverse and circumferential).
- v) Over the second layer of tarfelt final coat of hot bitumen not less than 6mm thick shall be applied.

#### **5.3.4 TESTING:**

After laying and jointing, the pipes and fittings shall be inspected under working condition of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost. Use of any compound or stop leak compound will not permit.

The pipes and fittings after they are laid shall be tested to hydraulic pressure of 1.5 times the working pressure or 7.5 Kg/Sq.cm whichever is more. The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw off taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least two hours. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing.

#### **5.3.5 PAINTING:**

The pipes shall be finally provided with synthetic enamel paint of approved quality for exposed pipes after the Hydrostatic test pressure. The cost of such painting should be included to the Contractor's quote.

### **5.4 EXTERNAL WORKS:**

#### **5.4.1 MATERIALS:**

##### **5.4.1.1 G.I. PIPES**

- i. The pipes shall be galvanised mild steel threaded pipes conforming to the requirement of IS: 1239 Part-I for heavy grade upto 150mm dia and IS: 3589 for pipes above 150mm dia. They shall be of the dia (nominal bore) specified in the description of the item. Galvanising shall confirm to IS: 4736.

- ii. The pipes shall be clearly finished, well galvanised in and out and free from cracks, surface flow, laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with axis of the tube.
- iii. All screw tubes shall have pipe threads conforming to the requirements of IS: 544-1955 (or revised).

#### 5.4.1.2 G.I. FITTINGS

- i. All fittings shall be conforming to IS: 1239 Part II (or as revised). All fittings shall have manufacturer's trade mark stamped on it. Fittings in G.I. pipe lines shall include elbows, tees, bends, reducers, nipples, union, G.I. Clamps / Steel structural supports of approved design, nuts, bolts, washers, etc. All fittings shall be tested at manufacturer's works. Contractors may be required to produce certificate to this effect from the manufacturers.
- ii. The fittings shall have screw threads at the ends conforming to the requirements of IS: 544-1955 (or revised). Female threads on fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered.
- iii. Contractor shall provide adequate number of unions on all pipes to enable dismantling later. Unions shall be provided near each gunmetal valve, stop cocks, or check valves and on straight runs as necessary at appropriate locations as required and/or directed by Client's Representative.

#### 5.4.1.3 CUTTING AND JOINTING:

- i) The pipes and fittings shall be inspected at site before use to ascertain that they conform the specification given in para no. 5.4.1.1 above. The defective pipes shall be rejected. Where the pipes have to be cut or re-threaded, the ends shall be carefully filled out so that no obstruction to bore is offered. The end of the pipes shall then be threaded conforming to the requirements of IS: 544-1955 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening screw threads which have become bent or damaged and shall not be used for turning of the threads so as to make them slack, as the later procedure may not result in water tight joint.
- ii) The screw threads of pipes and fittings shall be protected from damage until they are fitted.
- iii) The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped round the screwed end of the pipe. The end shall then be screwed in the socket. Care should be taken that all pipes and fitting are properly jointed so as to make the joints completely water tight and pipes are kept at all times free dust and dirt during the fixing. Burr from the joint shall be removed after laying. The open ends of the pipes shall be temporarily plugged to prevent access of water, solid or any other foreign matter.

#### 5.4.1.4 INSTALLATION:



**i) Trenches :**

The galvanised iron pipes and fittings shall be laid in trenches. The widths and depths of the trenches for different diameters of the pipes shall be as in Table below:-

Dia of pipe	Width of trench	Depth of trench
15 mm to 50 mm	30 cm	60 cm
65 mm to 150 mm	45 cm	75 cm

At joints the trench width shall be widened where necessary. All G.I. / C.I. pipes below ground in trenches minimum cover over pipes shall be 60cm. Covered shall be measured from top of pipe to the surface of ground. The bed of the trench if in soft or made up earth, shall be well watered and rammed before laying the pipes and depressions if any shall be properly filled with earth and consolidated in 20cm layers.

If the trench bottom is extremely hard and rocky or loose stony soil, the trench shall be excavated at least 150mm below the trench grade. Rocks, Stone or other hard substances from the bottom of the trench brought back the required grade by filling with selected fine earth or sand and compacted so as to provide smooth bedding for the pipe. When excavation required blasting operation, it shall be ensured that no pipes have be stacked in the vicinity and completed pipe in the vicinity has already been covered before starting of blasting operations; this is necessary to prevent damage to the exposed pipe in the vicinity by falling stone as result of blasting.

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

Roots of tree within distance of about 0.5 meter from the side of the pipe line shall be removed or killed.

The excavated materials shall be placed within 1 meter or half of the depth of the trench, whichever is greater, from the edge of the trench. The material excavated shall be separated and stacked so that in refilling they may be re-laid and completed the same order to satisfaction of the Client's Representative.

The filling shall be done in layers not exceeding 15mm in depth. Each layer shall be watered, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt end of the crow brass where rammers can not be used. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the trenches.

Filling in trenches shall be commenced soon after the joints of pipes, cables; conduits etc. have been tested and approved by Client's Representative. The space around the pipes shall be cleared of all debris where the trenches are excavated in hard/soft soil. The filling shall be done with earth on the sides and tops of pipes in layers not exceeding 15mm in depth. Each layer shall be watered rammed and consolidated. The clods and lumps of earth exceeding 8cm in any direction shall be broken or removed before the excavated earth is used for filling.

## ii) **Pipe Protection:**

For underground G.I. pipes following treatment will be given:

Coat of hot bitumen R 85/25

- a) Wrapping of fiberglass tissue.
- b) Coat of hot bitumen R 85/25 over fiberglass tissue.

The pipes shall be laid on a layer of 7.5 cm sand and filled upto 15 cm above the pipes. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be disposed off as directed.

**iii) Jointing :**

The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped around the screwed end of the pipes. The end shall then be screwed in the socket, tee etc with the pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joints shall be removed after screwing. After laying, the ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

**iv) Thrust Blocks :**

In case of bigger pipes (80 mm dia and above), thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate of 20 mm nominal size) shall be constructed on all bends as directed by the Client's Representative.

**5.4.1.5 TESTING:**

- i. All external water supply pipes shall be tested by hydrostatic pressure of 1.5 times the working pressure or 7.5 Kg/Sq.cm whichever is more.
- ii. Pressure shall be maintained for a period of at least 180 minutes without any drop in the pressure after fixing at site.
- iii. In addition to the sectional testing carried out during the construction. Contractor shall test the entire installation after connections to the hydro pneumatic system or pumping system. He shall rectify all leakages, and shall replace all defective materials in the system. Any damage done due to careless will has to be replaced by the Contractor.
- iv. The initial back fill shall be placed evenly in a layer of about 100mm thick. This shall be properly consolidated and this shall be continued till there is a cushion of at least 300mm of cover over the pipe.
- v. The joint or coupling during the testing of mains shall be left exposed for inspection before cover-up, sufficient back fill shall be placed on the pipe to resist the movement due to pressure while testing. In this way if any error if workmanship will be found shall immediately corrected at a minimum cost.

**5.4.1.6 MASONRY CHAMBER:**

- i) All masonry chambers for stop cocks, sluice valves and meter etc. shall be built as per supplied drawings.
- ii) The excavation for chambers shall be done true to dimension and level indicated on plans or as directed by the Client's Representative.
- iii) Concrete shall be having cement concrete 1:2:4 (1 cement: 2 fine sand: 4 graded stone aggregate 40mm nominal size).
- iv) Brick shall be in 1<sup>st</sup> class bricks in cement mortar 1:5 (1 cement: 5 fine sand).

- v) Plastering not less than 12mm/15mm thick shall be done in cement mortar 1:3 (1 cement: 3 coarse sand) finished with a floating coat of neat cement for inside plaster and same for outside but with Rough plaster.

#### 5.4.1.7 MEASUREMENTS:

All G.I pipes below ground shall be measured per linear meters (to the nearest cm) and shall be inclusive of all fittings e.g. coupling, tees, bends, elbows, unions, deduction for valves shall be made rate quoted shall be inclusive of all fittings, excavation, back filling and disposal of surplus earth, cutting holes and chase and making good all item mentioned in Bill of Quantities.

All C.I. class (LA) pipes below ground level shall be measured per linear meter (to the nearest cm) and shall be inclusive of all fittings e.g. tees, elbows, bends, deduction for valves shall be made. The portion of the pipe within the collar at the joints shall not be included in the length of the pipe work. Rate quoted shall be inclusive of all fittings, excavation, back filling of surplus earth including consolidation and compaction of earth.

### 5.5 VALVES:

#### 5.5.1 BUTTERFLY VALVES:

All the isolation valve 50cm and above on the equipment and water lines, where specified or shown on drawings shall be wafer type butterfly valves. They shall be designed to fit without gaskets, the water tight seal being obtained by EPDM seat projection at the faces compressed between the flanges. The valves shall be supplied inclusive of M.S. pipe flanges and high tensile steel bolts of dimensions recommended by suppliers of valves. The valves shall comply with following specifications:

- |       |                 |   |
|-------|-----------------|---|
| a)    | Test Pressure   | : Body 24 Bar, Seat 16 Bar                                    |
| b)    | Valve Component | : Material of Construction                                    |
| i)    | Body            | : Cast Iron, Gr. FG 260, IS:210                               |
| ii)   | Disc            | : Nylon or Epoxy powder coated high duty iron, Gr, FG         |
| iii)  | Stem            | : Stainless Steel or carbon steel IS: 1570, Part-II.          |
| iv)   | Seat            | : EPDM  |
| v)    | Hand Lever      | : Cast Iron (Mechanical Memory Stop)                          |
| vi)   | Bearings        | : PTFE or Nylon covered S.S. bush bearings at stem and pivot. |
| vii)  | Primary Seal    | : Reinforced PTEE slide bearings                              |
| viii) | Temperature     | : 80 Degree C (max.)  |

#### 5.5.2 INSTALLATION:

Valve shall be installed in a manner that allows future removal and service of the valve. Packing and gasket shall not contain asbestos.

The valve shall be of the same size as the pipe to which they are installing.

Valve above 150mm diameter shall be self locking worm gear type water proof and protory lubricated. Provide chain operators with chain cleats for all valves more than 2.4 meters above floor.

### 5.5.3 NON RETURN VALVES:

All non-return valves shall be provided as shown in the drawings conforming to relevant Indian Standards and in accordance with the following specifications.

Size	Construction	Ends
Up to 50 mm.	Gun metal	Screwe
65 mm and above	Gun metal/cast iron	d

Non-return valves shall be of approved make. Flap type non-return valve shall be used and tested to 15 Kg.  
/ Sq.cm. pressure.

### 5.5.4 BALL VALVES (FLOAT VALVE):

The ball valve shall be of high pressure class and shall be confirm to IS: 1703 of sizes as specified. The nominal size of a ball valve shall be that corresponding to the size of the pipe to which it is fixed. The ball

shall be of brass or gun metal as specified and the float shall be of polythene sheet. The minimum gauge of copper sheet used for making the float shall be 0.45mm for float upto 115mm dia and 0.55mm for float exceeding 115mm dia and shall be special in shape. The valve shall be constructed to permit replacing without console of the valve body from the valve line and the system shall not blow out under pressure. The jointing of the float shall be made by efficiently burnished, lapped and soldered seam or by bracing. Plastic float may also be used if specified. The body of ball valve when assembled in working conditions with the float immersed to not more than half of its volume shall remain closed against a test pressure of 10.5 Kg/Sq.cm. All ball valves shall be capable of withstanding a pressure of 14

Kg/Sq.cm. The ball valve shall generally conform to IS specifications No. 1703-1962.

### 5.5.5 BALL VALVES:

The ball valve shall be of Brass or Gunmetal as specified conforming to IS: 1703. The ball valve shall be as given below:

#### **High Pressure:**

Indicated by the abbreviation 'HP' for use on mains having pressure. These shall remain closed at a test pressure of 10.5 Kg/Sq.cm.

SL. NO.	NOMINAL SIZE OF BALL VALVE					
	15 mm	20mm	25mm	32mm	40mm	50mm
1. Diameter of spherical float						
High Pressure	127	152	203	229	254	305
Low Pressure	114	127	178	203	203	254
Minimum weight of ball valve including back nut, body and piston	283	446	823	1149	1589	1852

The ball valves shall be of following nominal sizes 15mm, 20mm, 25mm, 32mm, 40mm and 50mm. The nominal size shall correspond with the nominal bore of the inlet shanks.

#### 5.5.6 AIR VALVES:

Air valves shall be provided in all high points in the system to prevent air locks as shown on the drawings or directed by Client's Representatives.

#### 5.5.7 TESTING:

All valves shall be tested while installed in pipe by hydrostatic pressure of 1.5 time of the working pressure  
7.5 Kg/Sq.cm which ever is more.

#### 5.5.8 MEASUREMENTS:

All valves as mentioned in Bill of Quantities shall be measured by numbers and shall include all items mentioned in the Bill of Quantities.

### 5.6 CHLORINATION OF DOMESTIC WATER LINES:

5.6.1 After the completion of all the hot and cold water service piping, disinfect all the fresh water supply work and water reservoirs using a chlorine solution.

5.6.2 CHLORINATED SYSTEMS SHALL INCLUDE:

- i. Domestic fresh water tanks
- ii. Fire water tanks
- iii. All pipe work systems receiving suction from the above mentioned tanks apart from the fire systems.

5.6.3 Before handover of the system, submit to the consultant copies of the certification of performance and laboratory report (if required)

5.6.4 Under no circumstances the use of any portion of the fresh water system until it is properly disinfected, flushed and certified shall be permitted.

5.6.5 During the Chlorination work the Contractor shall take all necessary precautions to prevent site staff from drinking the system water. Such precautions shall include locking doors to 'wet' areas and providing warning signs in English and Hindi.

### 5.7 CPVC PIPES & FITTINGS:

- i. The pipes and fittings chemically known as Chlorinated Poly Vinyl Chloride [CPVC] shall be produced in Copper Tube Size [CTS] from ½" to 2" with two different standard dimensional ratios – SDR 11 and 13.5. The fittings shall be produced as per SDR 11. All the CPVC pipes and fittings in SDR 11 and SDR 13.5 shall be made from the identical CPVC compound

having the same physical properties. Pipes and fitting shall be produced as per SDR 11 & shall meet the requirement of ASTM D 2846 where as the pipes produced with SDR 13.5 shall meet the requirement derived from ASTM F 442, specific to CPVC in Iron Pipe Size[IPS] dimension, which also shall be applied to CPVC pipes in Copper Tube Size[CTS] dimension.

#### 5.7.1. CUTTING AND JOINTING AND INSTALLATION OF CPVC PIPES & FITTINGS:

##### i. CUTTING:

In order to make a proper and neat joint, the pipe length shall be measured accurately and make a small mark. Ensure that the pipe and fittings are size compatible. It shall be easily cut with a wheel type plastic pipe cutter or hacksaw blade. Cutting tubing as squarely as possible shall provide optimal bonding area within a joint.

##### ii. DEBURRING / BEVELING:

Burrs and filings shall prevent proper contact between tube and fitting during assembly and should be removed from the outside and inside of the pipe. A pocket knife or file shall be used for this purpose. A slight bevel on the end of the tubing shall ease the entry of the tubing into the fitting socket.

##### iii. FITTING PREPARATION:

Using a clean, dry rag, wipe dirt and moisture from the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 to 2/3 of the way into the fitting socket.

##### iv. SOLVENT CEMENTS APPLICATION:

Use only CPVC cement or an all – purpose cement conforming to ASTM -493 or joint failure may result. When making a joint, apply a heavy, even coat of cement to the pipe end. Use the same applicator without additional cement to apply a thin coat inside the fitting socket. Too much cement can cause clogged water ways.

##### v. ASSEMBLY:

Immediately insert the tubing into the fitting socket, rotate the tube ¼ to ½ turn while inserting. This motion will ensure an even distribution of cement within the joint. Properly align the fittings. Hold the assembly for approximately 10 seconds, allowing the joint to set-up.

##### vi. SET AND CURE TIMES:

Solvent cement set and cure times are a function of pipe size, temperature and relative humidity. Curing time is shorter for drier environments, smaller sizes and higher temperatures. It requires 10 to 20 minutes for perfect joint.

##### vi. CEMENTING:

- Verify the cement is the same as the pipes and fittings being used.
- Check the temperature where the cementing will take place.
- Cement takes longer time to set up in cold weather. Be sure to allow extra time for curing.
- Do not try to speed up the cure by artificial means – this could cause porosity and blisters



in the cement film.

- Solvents evaporate faster in warm weather. Work quickly to avoid the cement setting up before the joint is assembled. Keep the cement as cool as possible. Try to stay out of direct sunlight.
- Keep the lid on cements, cleaner and primers when not in use. Evaporation of the solvent will affect the cement.
- Stir or shake cement before using.
- Use ¾" dauber on small diameter pipes, 1 ½" dauber up through 3" pipe, and a natural bristle brush, swab or roller ½ the pipe diameter on pipes 4" and up.
- Do not mix cleaner or primer with cement.
- Do not use thickened or lumpy cement. It should be like the consistency of syrup or honey.
- Do not handle joints immediately after assembly.
- Do not allow dauber to dry out.
- Maximum temperature allowable for CPVC pipe is 180° F.
- All colored cements, primers and cleaners will have a permanent stain. There is no known cleaning agent.
- Use according to the step outline in ASTM D – 2846, joining of pipe and fittings.

### **5.7.2 TESTING**

After laying and jointing, the pipes and fittings shall be inspected under working condition of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost. Use of any compound or stop leak compound will not permit.

The pipes and fittings after they are laid shall be tested to hydraulic pressure of 1.5 times the working pressure or 7.5 Kg/Sq.cm whichever is more. The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw of taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least two hours. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing.

### **5.7.3 MEASUREMENTS**

The length above ground shall be measured in running meter correct to a cm for the finished work, which shall include G.I. pipe and G.I. fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, unions etc... Deductions for length of valves shall be made. Rate quoted shall be inclusive of all fittings, clamps, cutting holes chased and making good the same and all items mentioned in the specifications and Bill of Quantities.

## 5.8 COMPOSITE PIPES & FITTINGS :

- (a) The pipe shall conform to IS 15450 2004 having welded aluminium tube reinforcement between inner & outer polyethylene layers being bonded to aluminium tube by a melt adhesive with welded aluminium tube. The pipe dimensional detail shall be :

Nominal pipe size	Equivalent NB size	Wall thickness in mm	
ID : OD	In inch.	Minimum	Maximum
12:16	½	1.75	2.00
16:20	¾	2.00	2.25
20:25	1	2.45	2.70
25:32	1x1/4	2.80	3.20
32:40	1x1/2	3.40	3.80

- (b) The test pressure rating shall be as below :

Nominal pipe size	Minimum Burst Pressure
ID : OD	in kg per sq.cm
12:16	60
16:20	50
20:25	40
25:32	40
32:40	35

- (c) The internal test pressure rating for fittings shall be as below :

Nominal pipe size	Minimum Burst Pressure
ID : OD	in kg per sq.cm
12:16	34.30
16:20	26.70
20:25	26.70
25:32	23.00
32:40	22.30

- (d) The fittings shall withstand the following condition & the manufacturer shall submit the test certificate for the following:

Test Temperature : 83 deg Celcius  
 Test Pressure : 3.5 kg per  
 sq.cm.  
 Test duration : 3000 hrs.

- (e) Jointing:

Jointing shall be done by using proper fittings. Proper tools shall be used for the same

(f) **Installation:**

The pipe bending shall be done by using proper supports springs, either internal or external. The bending radius shall not be less than 5 times the OD of the pipe.

For concealed piping no supports shall be required but for exposed piping, the spacing of supports shall be as below:

The test pressure rating shall be as below:

Nominal pipe size	Support spacing for horizontal pipe	Support spacing for vertical pipe lines
ID : OD	in mtr.	In mtr.
12:16	0.80	1.00
16:20	0.80	1.00
20:25	1.00	1.00
25:32	1.20	1.20

Nominal pipe size	Support spacing for horizontal pipe	Support spacing for vertical pipe lines
32:40	1.20	1.20

### 5.8.1 INSULATION

5.8.1.1 All the Hot Water supply & Hot Water return pipe shall be insulated in the manner specified hereinafter.

5.8.1.2 Insulating material shall be rigid performed sections of mineral/rock wool with a “K” value of not more than 0.036 W/MK at 100 Deg. C mean temperature and of density 140 Kg/Cu.m

5.8.1.3 No insulation shall be applied until the pipe is satisfactorily pressure tested.

5.8.1.4 Pipes shall be insulated with rigid performed pipe sections of the following thickness:

Pipe Diameter (mm)	Thickness (Mineral Wool) mm
80-150	50

5.8.1.5 Pipe insulation shall be applied as follows OR AS SPECIFIED IN BOQ:

Pipe shall be thoroughly cleaned with wire brush and rendered free from all rust and grease and applied with two coats of anti-rust paint.

**a) Pipes in Shaft:**

- I) Fix rigid performed sections of insulation with adhesive between all points (transverse and circumferential).
- ii) The insulation shall be tied with GI chicken wire mesh.

- iii) The insulation shall be provided with 24 gauge aluminium cladding screwed at the joints with cadmium coated self tapping screws. Joints shall be overlapped minimum 12mm wide.

**b) Pipes exposed to weather:**

- i) Same as (a) (i) to (ii)
- ii) Provide polythene based hessian (500 gauges) overlapping 100mm on all joints (transverse and circumferential) and stitched at the joints.
- iii) The hessian shall be covered with 15mm x 20mm hexagonal chicken wire mesh.
- iv) Over the wire mesh the surface shall be covered with two layers of tarfelt grade-II and type-II with bitumen between layer overlapping 100mm on all joints (transverse & circumferential).
- v) Over the second layer of tarfelt final coat of hot bitumen not less than 6mm thick shall be applied.
- vi) Over the final layer of tarfelt and hot bitumen coat aluminium cladding shall be provided with 24 gauge aluminium shut screwed at the joints with cadmium coated self-tappings screws. Joints shall be overlapped minimum 25mm wide.

**c) Pipes Buried Underground:**

- i) Rigid pipe sections of insulation shall be fixed tightly to the surface taking care to seal all joints with 50mm wide aluminium adhesive tape (transverse and circumferential).
- ii) The insulation shall be tied with aluminium band not less than 6mm width and 24 gauge 4 bands per meter or equivalent plastic band using G.I. sheet clamp crimped at the joints.
- iii) Wrap the insulation with polythene sheet 400 gauges. Polythene sheet shall be tied with 6mm, 24 gauge, aluminum band 4 bands per meter or equivalent plastic tape using GI sheet clamp crimped at the joint.
- iv) The polythene surface shall be covered with two layers of tarfelt grade – II, type – II with bitumen between layers overlapped 100mm on all joints (transverse and circumferential).
- v) Over the second layer of tarfelt final coat of hot bitumen not less than 6mm thick shall be applied.

#### **5.8.1.6 TESTING**

After laying and jointing, the pipes and fittings shall be inspected under working condition of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost. Use of any compound or stop leak compound will not permit.

The pipes and fittings after they are laid shall be tested to hydraulic pressure of 1.5 times the working pressure or 7.5 Kg/Sq.cm whichever is more. The pipes shall be slowly and carefully

charged with water allowing all air to escape and avoiding all shock or water hammer. The draw of taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least two hours. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing.

## **5.9. Copper Pipes & Fittings**

The pipes shall be hard tempered copper pipes and tubes confirming to requirements of BS 2871 Table 'X' Part -1-1971 and the fittings shall confirm to BS 864 Part 2.

The fittings shall be as follows:

- a. Internal Solder Ring (ISR) fitting: For pipes from 15 mm to 35 mm dia.
- b. Endx Fittings: For pipes from 42 mm to 54 mm dia.
- c. End brazes Fittings: For pipes from 67 mm dia and above.

Fabricated fittings in NO case shall be allowed. Fittings of all types such as Tees, Crosses, Elbows, Reducers, Unions, Off Sets etc. shall be used on the pipes. Suitable fittings of approved type and make shall be used for jointing copper pipes to GI pipes and for-jointing copper pipes to CP fittings etc. shall be used. Use of DZR fitting shall be made for all connections.

Laving: and .Jointing: Of Copper Pipes and Capillary Fittings

The copper" pipes and fittings shall run in wall chase or ceiling or as specified, The fixing shall be done by means of standard pattern holder bat clamps keeping the pipes about 1.5 mm clear of the wall where to be laid on surface. Where it is specified to conceal the pipes, chasing may be adopted. For pipes fixed in the shafts, ducts, etc. there should be sufficient space to work on the pipes with the usual tools. As far as possible, pipes inlays are buried for short distances provided adequate protection is given against damage and where so required special care to be taken at joints. Where directed by the EMPLOYER's Site Representative I Architect, pipe sleeves shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and allow freedom for expansion and contraction and other movements. In case of pipe is embedded in walls or floors it shall be covered with a protective tape wrapped around the pipes and fittings.

Copper pipes shall be jointed with approved above mentioned fitting conforming to BS 864 Part 2. Care shall be taken to remove any burr from the end of the pipes after cutting. Only fittings of the size suitable to the pipe shall be used. The ends of the tube shall be cut to the correct size using a tube cutter or a fine blade hacksaw. Care shall be taken to ensure that the ends of the tube are cut perpendicular to the axis of the tube and that the ends remain undamaged and free of burrs. Any burrs remaining shall be removed with a smooth file. Clean the outside surface of the tube that shall go into the fitting. Flux shall be applied on the pipe surface ensuring even and uniform application. Insert the tube into the fittings and push home until the stop is reached. Wipe off excess flux with a soft cloth. Now the assembled joint shall be heated with a blow torch or any similar appliance that emits a clean, blue, soot free flume. The heat shall be turned off once a complete ring of solder has appeared around the mouth of the fitting.

The joint shall be allowed to cool without disturbance.

All copper pipes to G.I. pipe and connection with the valves and faucets shall be with De-zincified Resistance fittings (DZR).

## **5.10. ASTM - PVC PIPES & FITTINGS**

### **5.10.1 SCOPE:**

This specification covers the requirements for manufacture, supplying, lowering, laying, jointing, testing and commissioning of ASTM solvent welded PVC pipe with fittings for the conveyance & distribution system for above ground as well as below ground installation with required civil work.

#### **5.10.2      CODES & STANDARDS:**

The manufacturing, testing, supplying, jointing and testing at work sites of PVC pipes shall comply with all currently applicable statutes, regulations, standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred.

#### **5.10.3      MATERIALS**

ASTM D 1785            - Specification for Poly Vinyl Chloride (PVC) Plastic Pipes, SCH 40 & SCH 80.

ASTM D 2466            - Socket type Vinyl Chloride Plastic Pipe Fittings

SCH 40 ASTM D 2467    - Socket type Vinyl Chloride Plastic Pipe

Fittings SCH 80 ASTM D 2564    - Solvent Cement for Plastic Pipes & Fittings

ASTM D 2774            - Underground installation of Thermo plastic Pipes

#### **5.10.4      DESIGN**

Design of uPVC pipes shall be according to ASTM D-1785 & fittings shall be made according to ASTM D-2467 (for Schedule 80). The pipe shall have socketed solvent welded fittings.

#### **5.10.5      TRENCHING**

5.10.6      The width of the trench at the crown of the pipe shall be not less than the outside diameter of pipe

plus 300 mm to allow proper compaction of the side fills & at a 225 mm above the crown of the pipe. The trench width shall be as below :

NOMINAL PIPE SIZE (IN)	TRENCH WIDTH MIN. (IN MM)	TRENCH WIDTH MAX. (IN
110	450	600
160	450	600
200	600	700
225	600	700
250	600	700
315	700	850
355	750	900
400	800	950
450	850	1000

- 5.10.7 The minimum trench depth shall be width plus outer diameter of pipe or 0.75 mtr. above crown of pipe whichever is more.
- 5.10.8 The trench shall be backfilled as soon as possible.
- 5.10.9 The excavated material shall be deposited at a sufficient distance away from the edge of the trench to avoid damage to the pipes through falling stones & debris.
- 5.10.10 Pipe shall be laid with a cover, measured from the top of the pipe to the surface of the ground of not less than 1.2 mtr. under roads
- 5.10.11 The pipe bedding shall be with a granular material & backfilling shall be performed in layer of 6 inch with each layer & shall be sufficiently compacted to 85% to 95% compaction.
- 5.10.12 A mechanical compaction shall be carried out for compacting sand & gravel backfill. Optionally manual compaction shall be carried out.
- 5.10.13 A trench shall be completely filled & backfilling shall be placed & spread in uniform layers to prevent any unfilled spaces or voids. Large rocks, stones, etc. shall be removed. Heavy tampers or rolling equipment shall be used for final backfilling only.

#### **5.11 PIPE HANDLING & STORAGE :**

- 5.11.1 The pipe shall not be pushed or dragged from the truck bed. Pallets for pipe shall be removed with a fork lift. Loose pipe can be rolled down on timber.
- 5.11.2 The pipe shall be stored in open ground which shall be dry & free from sharp objects.
- 5.11.3 The pipe shall be protected from the sun & shall be in area with proper ventilation.
- 5.11.4 If the pipe shall be stored in racks or it shall be supported throughout its length with the spacing not more than 3 feet.

#### **5.12 LAYING & JOINTING :**

- 5.12.1 Pipe shall be cut square with the special tool.
- 5.12.2 The inside & outside edges shall be cleaned from any burrs with file or deburring tool.
- 5.12.3 The surface shall be cleaned with a clean dry cloth.

- 5.12.4 With light pressure, pipe should go one third to one half of the way into the fitting socket.
- 5.12.5 Pipes & fittings that are too tight shall not be used. Use an applicator having size equal to one half the pipe diameter.
- 5.12.6 For jointing, full even layer of cement shall be provided on external surface of the pipe & medium layer of cement shall be provided to the inside of a fitting
- 5.12.7 Pipe & fittings shall be assembled & pipe shall give a quarter turn.
- 5.12.8 The piping (for sch. 40) shall be supported by the means of hangers having recommended spacing as below  
:

NOMINAL PIPE SIZE (MM)	TEMPERATURE IN DEG. C				
	15.5	26.6	37.7	48.8	60
15	4.5 MTR.	4.5 MTR.	4 MTR.	2.5 MTR.	2.5 MTR.
20	5 MTR.	4.5 MTR.	4 MTR.	2.5 MTR.	2.5 MTR.
25	5.5 MTR.	5 MTR.	4.5 MTR.	3 MTR.	2.5 MTR.
32	5.5 MTR.	5.5 MTR.	5 MTR.	3 MTR.	3 MTR.
40	6 MTR.	5.5 MTR.	5 MTR.	3.5 MTR.	3 MTR.
50	6 MTR.	5.5 MTR.	5 MTR.	3.5 MTR.	3 MTR.
63	6.5 MTR.	6 MTR.	5.5 MTR.	4 MTR.	3 MTR.
75	7 MTR.	7 MTR.	6 MTR.	4 MTR.	3.5 MTR.
100	7.5 MTR.	7 MTR.	6.5 MTR.	4.5 MTR.	4 MTR.
150	8.5 MTR.	8 MTR.	7.5 MTR.	5 MTR.	4.5 MTR.

- 5.12.9 The pipe joint setting & curing time shall be recommended as :
- 5.12.10 SET TIME :

Temperature	Pipe size	Pipe Size	Pipe Size
Range	15 mm to 32 mm	40 mm to 75 mm	100 & 150 mm
15.5-37.7 deg C	15 minute	30 minute	60 minute
4.4-15.5 deg C	60 minute	120 minute	240 minute

- 5.12.11 CURE TIME :

Temperature	Pipe size	Pipe Size	Pipe Size
Range	15 mm to 32 mm	40 mm to 75 mm	100 & 150 mm
15.5-37.7 deg C	6 hrs.	12 hrs.	24 hrs.
4.4-15.5 deg C	12 hrs.	24 hrs.	48 hrs.



- 5.12.12 To compensate the expansion & contraction, suitable means shall be provided by expansion loops with 90 deg elbows / bellows subject to the application for the above ground installation
- 5.12.13 For underground application, the compensation for expansion & contraction shall be done by anaking the pipe in trench.

### **5.13 TESTING :**

- 5.13.1 The pipe shall be tested with water. Before testing, it shall be properly anchored.
- 5.13.2 Thrust blocks shall be provided at dead ends, at change in direction & at cahnge in size.
- 5.13.3 The piping shall be slowly filled with water with velocity not exceeding 1ft./sec.
- 5.13.4 Vents shall be provided at high points & air shall be release before testing.
- 5.13.5 All valves & vents shall kept open during testing to release the air.
- 5.13.6 The piping shall be tested for 125% of design working pressure for one hour maximum
- 5.13.7 During testing, if any joint is leaking, it shall be cut & replaced.

### **5.15 POLYPROPYLENE RANDOM CO-POLYMER (PP-R) PIPES**

#### **5.15.1 The PP-R is a bonded, multilayer pipe consisting of different layers of the pipe:-**

- (a) The inner-most layer of the pipe to be Anti – bacterial to prevent bacteria growth inside pipe Surface.
- (b) The middle layer to be of plain PP-R which is neither in contact with Water and nor under direct Effect of the atmospheric conditions.
- (c) The outer-most layer to be of U.V. stabilized PP-R to prevent the pipe surface from sunlight Under exposed atmospheric conditions. The pipes should in general be conforming to the requirements of IS 15801 except that specified within nomenclature of the item. The pipes should have smooth inner surface with no contracting diameters. The pipes shall be cleanly finished, free from cracks and other defects.

The pipes shall be clean and well cut along ends after taking into consideration the desired Length, using the pipe scissors. The Polypropylene used for manufacturing the pipe shall conform To the requirements of IS 10951 and IS 10910. The specified base density shall be between 900

**CPWD SPECIFICATIONS 2009** 822kg/m<sup>3</sup> and 910 kg/m<sup>3</sup> when determined at 27°C. The resin should be mixed with sufficient quantity of colour master batches. The colour master batch should be uniform throughout the pipe surface. The standard dimension ratio (SDR) i.e. ratio of the nominal outer diameter of a pipe to its nominal wall thickness should be 7.4/11 as given in the item.

#### **5.15.2 Fittings**

Plain fittings, Chrome plated brass threaded fittings and Valves shall be as per nomenclature of item or as directed by engineer- in- charge.

(a) The plain fittings shall be Polypropylene Random Copolymer and comply with all the Requirements of the pipes. The plain fittings shall comprise of Socket, Elbow, Tee, Cross, Reducer socket, Reduction Tee, End Cap, Crossover, Omega, Threaded Plug and wall clamps in Available sizes.

(b) The Chrome Plated Brass threaded fittings shall be Chrome Plated Brass threaded piece molded Inside Polypropylene random copolymer fitting. The material shall comply with all the Requirements of the pipes. The Chrome plated Brass threaded fittings shall comprise of Socket, Elbow and Tee (Male & Female) in available sizes. These are the fittings for C.P. connections And for continuations from existing Galvanized Iron Pipes and fittings.

(c) The valves shall be Polypropylene Random Copolymer Valves. The valves comprise of Gate Valve, Ball Valve, Concealed stop valve and Chrome Coated Valve in available sizes.

The Valves sizes availability in Polypropylene Random Copolymer is as follows:-

- (i) Gate Valve                                -20 mm to 63 mm
- (ii) Ball Valve                                - 20 mm, 25 mm, 32 mm, 40 mm, 50 mm & 63 mm
- (iii) Concealed Stop valve        - 20 mm & 25 mm
- (iv) Chrome Coated Valve        - 20 mm & 25 mm

However, the other Brass/Bronze Valves can be connected to Polypropylene Random pipes using C.P. Brass threaded fittings of desired sizes.

### 5.15.3 Laying and Jointing of Pipes and Fittings

The specifications described in 18.4 shall apply as far as possible. The pipes and fittings shall run in wall chase as specified. Pipes shall run only in vertical or horizontal alignment as far as possible. The installation of pipes is similar to that of the metal pipes with the only difference in the jointing procedure. The jointing of the PP- R pipes and fittings are done by fusion welding by means of a welding machine.

The marking on pipe shall carry the following information:-

- c) Manufacturer's name/ trade mark
- d) PPR pipe
- e) SDR
- f) Out side diameter and minimum wall thickness

g) Lot No. / Batch No. containing date of manufacturing. And machine number.

**5.15.4** The outside diameter of pipes, tolerance in the same and ovality of pipe shall be as given in Table 18.13 below.

**TABLE 18.13**  
**Outside Diameter, Tolerance and Ovality of**  
**Pipes**

<i>Sl.</i>	<i>Nominal Size</i>	<i>Outside Diameter</i>	<i>Tolerance (Only positive tolerance)</i>	<i>Ovality</i>
	<i>DN</i>	<i>mm</i>	<i>mm</i>	<i>mm</i>
(1)	(2)	(3)	(4)	(5)
(i)	16	16.0	0.3	1.2
(1)	(2)	(3)	(4)	(5)
(ii)	20	20.0	0.3	1.2
(iii)	25	25.0	0.3	1.2
(iv)	32	32.0	0.3	1.3
(v)	40	40.0	0.4	1.4
(vi)	50	50.0	0.5	1.4
(vii)	63	63.0	0.6	1.6
(viii)	75	75.0	0.7	1.6
(ix)	90	90.0	0.9	1.8
(x)	110	110.0	0.9	2.2

1. The values specified for tolerance on outside diameter have been calculated as  $0.009DN$ , Rounded off to the next higher 0.1 mm subject to minimum of 0.3 mm. No negative tolerances are allowed.

2. The basis for the values specified for ovality is:

(a) For nominal outside diameters  $\leq 75$  mm, the tolerance equals  $(0.008 DN + 1.0)$  mm, rounded To the next higher 0.1 mm, with a minimum value of 1.2 mm.

(b) For nominal outside diameters  $\geq 75$  mm and  $\leq 250$  mm, the tolerance equals  $0.20 DN$ , Rounded to the next higher 0.1 mm.

(c) For nominal outside diameter  $> 250$  mm, the tolerance equals  $0.35 DN$ , rounded to the next Higher 0.1 mm.

#### 5.15.5 Wall Thickness

The minimum and maximum wall thickness of pipes shall be as given in Table 18.14 below:-

**TABLE 18.14**

<i>Sl. No.</i>	<i>Nominal Size</i>	<i>SDR 11</i>		<i>SDR 7.4</i>	
	<i>DN</i>	<i>Min</i>	<i>Max</i>	<i>Min</i>	<i>Max</i>
(1)	(2)	(3)	(4)	(5)	(6)
(i)	16	-	-	2.20	2.70
(ii)	20	1.90	2.30	2.80	3.30
(iii)	25	2.30	2.80	3.50	4.10
(iv)	32	2.90	3.40	4.40	5.10
(v)	40	3.70	4.30	5.50	6.30
(vi)	50	4.60	5.30	6.90	7.80
(vii)	63	5.80	6.60	8.60	9.70
(viii)	75	6.80	7.70	10.30	11.60
(ix)	90	8.20	9.30	12.30	13.80
(x)	110	10.00	11.20	15.10	16.90

**Note:** The wall thickness tolerances have been calculated on the following basis:

(a) Limit deviation =  $0.1e + 0.2$  mm rounded up to the nearest 0.1 mm.

(b) A local increase in wall thickness of up to  $+0.2e$  is permissible for  $e$  up to 10 mm and up to 0.15 for  $e$  greater than 10 mm. The mean of the measurement shall, however, still lie within the given limit deviations.

The quality of each installation system ultimately depends on the tightness, stability and lifetime of its Connections. The pipe of the desired length is cut using the pipe scissors. The proper heating piece is taken and mounted on the welding machine. The welding device is switched on - Control lamp and Switch lamp will light. When ready, control lamp gets off, which means that welding temperature of 260Degrees  $\pm$ 10 Degrees Celsius has been reached. The pipe end and the fitting to be welded are heated on the welding machine. Before heating the fitting and the pipe, the dirty welding tools, pipe and fitting are cleaned with a cloth. When heated up (with heating time as per the Table shown below), the pipe and the fitting is removed from the welding machine and the two pieces connected together by applying a little pressure without twisting. The joint is allowed to cool down for a few seconds. The welding process is that safe because the properly heated part of Polypropylene create a homogeneous connection.

### **Guidelines for Welding PP-R Pipes and Fittings (DVS Guideline 2207, Part II)**

<i>Outer diameter of pipe(mm)</i>	<i>Heating Time (Seconds)</i>	<i>Cooling Period (Minutes)</i>
16	5	2
20	5	2
25	7	2
32	8	4
40	12	4
50	18	4
63	24	6
75	30	8
90	30	8

The same procedure shall be adapted for exposed as well as concealed fittings. The Crossovers May be used wherever the overlapping of the PP-R pipes is required. The fixing shall be done by means of Wall Support Clamps keeping the pipes about 1.5 cm clear of the wall where to be laid on the surface. Where it is specified to conceal the pipes, chasing may be adopted. For pipes fixed in the shafts, ducts etc. there should be sufficient space to work on the pipes with the usual tools. Pipe sleeves shall be fixed at a place the pipe is passing, through a wall or floor for reception of the pipe and allow freedom for expansion and contraction and other movements. Fixed supports prevent any movement of the pipe by fixing it at some points. Fittings are used in creating the fixed points. Fixed supports must not be installed at bending parts and the direction changes must be done in the pipe itself. In between the fixed supports some arrangements must be done to compensate any potential elongation or shrinkage in the pipe length. For exposed straight pipes having length more than 5 meters, to compensate the expansion an expansion piece must be used.

#### **5.15.6 Piping Installation Support**

Piping shall be properly supported by means of wall support clamps as specified and as required, Keeping in view the proper designing for expansion and contraction. Risers shall be supported at each floor with clamps. Due to high coefficient of thermal expansion the heat losses through the pipes is highly reduced. Therefore, for internal Bathroom hot geyser water distribution lines, the insulation is often not required.

#### **5.15.7 Installation of Water Meter and Valves**

PP-R lines shall be cut to the required lengths at the position where the meter and Valves are Required to be fixed. Suitable C.P. Brass threaded fittings shall be attached to the pipes. The meter and Valves shall be fixed in a position by means of connecting pipes, jam nut and socket etc. The stop

cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter shall be installed exactly horizontally or vertically in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken to not to disturb the factory seal of the meter. Wherever the meter shall be fixed to a newly fitted pipeline, the pipeline shall have to be completely washed before fitting the meter.

#### 5.15.8 Testing

All water supply system shall be tested to Hydrostatic pressure test. Maximum operating pressure at Varying degree of temperature is given in Table 18.15:-

<i>Sl. No.</i>	<i>Temperature</i>	<i>SDR 11</i>	<i>SDR 7.4</i>
		<i>Pressure MPa</i>	<i>Pressure MPa</i>
(i)	10	1.91	3.02
(ii)	20	1.63	2.58
(iii)	30	1.37	2.17
(iv)	40	1.15	1.84
(v)	50	0.98	1.55
(vi)	60	0.82	1.28
(vii)	70	0.62	0.98
(viii)	80	0.39	0.62
(ix)	95	0.27	0.4

The pressure test is performed in 3 steps being preliminary test, main test and final test. For the Preliminary test a pressure which is 1.5 times higher than the possible working pressure is applied and this is repeated two times in 30 minutes with intervals of 10 minutes. After a test period of 30 minutes, the test pressure must not be dropped more than 0.6 bar and no leak must occur. Main test follows the preliminary test. Test time is two hours, in doing so the test pressure taken from the preliminary test must not have fallen more than 0.2 bar.

After completion of these tests, the final test comes which has to be done under a test pressure of 10 bars and 5 bar in the interval of 15 minutes. Between the respective test courses, pressure has to be removed.

All leaks and defects in joints revealed during the testing shall be rectified and got approved at site by retest. Piping required subsequent to the above pressure test shall be retested in the same manner.

System may be tested in sections and such sections shall be entirely checked on completion of Connection to the overhead tanks or pumping system or mains. In case of improper circulation, the Contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and refinishing of floors and walls as required.

After commissioning of the water supply system, contractor shall test each valve by closing and Opening it a number of times to observe if it is working efficiently. Valves which are not working efficiently shall be replaced by new ones.

#### 5.15.9 Measurements

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm for the Finished work, which shall include PP-R pipe and fittings including plain fittings and Chrome Plated

Brass

Threaded fittings. Deductions for the length of valves shall be made. The cost includes cutting chases in the masonry wall and making good the same, trenching, refilling and testing of joints. The cost of gate valves/ wheel valves/union shall be paid for separately.

## **6.1 INTERNAL DRAINAGE (SOIL, WASTE, VENT AND RAIN WATER PIPES):**

### **6.2 SCOPE:**

6.2.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes as required by the drawings, specified hereinafter and given in the Bill of Quantities.

6.2.2 Without restricting to the generality of the foregoing, the soil, waste, vent and rainwater pipes system shall include the followings:-

- i. Cast Iron / UPVC vertical and horizontal soil waste and vent pipes, rainwater pipes and fittings, joints clamps and connections to fixtures.
- ii. Floor traps, floor drain clean out plugs, inlet fittings and rainwater roof drain, area/local drains, trench drain...
- iii. Waste pipes connections from all fixtures e.g. wash basins, sinks, kitchen equipment.
- iv. Testing of all pipes.
- v. Connection of main.

### **6.3 GENERAL REQUIREMENTS**

6.2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Client's Representative.

6.2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

6.2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

6.2.4 Pipes shall be securely fixed to walls by suitable clamps at intervals specified.

6.2.5 Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

6.2.6 All works shall be executed as directed by Client's Representative.

### **6.3 CAST IRON PIPES & FITTINGS**

6.3.1 Soil, waste, vent and anti-siphonage pipes shall be cast iron pipes with socket and spigot. All pipes shall be straight and smooth and inside free from irregular bore, blow holes, cracks and other manufacturing defects. Pipes shall be centrifugally spun iron soil pipes conforming to sand cast I.S.



1729-1967.

6.3.2 STANDARD WEIGHT DIMENSIONS AND PIG LEAD REQUIRED FOR JOINTS SHALL BE AS FOLLOWS:-

For conforming to I.S. 1729-1967 (sand cast iron soil pipes and fittings)

Diameter	Thickness	Overall length or 1.83 M	Internal diamete of socket	lead	Depth of
50	5	11.41	76	25	
75	5	16.52	101	25	
100	5	21.67	129	25	
150	5	31.91	181	32	

6.3.3 TOLERANCE

Acceptable tolerance for pipes to I.S. 1729 shall be as follows:-

- a) Wall thickness -15%
- b) Length  $\pm 20$  mm
- c) Weight  $\pm 10\%$

6.3.4 FITTINGS

Fittings shall conform to the corresponding Indian Standard as for pipes. Contractor shall use pipes and fittings of matching specification.

Access door shall be secured air and water tight with 3mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal.

6.3.5 JOINTING:

All soil, waste and vent pipes including fixture connections between traps and soil pipes shall be jointed with refined pig lead conforming to IS: 27-1977 sufficient sken of jute rope shall be caulked to leave a minimum space for the pig lead as given in 6.3.2 to be poured in. After pouring the lead shall be caulked into the joint with caulking tool and hammer. All surplus lead shall be cut and joint left flush with the rim of the socket neatly.

6.3.6 Vent pipes penetration through roof shall be by means of sleeves. The sleeve will be kept 100mm higher the finish roof level and annular space filled with fire proof materials like putty, fire seal etc.

6.3.7 PIPE, HANGERS, SUPPORT, CLAMP, BRACKE ETC.:

All vertical pipes shall be fixed by M.S. Clamps truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).

Inclined pipes running along ceiling shall be fixed on M.S. adjustable hangers of special design shown on the drawings or as directed. Pipes shall be laid to uniform slope and the hangers adjusted to the proper levels so that the pipes fully rest on them.

M.S. clamps shall be of standard design and fabricated from M.S. flat 40mm x 3mm x 3mm thick. They shall be painted with two coats of black bitumen paint before fixing.

Structural clamps shall be fabricated from M.S. structural members e.g. rods, angles, channels, flats,

as per detailed drawing or as directed. Contractor shall provide all nuts, bolts, welding and paint the clamps with one coat of red oxide. Wooden saddles shall be provided free of cost.

Slotted angle/channel supports on walls shall be provided wherever shown on drawings or as required. Angles/channels shall be fixed to brick walls and bolts embedded in cement concrete blocks and to RCC walls with suitable anchor fasteners. Holes required in RCC walls shall be neatly drilled by electric drills and no manual chiseling will be allowed. The spacing of supports horizontally shall not exceed 1.8 M.

Wherever M.S. clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement and for making good with cement concrete 1:2:4 (mix 1 cement :2 coarse sand :4 stone aggregate 20mm nominal size) as directed by the Client's Representative.

#### 6.3.8 TESTING:

All pipe work shall be tested before connecting any appliances and then again after connection of appliances. Pipe shall be tested after installation by one of the test given below as directed by the Client's Representative.

Before use at site, all C.I. soil pipes shall be tested by filling up with water for at least 10 minutes at 3 meter head. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defective pipes shall be rejected and removed from the site within 48 hours.

##### Water Test:

Pipes shall be tested after installation by filling up the stack with water. All openings and connections shall be suitable plugged. The total head in the stack shall however not 3 M exceed. The level of water in the stack shall not drop within 8 hours. If there is a drop in level of water the leak shall be detected and rectified and test shall be re-conducted until satisfactory result is achieved.

##### Smoke Test:

Contractor may test all soil and waste stacks by a smoke testing machine. Smoke shall be pumped into the stack after plugging all inlet and outlet connections.

The stack shall then be observed for leakages and all defective pipes and fittings removed or repaired as directed by the Client's Representative.

#### 6.3.9 UPVC PIPES AND FITTINGS (RAIN WATER):

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, and free from grooving and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designated by external diameter and shall conform to IS: 4985-1981.

OUTER DIA.	PRESSUR E	INNER DIA.	WEIGHT/M T (KG.)
110	4	104.5	1.315
125	4	118.7	1.712

140	4	133.0	2.131
160	4	152.0	2.783
180	4	175.9	3.560
200	2	190.1	4.526
225	4	213.8	5.480

#### **Fittings:**

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to Indian Standard.

#### **Laying and Jointing:**

The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively plastic clamps of suitable designs shall be preferred. Provision shall be made for the effect of thermal movement by not gripping or disturbing the pipe at supports between the anchors for suspended pipes. The supports shall allow the repeated movements to take place without abrasion.

Jointing for UPVC pipes shall be made by means of solvent cement for horizontal lines and 'O' rubber ring for vertical line. The type of joint shall be used as per site conditions/direction of the Client's Representative. Where UPVC pipes are to be used for rain water pipes, the pipe shall be finished with G.I. adopter for insertion in the R.C.C. slab for a water proof joint complete as directed by Client's Representative.

#### **Supports:**

UPVC pipes require supports at close intervals. Recommended support spacing for unplasticised PVC pipes is 1400 mm for pipes 50 mm dia and above. Pipes shall be aligned properly before fixing them on the wooden plugs with clamps. Even if the wooden plugs are fixed using a plumb line, pipe shall also be checked for its alignment before clamping, piping shall be properly supported on, or suspended from clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency. Pipe supports shall be primer coated with rust preventive paint.

#### **Repairs:**

While temporary or emergency repairs may be made to the damaged pipes, permanent repairs should be made by replacement of the damaged section. If any split or chip out occurs in the wall of the pipe, a short piece of pipe of sufficient length to cover the damaged portion of the pipe is cut. The sleeve is cut longitudinally and heated sufficiently to soften it so that it may be slipped over the damaged hard pipe.

#### **Testing:**

All lengths of PVC rain water pipes shall be fully tested for water tightness by means of water test maintained for not less than 30 minutes. All pipes shall be subjected to a test pressure of at least 1.5 meter head of water head. The test pressure shall, however, not exceed 6 meter head at any point. The pipes shall be plugged preferably with standard design plugs with rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head.

#### **6.3.10 WASTE PIPE FROM APPLIANCES:**

- i) Waste pipe from appliances e.g. wash basins, sinks, urinals, chrome plate where seen water

coolers shall be of galvanised steel (heavy class) conforming to IS:1239-1979.

- ii) All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on structural clamps. Spacing for clamps for such pipes shall be as follows:-

<b>Horizontal</b>	<b>Vertical</b>	
G.I. Pipes	300 cms	240 cms
PVC Pipes	180 cms	120 cm

#### 6.3.11 PAINTING

Soil, waste vent and rainwater pipes in exposed location, in shafts and pipe spaces shall be thoroughly cleaned to remove dirt, rust and other contamination, and painted with two or more coats of synthetic enamel paint to give an even shade.

Paint shall be of approved quality and shade, where directed pipes shall be painted in accordance with approved pipe colour code.

Waste pipes in chase shall be thoroughly cleaned to remove dirt, rust and other contamination, and painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with two or more coats of synthetic enamel paint.

C.I. soil and waste pipes below ground and covered in cement concrete shall not be painted.

#### 6.3.12 MEASUREMENTS:

C.I. / UPVC/ G.I. waste/soil, waste, vent and rain water pipes shall be measured over all along the centre line correct to a centimetre including all fittings along its length. The rate for these pipes shall be inclusive of all fittings, holder bat clamps, lead caulked joint for C.I. and cement joints for UPVC and all other items described in the Bill or Quantities. The portion of the pipe within the collar for C.I./UPVC pipe at the joint shall not be included in the length of the pipe work.

#### 6.4. SWR uPVC PIPES AND FITTINGS:

- 6.4.1 Soil, waste, vent SWR Ring Fit pipes with socket and spigot. All pipes shall be straight and smooth and inside free from irregular bore, blow holes, cracks and other manufacturing defects. These pipes conform to Indian Standard IS: 4985 – 2000 and are designed to withstand continuous internal hydraulic pressure of 4 Kgf/cm so as to ensure life-long trouble free working. The pipes are provided with an integral rubber ring type socket at one end while the other end is kept plain, smooth and free from burrs. Rubber ring type socket ends provide easy push – fit type jointing. Simultaneously, allowance for thermal expansion can also be provided during installation. Pipes shall be centrifugally spun iron soil pipes conforming to sand cast I.S. 1729-1967.

#### 6.4.2 FITTINGS:

Fittings shall conform to the corresponding Indian Standard as for pipes. Contractor shall use pipes and fittings of matching specification.

Access door shall be secured air and water tight with 3mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal.

#### 6.4.3 JOINTING:

**Rubber Seal Rings for Joints & Access Doors :** Manufactured in accordance with IS : 5382 for 75 mm / 90 mm / 110 mm sizes. These are made out of natural rubber with a shore 'A' hardness pf 40 × 5. Provide superior resistance to biological attack. Special design of cross section ensures perfect sealing.

**Lubricant:** Available in 100 gms, 250 gms & 500 gms packing. Specially formulated for compatibility with rubber seal as well as PVC. Does not support the growth of bacteria or fungi.

#### 6.4.4 PIPE, HANGERS, SUPPORT, CLAMP, BRACKE ETC.:

##### **Supports:**

UPVC pipes require supports at close intervals. Recommended support spacing for unplasticized PVC pipes is 1400 mm for pipes 50 mm dia and above. Pipes shall be aligned properly before fixing them on the wooden plugs with clamps. Even if the wooden plugs are fixed using a plumb line, pipe shall also be checked for its alignment before clamping, piping shall be properly supported on, or suspended from clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency. Pipe supports shall be primer coated with rust preventive paint.

#### 6.4.5 TESTING:

Before the system is put into use, it should be tested for leakages by air test, hydraulic test or smoke test.

#### 6.5 TRAPS:

##### 6.5.1 NAHANI TRAP OR FLOOR TRAPS:

Nahani traps or floor traps shall be cast iron/ PVC / , deep seal with an effective seal of 50 mm. The trap and waste pipes shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1:2:3 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) mixed with water proof compound and extended to 40 mm below finished floor level. Contractor shall provide all necessary shuttering and cantering for the blocks. Size of the block shall be 30 x 30 cms of the required depth. The trap shall be installed at lowest point ensure no pending occurs at perimeters of the drain.

#### 6.6 FLOOR TRAP INLET

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, the Contractor shall provide a special type galvanised iron inlet fitting without or with one, two or three inlet sockets to receive the waste pipe. Joint between waste and fitting shall be connected to a C.I. 'P' or 'S' trap with at least 50mm seal (Hopper and traps shall be paid for separately). Floor trap inlet fittings and the trap shall be set in cement concrete blocks.

## **6.7 C.P./STAINLESS STEEL GRATINGS**

Floor and Urinal traps shall be provided with 100-150mm square or round C.P./Stainless steel grating as approved by Client's Representative with rim, of approved design and shape. Minimum thickness shall be 4-5mm or as specified in the Bill of Quantities.

## **6.8 CLEANOUT PLUGS**

Contractor shall provide cast brass cleanout plugs in all horizontal run more than 15 meter length required one cleanout plugs shall be threaded and provided with key holes for opening. Cleanout plugs shall be fixed to the pipe by a G.I. socket and lead caulked joint.

## **6.9 PIPE SLEEVES**

Pipe sleeves 50mm larger diameter than pipes shall be provided wherever pipes pass through walls and slabs and annular space filled with fire proof materials like putty, fire seal etc. All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burs removed before laying. Open ends of the pipe shall be closed as the pipe is installed to avoid entrance of foreign matters. Vertical sleeve shall finish 50mm above finish floor level.

## **6.10. LOW NOISE SWR PIPES AND FITTINGS:**

- 6.10.1 Low Noise Silent piping is an effective non-pressure soundproof wastewater and drainage piping system made of mineral reinforced polypropylene compound (PP-MD). Available in diameters from 32 mm to 160mm, all mechanical and measurement requirements (EN 1451-1) and suit above and below ground installation both inside and outside the building structure. The system fittings are produced from black PP- MD compound and sealed with SBR-NR seals. All pipes have three layers to provide the highest mechanical performance.
- External black PP layer provides high-impact strength and excellent UV resistance.
  - Intermediate PP-MD layer provides acoustic insulation and increases the pipe stiffness.
  - Internal low-friction white PP layer provides the best flow performance, high resistance to chemical agents and high-definition contrast for visual monitoring.
- Soil, waste, vent SWR Low Noise Ring Fit pipes with socket and spigot. All pipes shall be straight and

smooth and inside free from irregular bore, blow holes, cracks and other manufacturing defects. These pipes conform to Standard EN-13501 .

EN 1451-1: Polypropylene (PP) piping systems for soil and waste discharge (low and high temperature) within the building structure.

EN13501-1:2009: Classification of system's fire behavior, smoke emission, flaming and droplets

EN 4102-2: Reaction to fire tests - Ignitability of building products subjected to direct impingement of flame.

EN 14366: Laboratory measurement of noise from waste water installations. Measurement test results according to EN14366

System / Flow rate	0.5 l/s	1.0 l/s	2.0 l/s	4.0 l/s
Low Noise	10 db	13 db	15 db	19 db

## **6.10.2 APPLICATION:**

Soundproof pipes and fittings for drainage, soil and waste water discharge, low and high

temperature, made of PP-MD (Polypropylene and mineral filled polypropylene compounds) in diameters Ø32-160 with push-fit connection method. Application area "BD" according to SKZ specification for test and inspection HR

3.43. Waste water, drainage and sewerage applications • Grey waste water - Collecting water from bathroom sinks, baths and showers and from washing machines. Applicable systems: Silent, HT System and Thread Lock™. • Waste water - Collecting waste water from toilets and kitchen sinks. Applicable systems: Water closet waste water drainage.

#### 6.10.3 MATERIAL:

All materials comply with RoHS directive and are Halogen and Cadmium free three layers. External :- Black PP provides excellent impact resistance and long-term UV protection

Middle :- PP and PP-MD provide high mechanical resistance and excellent soundproofing performance. Inner :- White PP provides the best flow performance and high-definition contrast for visual inspection.

#### 6.10.4 CONNECTION METHOD:

All fittings & pipe are connected by means of push-fit insertion, with single-lip high quality seals made of SBR-NR, for guaranteed sealing and leak-proof performance.

Push Fit Connection Method:-

Check the position and integrity of the lip seal in the socket gasket slot. Clean the seal and the socket. • Clean the plain pipe end from sawdust and scraps - it's recommended to apply a thin layer of lubricant around the plain pipe end. • Push the plain end into the socket while slightly turning until the end of the socket sleeve, then pull the pipe back approximately 10 mm

#### 6.10.5 Cutting to length and assembly preparations:

Pipes are sold in various lengths with one or two sockets and gaskets and with plain ends pre-beveled. If cutting to length is needed, use only proper cutting tools for plastic pipes (manual or mechanical) and work according to all safety rules, using proper protective equipment. • It is recommended to bevel the cut pipe end for easier installation (angle of approximately 15° with bevel length of 5 mm). Removing chips, shavings and sawdust is necessary before installing.

#### 6.10.6 PIPE, HANGERS, SUPPORT, CLAMP, BRACKET ETC.:

For mounting Ultra Silent™ system, use steel brackets with rubber inserts approved for acoustic insulation systems. • Where pipes are installed vertically, every pipe must be fastened with brackets directly under the socket, to prevent pipe movement (Figure 2). • Maximum distances between the brackets for horizontal and vertical installation, as below.

Pipe DN (external diameter)	Max. bracket distance for horizontal installation - D1	Max. bracket distance for vertical installation -
50mm	0.80	1.50
75mm	1.10	2.0
90mm	1.40	2.0
110mm	2.0	2.0
125mm	2.0	2.0
160mm	2.40	2.0



#### 6.10.7 TESTING:

Before the system is put into use, it should be tested for leakages by air test, hydraulic test or smoke test.

### 7.1 EXTERNAL DRAINAGE SYSTEM (SEWERAGE AND STORM WATER):

#### 7.2 SCOPE:

- i. Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install the drainage system as required by the drawings and specified hereinafter or given in the Bill of Quantities.
- ii. Without restricting to the generality of the foregoing, the drainage system shall include: Sewer lines including excavations, pipe lines, man holes, drop connections, underground storm water drains, including pipes, man holes, catch basins and open drains, thrust blocks.

#### 7.3 GENERAL REQUIREMENTS:

All materials shall be new of the best quality conforming to specifications and subject to the approval of the Client's Representatives.

Drainage lines shall be laid to the required gradients and profiles.

All drainage work shall be done in accordance with the local municipal bye-laws.

Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority and also existing invert levels required to enter sanitary system.

Location of all manholes, catch basins, etc. shall be confirmed by the Client's Representatives before the actual execution of work at site.

All excavation, trenches etc shall be barricaded as per instruction of the Client's Representatives. All works shall be executed as directed by the Client's Representatives.

### 7.4 TRENCHES FOR PIPE & DRAINS:

#### 7.3.1 ALIGNMENT AND GRADE:

The drains are to be laid to alignment and gradients in continuous shown on the drawings but subject to such modifications, as shall be ordered by the Client's Representative from time to time to meet the requirements of the works. No deviations from the line, depths of cutting or gradients of sewers shown in the plans and sections shall be permitted except by the express direction in writing of the Client's Representative.

#### 7.3.2 OPENING OUT TRENCHES:

In excavating the trenches at the road metaling, pavement kerbing etc. are to be placed on one side and preserved for rein statement when the trench or other excavation shall be filled-up.

Before any road metal is replaced, it shall be carefully shifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Client's Representative. The Contractor shall not cut or break down any live fence or trees in the line of the proposed works but shall tunnel under them unless the Client's Representative shall order to the contrary. Trench to be excavated to alignment + depth required. Trench to be properly dressed and de-watered. Trench shall be kept free of water at all time. Discharge of water shall be into nearest drainage channel not on the road.

All under ground pipe to be laid open in trench. Pipes to be laid and maintained at required levels and grade during course of work. All joints to be aligned and complete.

Trench shall be of 450mm wide than pipe. Concrete anchors at change in direction for C.I. pipe shall be provided. Pipe shall be rest on cushion in the trench.

The Contractor shall scrub up and clear the surface over the trenches and other excavations of all stumps, roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the Client's Representative.

#### 7.3.3 CONSTRUCTION ACROSS THE ROADS:

All the pipe line or drain crossing existing road, the road crossing shall be excavated at a time, the second half being commenced after the pipes have been laid in the first half and the trench refilled. Necessary safety measure for traffic as directed shall be adopted. All type of pipes, water mains, cables etc. met within the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the electrical and communication cable removal of which is necessary shall be arranged by the Client's Representative or the Contractor shall arrange to support and protect them during excavation.

#### 7.3.4 EXCAVATION TO BE TAKEN TO PROPER DEPTH:

The trenches shall be excavated to such depth and width that the sewers pipe shall rest on cushion so that the inverts may be at the levels given on the section/plan. In bad ground the Client's Representative may order the Contractor to excavate to a greater depth than that shown on the drawings and to fill up the excavation to the level of the sewer with such materials as decided by Client's Representative in writing.

#### 7.3.5 REFILLING:

The filling shall be done in layers not exceeding 15mm in depth. Each layer shall be watered, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt end of the crow brass where rammers can not be used. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the trenches. Filling in trenches shall be commenced soon after the joints of pipes, cables; conduits etc. have been tested and approved by Client's Representative. The space around the pipes shall be cleared of all debris where the trenches are excavated in hard/soft soil. The filling shall

be done with earth on the sides and tops of pipes in layers not exceeding 15mm in depth. Each layer shall be watered rammed and consolidated. The clods and lumps of earth exceeding 8cm in any direction shall be broken or removed before the excavated earth is used for filling. Generally no test is done to determine the instrument diversity of filled earth but on the discretion of Client's Representative the 95 proctor's compaction test may be done to ensure the in situ density after filling. Consolidation is removal of water from the pores and compaction is the explosion of air from the pores. In case of refilling consolidation places most important role as the watering of the each layer is being done properly. If required by the Client's Representative proctors needle may also be used for the proper checking of the refilling items of in situ density.

#### 7.3.6 CONTRACTOR SHALL RESTORE SETTLEMENT AND DAMAGES:

The Contractor shall at his own cost make good promptly during the whole period the works are in hand, any settlements that may occur in the surfaces or roads, beams, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by his other excavations due to not using the method of compaction as given in clause 7.3.5 and he shall be liable for any accidents caused thereby.

He shall also at his own expense and charges, repair and make good any damage done to the building and other properties.

#### 7.3.7 DISPOSAL OF SURPLUS SOIL:

The Contractor shall at his own cost and charge, dispose off from the site all surpluses excavated material not required to be used on the works.

- i. The width of excavated trench shall be as per table given below:

<b>Excavation upto</b>	<b>Upto 100 mm 150 mm Dia. Pipe pipe</b>	<b>Upto Dia.</b>
90 cms depth	33 cms	33 cms
90 - 150 cms depth	60 cms	60 cms
150 - 300 cms depth	75 cms	75 cms
300 - 500 cms depth	90 cms	100 cms

#### 7.3.8 PROTECTION OF EXISTING SERVICES:

All pipes, water mains, cables etc encountered in the course of excavation shall be carefully protected and supported. In case of any damage caused the same shall be made good at no extra cost failing which necessary works will be carried out by the Clients Representative and contract charged to the Contractor.

#### 7.4 RCC PIPES:

- 7.4.1 All underground storm water drainage pipes and sewer lines where specified (other than those specified cast iron) shall be centrifugally spun RCC pipes NP2 for general and NP3 where road crossing. Pipes shall be true and straight with uniform bore throughout. Cracked, wrapped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, prior to use on site, a certificate to that effect from the manufacturer.

The pipes shall be with or without reinforcement as required and of the class as specified.

These shall conform to IS: 458 - 1971. The reinforced cement concrete pipes shall be manufactured by centrifugal (or spun) process.

All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding. The pipes shall be R.C.C. light duty, NP2 and NP3 type.

#### 7.4.2 LAYING:

R.C.C. spun pipes shall be laid on cement concrete bed or cradles as specified and shown on the detailed drawings. The cradles may be pre-cast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12mm below the invert level of the pipe and properly placed on the soil to prevent any disturbance. The pipe shall then be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and boning rods, etc. Cradles or concrete bed may be omitted, if directed by the Client's Representatives.

#### 7.4.3 JOINTING (RIGID SPIGOT AND SOCKET JOINT):

Hemp rope soaked in neat cement wash shall be passed round the joint and inserted in it by means of caulking tool. More skein of yarn shall be added and rammed home. Cement mortar with one part of cement and one part of sand and with minimum water content but on no account soft or sloppy, shall be carefully inserted, punched and caulked into the joint and more cement mortar added until the space of the joint has been filled completely with tightly caulked mortar. The joint shall then be finished off neatly outside the socket at an angle of 45 degree.

#### 7.4.4 CURING:

The joint shall be cured for at least seven days.

#### 7.4.5 CEMENT CONCRETE FOR PIPE SUPPORTS:

- a) Unless otherwise directed by the Client's Representative cement concrete for bed, all round or in haunches shall be laid as follows:

	<b>Upto 1.5m</b>	<b>Upto 3m depth</b>	<b>Beyond 3m depth</b>
Pipes in open ground (no sub soil water)	all round	in haunche	all round
RCC/C.I. pipes in sub soil water	all round	in haunche	in haunche
RCC/C.I. pipes (in all conditions)	all round	in haunche	in haunche
RCC/C.I pipes under road or building	all round	all round	all round

- b) RCC pipes or CI pipes may be supported on brick masonry or pre-cast RCC or in situ

cradles. Cradles shall be as shown on the drawings.

- c) Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings.

7.4.6 TESTING:

All lengths of the sewer and drain shall be fully tested for water tightness by means of water head maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subjected to a test pressure of at least 1.5 meters head of water at the highest point of the section under test. The pipes shall be plugged preferably with standard drain plugs (with rubber rings) on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head.

Permissible drops in water head should not exceed .....

a) **WIDTH OF TRENCH**

**Recommended width of trenches at the bottom of the trench is as follows:**

100 mm dia pipe	55 cms
150 mm dia pipe	55 cms
225-250 mm dia pipe	60 cms
300 mm dia pipe	75 cms

Maximum width of the bed concrete shall be also as above. No additional payment is admissible for widths greater than specified.

### m) TESTING

1. All lengths of the sewer and drain shall be fully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subjected to a test pressure of at least 1.5 mtrs. head of water. The test pressure shall, however, not exceed 6 metres head at any point. The pipes shall be plugged preferably with standard design plugs with rubber plugs on both sides. The upper end shall, however, be connected to a pipe for filling with water and getting the required head poured at one time permit.
2. Sewer lines shall be tested for a straightness by :
  - (i) Inserting a smooth ball 12 mm less than the internal diameter of the pipe. In the absence of obstruction such as yarn or mortar projecting at the joints the ball should roll down the invert of the pipe and emerge at the lower end.
  - (ii) Means of a mirror at one end and a lamp at the other end. If the pipe line is straight the full circle of light will be seen otherwise obstructions or deviations will be apparent.
  - (iii) The contractor shall give a smoke test to the drain and sewer at his own expense and charges, if directed by the Consultant/ Client/ Architect.
  - (iv) A test register shall be maintained which shall be signed and dated by contractor. Architect and representative of consultants.

### n) MASONRY WORK

Masonry work for manhole, chambers, septic tanks and such other works as required shall be constructed from local best quality bricks in cement mortar 1 : 5 mix (1 cement : 5 coarse sand) or as specified in the Bill of Quantities. All joints shall be properly raked to receive plaster.

### o) CEMENT CONCRETE FOR PIPE SUPPORT

1. Wherever specified or shown on the drawings, all pipes shall be supported in bed all round or in haunches. The thickness and mix of concrete shall be as given in the Bill of Quantities. Widths of the bedding shall be as per Para 13.
2. Unless otherwise directed by the Consultant/ Client/ Architect, cement concrete of bed, all round or in haunches shall be laid as follows:

	Upto 1.5 m depth	Upto 3 m depth	Beyond 3 m depth
RCC, stoneware pipes in open ground (above sub soil C.I.pipes in sub soil water	All round (1 All round	In haunches In haunches	In haunches In haunches
RCC or S.W. pipes in sub soil water	All round	All round	All round

RCC or S.W. pipes under floors or building	All round	All round	All round 3. : 2 : 4)
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3. RCC pipes or C.I. or stoneware pipes may be supported on brick masonry or precast RCC or in situ cradles. Cradles shall be as shown on the drawing.
4. Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings.
5. Hand mixing on properly constructed platforms may be allowed for small quantities by the Consultant/ Client/ Architect. Rate for cement concrete shall be inclusive of all shuttering and centering at all depths and heights.
6. Concrete work shall be of such thickness and mix as given in the Bill of quantities.
7. All concrete work shall be cured for a period of at least 7 days. Such work shall be kept moist by means of gunny bags at all times. All pipes trenches and foundations shall be kept dry during curing period.

## **7.5 SEWER MANHOLES WITH FRAME AND COVER:**

### **7.5.1 SCOPE**

This specification covers the requirements for providing and constructing of Brick Masonry (for up to 3 mtr. depth)  
/ RCC M 20 grade or 1:1x1/2 :3 mix (for more than 3 mtr. depth) manholes with steps, frame, cover and vent shafts.

### **7.5.2 STANDARDS**

The following standards/codes, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards /codes shall be referred to.

IS : 210	Specification for gray iron castings
IS : 269	Specification for ordinary and low heat Portland cement
IS : 383	Specification for coarse and fine aggregates from natural sources for concrete
IS : 432	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
IS : 516	Methods of tests for strength of concrete
IS : 651	Specification for salt-glazed stoneware pipes and fittings
IS : 1077	Specification for common burnt clay building bricks
IS : 1726	Specification for cast iron manhole covers and frames
IS : 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS : 2116	Specification for sand for masonry mortars
IS : 3495	Methods of tests of burnt clay building bricks
IS : 5455	Specification for cast iron steps for manholes

### 7.5.3 CODES OF PRACTICE

IS : 456	Code of practice for plain and reinforced concrete
IS : 2212	Code of practice for brickwork
IS : 2250	Code of practice for preparation and use of masonry mortars
IS : 4111	Code of practice for ancillary structures in sewerage system part
IS : 4127	Code of practice for laying of glazed stoneware pipes

### 7.5.4 LOCATION

Manholes shall be constructed in accordance with the drawings at the locations indicated thereon.

### 7.5.5 CONSTRUCTION MANHOLES:

At every change of alignment, gradient or diameter of a drain, there shall be a manhole or inspection chamber. Bends and junctions in the drains shall be grouped together in manhole as far as possible. The maximum distance between manholes shall be according to NBC.

Manholes of different types and sizes as specified shall be constructed in the sewer line at such places and to such levels and dimensions as shown in the drawings or as directed by the Engineer-in-charge. The size specified shall indicate the inside dimensions between brick faces of the manholes.

Where the diameter of the drain is increased, the crown of the pipe shall be fixed at the same level and necessary slope given in the invert of the manhole chamber. In exceptional cases and where unavoidable, the crown of the branch sewer may be fixed at lower level but in such cases the peak flow level of the two sewers shall be kept the same.

Sewers of unequal sectional area shall not be jointed at the same invert in a manhole. The invert of the smaller sewer at its junction with main shall be at least  $\frac{2}{3}$  the diameter of the main above the invert of the

main. The branch sewers shall deliver sewage in the manhole in the direction of main flow and the junction must be made with care so that flow in main is not impeded.

No drain from house fittings, e.g. gully trap or soil pipe, etc. to manhole shall normally exceed a length of 6 m unless it is unavoidable.

Manholes 90 x 80 cm are generally constructed within compound for house drainage only and near the buildings for house drainage. Manholes 1.2 m x 90 cm are generally constructed for main drainage work for depths less than 1.5 m.

Manhole 1.4 m x 90 cm is of the arched type and is generally constructed for main drainage works where



depth is 1.50 m or more. The width of manholes shall be increased more than 90 cm on bends or junctions or pipes with diameter greater than 450 mm and that the benching width on either side of the channel is minimum 20 cm.

Manholes 1.4 m internal diameter are generally constructed for main drainage works where depth is 2.45 m or more as an alternative to manholes of arch type. The diameter shall be increased suitably, for pipes with diameter greater than 450 mm in the same manner as in the case of rectangular manholes.

Before deciding size of manholes, it shall be as specified in BOQ or as per Local Municipal Bye Laws. When manholes are constructed on foot path, these shall be provided with cover of medium duty casting and when built within the width of the road under vehicular traffic, these shall be provided with cover of heavy duty casting.

#### **7.6.6. EXCAVATION**

The excavation for manhole shall be true to dimensions and levels shown on the plans or as directed by the Engineer-in-charge.

#### **7.6.7 BED CONCRETE**

The manhole shall be built on a bed of foundation PCC 1 : 2 : 4 unless required by local authorities. The thickness of the bed concrete shall be 15 cm for manholes up to 4.5 m depth and 30 cm for depths beyond 4.5 m unless otherwise specified or directed by the Engineer-in-charge. In bad ground, special foundations as suitable shall be provided.

#### **7.6.8. BRICK MASONRY / CEMENT CONCRETE WORK**

##### **BRICK MASONRY**

For depth up to 3 mtr, manhole shall be constructed with masonry wall, for more than 3 mtr. Depth, it shall be of M 20 grade as specified below:

The brick work shall be with class 75 bricks in cement mortar 1:4 (1 cement: 4 coarse sand).

The brick work shall be with class 75 bricks in cement mortar 1:4 (1 cement: 4 coarse sand). The external joints of the brick masonry shall be finished smooth, and the joints of the pipes with the masonry shall be made perfectly leak proof. For arched type and circular manholes, brick masonry in arches and arching over the pipes shall be in cement mortar 1 : 3 (1 cement: 3 fine sand). In the case of manholes of circular type the excess shaft shall be corbelled inwardly on three sides at the top to reduce its size to the cover frame to be fitted.

The walls shall be built of one brick thickness for depths up to 4.25 m. below a depth of 4.25 mtr in ordinary subsoil the wall thickness shall be increased to one and half brick and at 9.75 m below ground two brick thick walls

##### **CEMENT CONCRETE WORK**

The walls shall be built of M20 grade (1 cement : 1.5 coarse sand : 3 coarse aggregate having 20 mm nominal size) with 15 cm thickness for depth up to 4.5 m. Below a depth of 4.5 m in ordinary subsoil the wall thickness shall be increased to 30 cm

The thickness of the wall shall be take the total load coming over it including earth pressure & water pressure. The chamber shall be tested for water tightness.

The wall shall further be water proofed with addition of approved water proofing compound in a quantity as per manufacturer's specifications. In case Local Authorities/Bye Laws specify richer specifications, the same shall be adopted.

For earth work excavation, bed concrete work, R.C.C. work and refilling of earth, respective specifications shall be followed.

## PLASTER AND POINTING

In case of brick walls, the walls of the manholes shall be plastered inside with 20 mm thick cement plaster 1:2 (1 cement: 2 coarse sand) finished smooth. The plaster shall further be water proofed with addition of approved water proofing compound in a quantity as per manufacturer's specifications. In case Local Authorities/Bye Laws specify richer specifications, the same shall be adopted.

For earth work excavation, bed concrete brick work, plaster and pointing, R.C.C. work and refilling of earth, respective specifications shall be followed.

### 7.6.9 BENCHING

The channels and benching shall be done in cement concrete 1:1.5:3 (1 cement : 1.5 coarse sand : 3 graded stone aggregate 20 mm nominal size) and rendered smooth with neat cement. The depth of channels and benching shall be as given in Table .

SIZE OF DRAIN WALLS ABOVE	TOP OF CHANNEL AT	DEPTH OF BENCHING THE CENTER ABOVE		AT	SIDE
	BED CONC.	BED CONC.			
10 cm	15 cm	20 cm			
15 cm	20 cm	30 cm			
20 cm	25 cm	35 cm			
25 cm	30 cm	40 cm			
30 cm	35 cm	45 cm			

### 7.6.10 FOOT RESTS

All manholes deeper than 0.8 m shall be provided with foot rests.

7.6.10.1 Foot rest shall be CI type, each weighing 5.5 Kg, 1:2:4 coping.

7.6.10.2 Alternatively MS foot rest shall be provided. These shall be embedded 20 cm deep in 20 x 20 x 10 cm blocks of cement concrete 1:2:4 (1 cement : 4 coarse sand : 4 graded stone aggregate 20 mm nominal size). The concrete block with M.S. foot rest placed in its center shall be cast in situ along with the RCC wall & finished smooth.

SIZE OF DRAIN MM	TOP OF CHANNEL AT THE CENTER ABOVE BED CONCRETE CM	DEPTH OF BENCHING AT SIDE WALLS ABOVE BED CONCRETE
100	15	20
150	20	30
200	25	35
250	30	40
300	35	45
350	40	50
400	45	55
450	50	60

Foot rests which shall be of 20x20 Sq. M.S. bars.

Foot rests shall be fixed 40 cm apart vertically and staggered laterally and shall project 10 cm beyond the surface of the wall. The top foot rest shall be 45 cm below the manhole cover.

Foot rests shall be painted with coal tar, the portion embedded in the cement concrete block being painted with thick cement slurry before fixing.

#### **7.6.11 MANHOLE COVERS AND FRAMES**

The frame of manhole shall be firmly embedded to correct alignment and levels in R.C.C. slab or plain concrete as the case may be on the top of the masonry. After completion of the work, manhole covers shall be sealed by means of thick grease.

### **7.7 DROP CONNECTION**

In cases where branch pipe sewer enters the manhole of main pipe sewer at a higher level than the main sewer, a drop connection shall be provided. The work shall be carried out as per specifications and RCC pipes and special conforming to IS: 458 shall be of the same size as that of the branch pipe sewer.

For 150 and 250 mm main line, if the difference in level between the water line (peak flow level) and the invert level of the branch line is less than 60 cm, a drop connection may be provided within the manhole by giving suitable ramp. If the difference in level is more than 60 cm, the drop shall be provided externally.

The sewer main lines shall be designed with 0.8 full flow.

#### **7.7.1 EXCAVATION**

The excavation shall be done for the drop connection at the place where the branch line meets the manhole the excavation shall be carried up to the bed concrete of the manhole and to the full width of the branch line.

#### **7.7.2 MEASUREMENTS**

Drop connection shall be enumerated. The depths beyond 60 cm shall be measured in running metres correct to a cm under relevant items.

### **7.7.3 TESTING**

The interior of manholes shall be cleared of all debris after construction and before testing the same for water tightness by Contractor.

Water for testing of manholes along with pipeline shall be arranged by Contractor at his own cost.

### **7.7.4 R.C.C PRE CAST M.H.F.C.**

Manufacture, supply delivery at site of work and fixing on top of manhole precast RCC Frame & cover suitable to drainage M.H. and including cost of reinforcement M.S. Angles or Flat, curing, mold work etc.

### **7.7.5 GENERAL SPECIFICATION**

R.C.C Precast manhole frame & cover shall be manufacture as per standard type design. Frame shall confirm to IS: 12592 part – II – 1991. Cover shall confirm to IS : 12592 part – I – 1988.

### **7.7.6 MATERIAL**

Sand, cement, water, aggregates and reinforcement steel shall confirm to relevant I.S. specifications. Thickness of frame shall be 10 cm. Necessary reinforcement, M.S. angle or flat shall be placed as per design during the concreting work fabrication of R.C.C. M.H.F.C shall be carried out by mechanically vibrating process.

### **7.7.7 INSPECTION :**

Inspection of materials will be carried out at work site by the Engineer who shall carry out inspection as soon as material is brought on work site. Inspection will be carried out normally within one week time. The supplier has to take care of the following points.

The manufacturer has to go in for one line stenciling for identifying size and class for proper separation.

The unloaded material has to be stacked in manageable batches with adequate inspection space like spreading the pieces etc. to permit proper inspection.

### **7.7.8 TRANSIT RISK**

The contractor shall bring goods at his own risk or it should be covered against the transit risk at its own cost.

### **7.7.9 TEST CERTIFICATE**

The contractor shall always provide manufacturer's test certificate in accordance with every batch/lot of goods so manufactured and supplied.

The supplier shall also produce in addition to manufacturer's test certificate as mentioned in above, the inspection certificate issued by Engineer for the same purpose.

### **7.7.10 FIXING**

Precast R.C.C. frame shall be fixed on the top of manhole and properly embedded in cement concrete 1:1.5:3 in required quantity in such a way that the top of the cover when placed in position shall remain at the finished road level.

#### **7.7.11 MEASUREMENT**

The measurement shall be made on number basis subsequent to fixing the frame on top of manhole and placing the cover in the frame.

#### **7.7.12 MARKING**

Each manhole frame and cover shall have cast on them the following information.

- a) Manufacturer's name or trademark.
- b) Grade denoted by abbreviation such as HD, MD or LD.
- c) The word SWD or sewer to denote storm water drain or sewer respecting if desired.
- d) An identification name as required by purchaser.

**8.0 LIST OF APPROVED MAKES:**

Sr. No.	Item	Approved Make
1	SWR PVC PIPE & FITTINGS 6 KG CM <sup>2</sup> ; FITTINGS : 6 KG CM <sup>2</sup> ECO. DRAIN PIPE & FITTINGS	ASTRAL /ASHIRVAD/ SUPREME
2	GULLY TRAP	GIRCO / TIRUMALA / SONIA/ SUPREME/ ASTRAL
3	STONE WARE PIPES FOR INTERNAL UNDER GROUND	GIRCO / TIRUMALA / SONIA
4	RCC HUME PIPES	INDIAN HUME PIPE / PRANALI
5	C.I. PIPE & FITTINGS	NECO OR EQ.
6	PPR PIPES & PPR FITTINGS	SUREME/PRINCE/
7	M.S/G.I. PIPES FOR WATER SUPPLY	TATA / JINDAL/ SWASTIK
8	UPVC/CPVC PIPE & FITTINGS	ASTRAL /ASHIRVAD/ SUPREME
9	COMPOSITE PLUMBING PIPE & FITTINGS	KITEC OR EQ.
10	G.I. PIPES FITTINGS WATER	DRP-M / R-BRAND / ZOLOTO
11	GI TO GI JOINTS	CHAMPION / EQUIVALENT
12	SOLVENT CEMENT	SUPREME / KISSAN / FINOLEX
13	BALL VALVES	LEADER / ZOLOTO / AUDCO
14	WHEEL VALVES	LEADER / ZOLOTO/AUDCO
15	DCV / NRV	ZOLOTO/SPIREX/AUDCO
16	TAR	SHALIBIND / TIKIBOND-BS
17	SELF PRIMING SEWAGE PUMPS	HBD / GRUNDFOS
18	VALVES	AUDCO/ZOLOTO / R.B. / KBL / KSB
19	PUMPS	GRUNDFOS/ITT- LOWARA/
20	STARTER	SIEMENS / L&T
21	PRESSURE GAUGE	BELLS / H GURU
22	BOTTLE TRAP & WASTE	JAQUAR /
23	DEWATERING PUMPS	GRUNDFOS/ITT- LOWARA/
24	HYDROPNEUMATIC SYSTEM	GRUNDFOS/ITT- LOWARA/
25	SANITARY FIXTURES	HINDWARE / PARRYWARE / CERA /KHOLAR/ JAQUAR

26	EOT CRANE WITH HOIST	INDEF / ELECTROMECH / SAFEX / WH- BRADY / EQUIVALENT
27	METALLIC BELLOWS	BELLOW FLEX / PRICISION / DHRUV /

Sr. No.	Item	Approved Make
		B.D. ENGR.
28	R.O.PLANT	ION EXCHANGE /POWER H20 /
29	SOFTENER PLANT	ION EXCHANGE /POWER H20 /
30	SOLAR SYSTEM	BENCHMARK/SOAHEART/SUNTEC/TATA- BP
31	ELECTRIC GEYSER	A-O SMITH/ RECOLD/SPHERHOT
32	HOT WATER HEAT PUMP SYSTEM	A-O SMITH/BENCHMARK/SOLAHERT/SUN
33	SEWAGE TREATMENT PLANT	ENVISOL/SINTEX/THERMAX / ION EXCAHNGE /

- NOTE : (1) Equivalent makes shall be approved by PMC before procurement  
 (2) Make & Model No. of Sanitary & Bath Fixtures will be finalized by the Architect/Client.



## EXTENT OF WORK

The scope of work for the total package of new Fire hydrant system as described in the tender and includes the detail engineering, supply of all material at site, construction / fabrication, installation, inspection, testing and commissioning in accordance with the drawing, specification and data sheet enclosed herewith to meet the guideline of NBC. / CFO/ CPWD.

The scope of works mainly involves as described below, but not limited to the following:

- a) Design supply erection and commissioning of New fire hydrant & sprinkler system
- b) Design, engineering, supplying of all material related to new fire fighting system, construction, fabrication, erection, testing, commissioning entire system
- c) External yard hydrant valves with hydrant post & hose box
- d) Fire pump room
- e) Four way & two way fire brigade inlet
- f) Internal fire escape hydrant valves, hose box, branch pipe, hose reel near staircase landing
- g) Supply and installation of RCC pipe supports for above ground piping
- h) Excavation & backfilling for underground pipe at road crossing
- i) Supply and installation of RCC pipe for Road crossing (NP-2 class)
- j) Portable fire extinguishers and fire buckets shall be ISI marked
- k) Approval of entire fire hydrant & sprinkler system from any agency nominated by Insurance company
- l) Training of Clients personnel in operation and maintenance of fire extinguishers, fire protection system (hydrant) including mock drill
- m) Quantity can varying, EMPLOYER has right to Change/Delete any Tender for Fire Fighting System
- n) Any other civil work and structural work required/directed by EMPLOYER/ Consultant Civil work like making / opening in wall/ceiling and regularization the same shall be done by contractor
- o) Any other work required for the functional and operation completion of the work but not specifically mentioned in the scope of work shall be in contractor's scope of work and shall be carried out as per instruction of EMPLOYER / Consultant.
- p) Quantity can varying, EMPLOYER has right to Change/Delete any Tender for Fire Fighting System
- q) Quantity / specified in the Tender
- r) Any other civil work and structural work required/directed by EMPLOYER/ Consultant Civil work like making opening in wall/ceiling and regularisation the same shall be done by contractor;
- s) Any other required for the functional and operation completion of the work but not specifically mentioned in the scope of work shall be in contractor's scope of work and shall be carried out as per instruction of EMPLOYER / Consultant.
- t) Any extra item shall be calculated on the rate analysis basis approved by EMPLOYER

### 5.0 INTERPRETATION OF PROJECT DOCUMENTS:

5.1 The Specification, Drawings, and Bill of quantity shall be interpreted in accordance with good installation practice defined in the appropriate regulations and standards whether specifically referred to or not. If there is any discrepancy or shortfall in the application of the regulations to any aspect of this contract or the contractor considers there is anything detrimental to the standards or inconsistent with his obligations and guarantees, EMPLOYER shall be informed prior to signing the contract and shall thereafter inform the contractor in writing the course to be followed. Where the drawings are to a small scale or are expressed in symbolic terms or are in the form of a diagram, then exact location of items shall not be inferred and in all cases, the work shall be fully integrated with the work of other trades and with the fabric of the building. The contractor shall appraise the duties of all plants and equipment's taking

account of any additions or variations and shall inform the EMPLOYER of any matters which may affect the design. In all cases the equipment installed shall be of appropriate rating for the duty it performs.

5.2 The Specifications and Bill of quantity shall be considered as part of this contract and any work or material shown on BOQ and not called for in the specification or vice versa, shall be executed as if specifically called for in both. The Drawings indicate the extent and general arrangement of the FIRE

FIGHTING (PROTECTION) Equipment Layout etc. and are essentially diagrammatic.

The work shall be installed as indicated on the drawings, however, any minor changes found essential to coordinate the installations of this work with other services shall be made without any additional cost to the EMPLOYER. The drawings are for the guidance of the contractor, exact locations, distances and levels will be governed by the building. The contractor shall examine all structural and fire fighting (protection) drawings before starting the

work, and report to EMPLOYER or its representative, any discrepancies which in his opinion appear on them, and get them clarified.

#### **6.1 FIRE FIGHTING (PROTECTION) System Comprises of :**

6.1.1 SITC of Fire Pumps at ground level & booster pumps on terrace

6.1.2 SITC of fire hydrant system including wet riser/down comers, hose, hose box/cabinet, internal hydrant valves, hose reels, yard hydrant, stand post, etc.

6.1.3 SITC of automatic sprinkler system for Fire Station consisting of sprinkler riser, drain down take, isolation control valve, sprinkler alarm valve, flow switch, test & drain assembly, upright/pendent sprinklers

6.1.4 SITC of Fire panel with starter, power & control cable, earthing, etc.

6.1.5 SITC of Instruments like Pressure Gauge, Pressure Switch, Level switch etc.

6.1.6 SITC of fire brigade inlets

6.1.7 SITC of Fire extinguishers

6.3 All qualities mentioned in the Bill of quantity are approximate and the contractor shall not be eligible for any claim due to any variation in / or omission of any item. 6.4 Any extra item shall be calculated on the rate analysis basis approved by EMPLOYER.

6.5 **Liaisoning work for** /pre NOC,/ NOC /Approval/certificates required from local CFO as well as any other competent authority shall be done by the Contractor, at no extra cost. Any applicable statutory fees paid by contractor regarding the same shall be reimbursed against receipt produced for the same.

**Note :** The over all FIRE FIGHTING (PROTECTION) System shall be designed, supplied, executed and commissioned within **6 months** time. The contractor shall have to plan the whole activity in line with Construction schedule.

#### **7.0 ABBREVIATIONS:**

The following abbreviations have been used in the accompanying specifications, drawings and Bill of quantity:

<b>SR NO</b>	<b>ABBREVIATION</b>	<b>MEANING</b>
1	LV	Landing Valve
2	SV	Sluice / Stop Valve
3	NRV	Non Return Valve
4	HR	Hose Reel
5	HB	Hose Box
6	BHR	Basement Hose Reel
7	BHB	Basement Hose Box
8	ARV	Air Release Valve
9	BM	Bell Mouth
10	ST	Strainer
11	BLV	Basement Landing Valve
12	HPS Hydrant	Pressure Switch
13	SPS Sprinkler	Pressure Switch
14	FHR	Fire Hydrant Riser
15	FSR	Fire Sprinkler Riser
16	AV	Air Vessel
17	FIRE FIGHTING(PROTECTION)	Fire Hydrant & sprinkler System

#### **8.0 REGULATIONS AND STANDARDS:**

The design shall follow guidelines appearing in the following Indian Standards:

##### **SR. NO./ IS NO. /TITLE**

1	1239 / 3589 G.I. Pipe / M.S. pipe
2	14846 Sluice valve
3	BS 5155/ IS 13095 Butterfly valves
4	API 594/598 Non Return Valves
5	5290 Fire Hydrants
6	884 Fire Hose Reel

- 7 903 Fire Hose, couplings, branch pipe, nozzles
- 8 636 RRL Hose
- 9 778 Gun Metal valves
- 10 5132 Rubber Hose Pipe
- 11 8423 C. P. Hose
- 12 6595 / 12469 Pumps
- 13 325 Motors
- 14 884 Fire Hose Reel
- 15 10001 / 10002 Diesel Engine
- 16 934 / 2878 Fire Extinguishers
- 17 13095 / BS 5155 Fire Extinguishers
- 18 10221 Coating / wrapping of underground M.S. pipe

Codes for FIRE FIGHTING (PROTECTION) Pumps, Motors, Cabling, wiring and accessories as per relevant Indian / International codes and standards.

#### **9.0 FEES, PERMITS AND TESTS:**

The Contractor shall pay for any and all fees and obtain permits required for the installation work. On completion of the work the contractor shall obtain and deliver to the Employer, certificates of final inspection and approval by the local fire authority and the chief fire officer.

#### **10.0 UTILITY SUPPLY:**

The location of receipt of incoming utilities supply (Hook up Points) like LT power supply, It is the responsibility of the contractor to co-ordinate with various utility agencies, the exact location of such Hook up Point and mode of connection. Further the contractor shall co-ordinate with such utility agencies to provide necessary drawings, documents, get their approval, make the necessary arrangement for the payments and arrange the utilities supply at no extra cost.

#### **11.0 ACTUAL ROUTE OF PIPING:**

The location of the sprinkler & piping etc. is only indicative, therefore, the actual route of piping and the location of the same may differ from the plans according to the details of the building construction and the conditions of executions of the installation.

The contractor shall supply and install at his expense all secondary materials and special fittings found necessary to overcome the interference and to supply the modifications on the route of ref. piping that are found necessary during the work, to the complete satisfaction of the EMPLOYER's representative.

#### **12.0 MATERIAL AND EQUIPMENT:**

All material and equipment shall conform to the relevant standards and shall be of the approved make and design. The materials and equipment shall conform to relevant Indian Standards. The Contractor shall be responsible for the safe custody of all the materials and shall insure them against theft, damage by fire, earthquake etc. A list of items of materials and equipment, together with sample of each shall be submitted to the EMPLOYER within 10 days of the award of the contract. Any item which is proposed as a substitute, shall be accompanied by all technical detail giving sizes, particulars of materials and the manufacturer's name and shall be submitted along with the tender or bid offer. At the time of the submission of proposed substitute the Contractor shall state the credit, if any due to the EMPLOYER. In the event the substitution is approved, all changes and substitutions shall be requested in writing and approvals obtained in writing from EMPLOYER. EMPLOYER's decision in the matter shall be final. All materials of the same kind of service shall be identical and made by the same manufacturers. Any deviation to this rule shall be approved by the Consultant. Top priority shall be given to the products that have a permanent agent providing spare parts and maintenance facilities in the same city where the project is situated.

Make of fire fighting (protection) equipments, components, accessories, etc. has been mentioned in order of priorities. The tenderer has to quote for the first priority as mentioned above after ascertaining that the first preference materials are available. If at a later stage during executing the work, material of the first preference make are not available, the contractor has to get approval from the EMPLOYER to use

other make of material prior to procurement. Any rate difference for the first preference make and the one approved will be passed on to the EMPLOYER.

### **13.0 MANUFACTURERS :**

Where manufacturers have furnished specific instructions relating to the materials used in this job, covering points not specifically mentioned in these documents, these instructions shall be followed in all cases.

Where manufacturer's names and/or catalogue numbers are given, this is an indication of the quality, standards and performance required. When interfacing occurs, equipment shall be mutually compatible in all respects.

### **14.1 RATING:**

Rating of all items shall be appropriate for the conditions on the particular site on which the items will be used. All the equipment shall be fit for continuous work under the worst conditions of site and shall be rated for the following ambient condition.

- Outdoor temperature 45 deg. cel.
- Temperature under shed 40 deg. cel.
- Salty, dusty and humid

### **15.0 INSPECTION AND TESTING:**

EMPLOYER'S representative reserves the right to request inspection and testing at manufacturer's works at all reasonable times during manufacture of items for this contract. Tests on site of completed works shall demonstrate, among other things:

15.1 That the equipment installed complies with specification in all particulars and is of the correct rating for the duty and site conditions.

15.2 That all items operate efficiently and quietly to meet the specified requirements.

15.3 That all the features performed at its best and loading \_ unloading of the system.

15.4 That all the accessories used in low side work are of specified make only. And any deviation in the same needs written approval from our technical consultant.

The contractor shall provide all necessary instruments and labor for testing, shall make adequate records of test procedures and readings, shall repeat any tests requested by the EMPLOYER and shall provide test certificates signed by a properly authorized person. Such test certificates shall cover all works.

If tests fail to demonstrate the satisfactory nature of the installation or any part thereof then no claims for the extra cost of modifications, replacements or re testing will be considered. EMPLOYER's decision as to what constitutes a satisfactory test shall be final.

The above general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere.

### **17.0 TEST CERTIFICATES:**

The contractor shall submit test certificates for all the High side FIRE FIGHTING (PROTECTION) system installed. These shall be issued by Engineer In charge certifying that all equipment, materials, construction and functions are in agreement with the requirements of these specifications, ISI and when ISI is not applicable other approved certifying agencies.

### **18.0 INSTRUCTION MANUAL:**

The contractor shall prepare and produce instruction, operation and maintenance manuals in English for the use, operation and maintenance of the supplied equipment and installations, and submit 3 sets to EMPLOYER, at the time of handing over.

### **19.0 SAMPLES AND CATALOGUES:**

Before ordering the material necessary for these installations, the contractor shall submit to EMPLOYER for approval, a sample of every kind of material such as cable, Hose box, flow & pressure switches, sprinkler, etc. along with the catalogues.

For big items such as Pump, Motor, Isolation Valves, Hydrant valve, Hose, Hose reel, Pump panel, etc. the submission of data sheet, drawings & catalogues shall be enough. Prior to ordering any equipment/material/system, the contractor shall submit to EMPLOYER, the catalogues, along with

the samples if asked by Consultant/EMPLOYER. After the selection of manufacturer by Consultant/EMPLOYER, the contractor shall arrange to submit manufacturer's detailed data sheet, drawing, installation drawing, curves, catalogues, etc.. If required, the inspection and testing of the material will be carried out at the manufacturer's factory or assembly shop for final approval. No material shall be procured prior to the approval of the EMPLOYER. With the delivery of material, the contractor shall submit all necessary documents, catalogues, drawings, installation & O&M manual in required copies.

## **20.0 VENDOR AND SHOP DRAWINGS:**

The contractor shall prepare and submit to EMPLOYER, for his approval, Six sets of vendor detailed drawings of FIRE FIGHTING (PROTECTION) Plant Room Equipments, Hydrant Piping Route Proposed, Detail sprinkler drawing with pipe routing & sprinkler location and hose box to be fabricated by the contractor, or other vendor shall be submitted within 10 days of signing of the contract. Before starting the work, the contractor shall submit to EMPLOYER for his approval in the prescribed manner, the shop/execution drawings for the entire installation, specially the main connections and junctions, the route of piping & sprinkler location, location of hydrants, hose box and any other information required by EMPLOYER. EMPLOYER reserves the right to alter or modify these drawings if they are found to be insufficient or not complying with the established technical standards or if they do not offer the most satisfactory performance or accessibility for maintenance.

### **21.0 AS BUILT DRAWINGS**

At the completion of work and before issuance of certificate of virtual completion the contractor shall submit to EMPLOYER, three sets of layout drawing drawn at appropriate scale indicating the complete wiring system "as installed". These drawings must provide (in plan, folded elevation and section)

21.1 Location and specification details of all FIRE FIGHTING (PROTECTION) Pumps & related other accessories, Fire Panel

21.2 Location of all yard hydrant / landing hydrant, hose box, hose reel, isolation valves for all floors.

21.3 Route and particulars of Yard Hydrant Piping,

21.4 Route & particulars of Wet risers / Downcomers.

21.5 Route & particulars about sprinkler piping, sprinkler location, location of isolation valve, flow switch, test & drain assembly for all floors

21.6 Location of Fire extinguishers

21.7 GA Drawing of all major FIRE FIGHTING (PROTECTION) Equipment like pump & panel

## **23.0 SAFETY OF MATERIALS:**

The contractor shall provide proper and adequate, storage facilities to protect all the materials and equipment including those issued by EMPLOYER against damage from any cause whatsoever.

### **24.0 COMPLETION CERTIFICATE:**

On completion of the FIRE FIGHTING (PROTECTION) SITC (or an extension to an installation) a certificate shall be furnished by the contractor countersigned by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local supply authority. The contractor shall be responsible for getting the fire fighting (protection) installation inspected and approved by the CFO of local concerned authorities.

## **TECHNICAL SPECIFICATION FOR FIRE FIGHTING SYSTEM**

### **1.0 SCOPE OF WORK**

The scope includes fire protection system only. The detection system is covered under separate tender

#### **1.1 Fire Hydrant system**

## 1.2 Fire Extinguishers

The detailed scope is described in the chapter “Extent of Work. “

## 2.1 FIRE EXTINGUISHERS

### 2.2 GENERAL:

The scope of work under this part of the specification covers supply and installation of internal appliances as per requirements specified in schedule & marked on drawings and instructions of enG.I./M.S.neer-in- charge.

Makes of all the appliances supplied and installed shall be as per the ‘List of Approved Make ‘ or as approved by LFA and shall be of identical design for the entire premises.

Mounting accessories, indicator boards etc are part of the scope of supply of internal appliances.

### 2.3 SPECIFICATIONS:

Internal appliances with various fire extinguishing medium shall conform to the following specifications and shall be installed and maintained as per IS: 2190 / NFPA 10

IS: 2878 / IS:15683 Fire extinguisher, portable CO2

IS: 2171/ IS:15683 Fire extinguisher, portable, dry powder

type. IS: 13849/ IS:15683 Fire extinguishers, ABC stored pressure type

Portable Extinguishers of the following types shall be installed.

1. Dry chemical Powder type
2. Co2 type
3. Water type

#### 2.2.1 DRY CHEMICAL POWDER TYPE:

The Dry chemical powder type shall be of 5 Kg. Capacity and shall have the IS mark 2171/ IS:15683 complete with powder and charged including with fixing bracket, fitted with gunmetal cap, and discharge hose and open grip nozzle.

#### 2.2.2 CO2 TYPE:

The Co2 Extinguisher shall be ISI mark, with initial charge with high pressure cylinder, complete with wheel type valve, internal discharge tube, with high pressure discharge hose with horn and suspension brackets. The extinguisher shall have ISI mark of 2878/ IS:15683 and capacity shall be 4.5 Kgs.

#### 2.2.3 WATER TYPE :

The water type shall be of 9 ltr. Capacity and shall have the IS mark including with fixing bracket, fitted with all accessories.

## 3.1 PIPE WORK

### 3.2 GENERAL REQUIREMENTS:

- 3.2.1 All the materials shall be of CPWD./NBC/NFPA/CFO./NBC/NFPA/CFO./LFA approved, best quality conforming to the specifications and subject to the approval of the Client or his representative. If so directed, materials shall be tested in an approved testing laboratory & the contractor shall produce the test certificate in oriG.I./M.S.nal to the EnG.I./M.S.neer-in-charge & the entire charges for oriG.I./M.S.nal as well as repeated tests shall be borne by the Contractor.
- 3.2.2 Before welding, the pipe faces shall be cleared & then shall be welded conforming to IS : 9595 – 1996. The electrodes used for welding shall comply with IS: 814. the laying of welded pipe shall also comply to IS 5822 – 1994. The welding joints shall be tested in accordance to IS:3600, Part 1973.
- 3.2.3 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.
- 3.2.4 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- 3.2.5 Pipes shall be securely fixed to walls, and ceilings by suitable clamps or supported at every 3 mtr. & at change of direction as required. Only approved type of anchor fastners shall be used for RCC ceiling and walls.
- 3.2.6 Valve and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

### 3.3 PIPING

Pipes of the following types are to be used:

- 3.3.1 G.I./M.S.pipes as per IS : 1239, heavy duty (for pipes of sizes 150 mm N.B. and below) suitably lagged on the outside to prevent soil corrosion. M.S. pipes buried below ground shall be lagged as per IS: 10211.
- 3.3.2 G.I./M.S. pipe lines upto 150 mm dia. shall have all fittings as per IS:1239, Part-II (heavy grade) while pipelines above 150 mm dia shall be fabricated from IS:3589 Gr.320 pipes as applicable or from steel plates.
- 3.3.3 For G.I./M.S. pipelines upto 50 mm dia tapered threaded jointing shall be adopted, while for pipelines above 50 mm dia welded or flanged construction is to be carried out or as specified in Schedule of quantities.
- 3.3.4 Hangers and supports shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. All guides, anchor, braces, dampener, expansion joint and structural steel to be atCPWD./NBC/NFPA/CFO./NBC/NFPA/CFO.hed to the building structure trenches etc. shall be provided. Hangers and components for all piping shall be approved by the Consultant / Client / Architect.
- 3.3.5 The piping system shall be capable of withstanding 150% of the working pressure including water



hammer effects.

- 3.3.6 Flanged joints shall be used for connections to vessels, equipment, flanged valves and also on suitable straight lengths of pipeline of suitable points (@ at every 15-20 mtr.) to facilitate erection and subsequent maintenance work.
- 3.3.7 Excavation for pipe line shall be in open trenches. Pipes shall be buried atleast one meter below ground level and shall have 230 mm x 230 mm masonry supports atleast 300mm high at 3m intervals. Masonry work to have plain cement concrete foundation (1 cement : 4 coarse sand : 8 stone aggregate) of size 380 x 380 x 75 thick resting on firm soil.
- 3.3.8 Wherever required Contractor shall support all trenches or adjoining structures with adequate supports to prevent land slides.
- 3.3.9 On completion of testing and painting trenches shall be refilled with excavated earth in 15 cm layers and compacted.
- 3.3.10 Contractor shall dispose off all surplus earth within the site.
- 3.3.11 Contractor shall provide suitable cement concrete anchor blocks for overcoming pressure thrusts in underground / external pipes. Anchor blocks shall be of cement concrete 1:2:4 mix.

#### **4.0 VALVES**

- 4.1 Valves shall be used to start, stop or control flow. Non-return valves shall be provided unidirectional flow.
- 4.2 Butterfly valve conforming to BS 5155 or as indicated in BOQ will be used for isolation of flow in pipelines. Optionally, gate valves having outside screw rising spindle shall be used and shall be as per IS: 780 / 14846 PN 1.0/1.6, as applicable. For sizes 50mm to 200mm, Butterfly valve shall be as per IS: PN = 1.6 or as specified in Schedule of quantities. Non-return valves shall be swing check/spring operated type. An arrow mark in the direction of flow shall be marked on the body of the valve. These valves shall conform to IS:5312 for swing type or API 596/598 for spring type check valves

Valves below 50 mm size shall have screwed ends while those of 50 mm and higher sizes shall have flanged connections. Drain lines will have locks for draining.

#### **5.0 INTERNAL HYDRANT:**

Internal hydrant shall be provided at each landing or at suitable location consisting of single / twin headed gunmetal landing valve as indicated in BOQ with 63 mm dia oblique female instantaneous pattern with caps & chains. Outlet and 80 mm inlet (IS:5290-1993) with separate shut off valve. Landing valves shall be 63 mm dia. oblique female instantaneous pattern with caps and chains. Landing valves shall be of gunmetal and fitted with instantaneous coupling conforming to IS:901. The valve body, stop valve, check valve, nut, instantaneous female outlet and blank cap shall be of leaded-tin bronze conforming to Grade-II of IS: 318-1981. The valve spindle shall be of brass rod conforming IS:320 - 1962. The hand wheel shall be mild steel or cast iron washers gaskets shall be of rubber conforming to IS:638 - 1965 or leather conforming to IS:581 : 1969. The coupling shall be fitted with an internal plug secured by chain landing valves shall be installed on hydrant riser at a height of 1.0 to 1.2 meter from the floor level.

Each internal hydrant shall be provided with two nos. 63 mm. Diameter 15 mtr. Long hose pipe with gunmetal male and female instantaneous type coupling, machined wound with G.I./M.S.wire hose of IS 636 type A and couplings to IS:903 with IS certification, gunmetal branch pipe

with 16 mm nozzle conforming to IS:903.

## **6.0 HOSES**

Hoses pipes shall be of fabric reinforced rubber lines as per IS:636 Type II or canvas hose as per IS:4927, with nominal size of 63 mm and lengths of 15 meter, as per quantities specified for in schedule or bill of quantity.

All hose pipes shall carry ISI marking on the body of the hose.

The hose shall have instantaneous spring lock-type coupling on ends. The instantaneous coupling shall be as per IS:901. It shall be fixed to each other by copper rivets and galvanised M.S. wires and leather bands. All coupling shall be interchangeable with each other, and shall bear ISI markings.

## **7.0 HOSE CABINETS ( HOSE BOX )**

Each hydrant shall be housed in a Hose cabinet of suitable size. The hydrant cabinet shall hold double / single headed hydrant as specified , 2 hoses and one branch pipe as required. Internal hydrants shall normally fit the size of the niche made for it. The cabinet shall be of minimum 16 SWG M.S. sheet with centre opening, double glass front doors (cleat glass of 4mm thickness). The glass shall be firmly fixed by means of steel clips and screw with rubber beading. Hinges shall also be screwed and not welded. The corner members (frame) shall be of 25 x 25 x 3 mm thick angle. The hose box shall be firmly fixed to the wall/support by means of brackets and dash fasteners. The steel work shall have one coat of primer and two

coats of red paint. The words “Yard Hydrant”, “Hydrant” etc. should be painted in white or red on the glass in 75 mm high letters. The hose box shall be lockable for internal hydrant installation..

## **8.0 HOSE REEL**

The hose reel shall be directly tapped from the riser through a 25 / 32 mm dia pipe, the drum and the reel being firmly held against the wall by use of dash fasteners.

The Contractor shall provide standard fire hose reels with 20 mm diameter high pressure rubber hose of 36.5 meter length with gunmetal nozzle with 5mm bore, and control valve, shut of nozzle connected wall mounted on circular hose reel of heavy duty mild steel construction and cast iron brackets. Hose reel shall conform to IS: 884-1969. The hose reel shall be connected directly to the M.S pipe riser through an independent connection.

## **9.0 BRANCH PIPES**

Branch pipe shall be of either gun metal or aluminium and should conform to IS:903. One end of the branch pipe will receive the coupling while the other end shall have a nozzle screwed to it. It shall bear ISI marking.

## **10.0 YARD / EXTERNAL HYDRANT**

Yard or External Hydrants shall be as per IS:908-1975 and the valve as per IS:5290-1993. The hydrant shall consist of stand post assembly and a masonry base 200 mm X 200 mm X 200 mm high and shall be made at the point where it comes out of the soil. The valve shall complete with hand wheel, quick coupling connection spring and blank cap. The hydrant shall be laid on 150 dia. or as mentioned in BOQ.

Yard or External hydrant shall be controlled by a cast iron sluice valve. Hydrant shall have oblique female instantaneous pattern 63 mm diameter outlet with caps and chains. The hydrant shall be of gunmetal and flange inlet and single outlet conforming to IS:5290-1993, a duck foot bend and flanged riser of required height to bring the hydrant to level above ground. The valve body, stop valve, check valve, nut, instantaneous female outlet and blank cap shall be of leaded-tin bronze conforming to Grade-II of IS:318- 1981. The valve spindle shall be of brass rod conforming IS:320 - 1980. The hand wheel shall be mild steel or cast iron washers gaskets shall be of rubber conforming to IS:638 - 1979 or leather conforming to IS:581 : 1976.

Each external hydrant shall be provided with two nos. 63 mm. Diameter 15 mtr. Long hose pipe with gunmetal male and female instantaneous type coupling, machined wound with G.I./M.S.wire hose of IS 636-1988 type A and couplings to IS:903 with IS certification, gunmetal branch pipe with 20 mm nozzle conforming to IS:903-1993.

#### **11.0 VALVE CHAMBERS**

A valve chamber shall be brick masonry chamber in cement mortar 1:5 (1 cement : 5 coarse sand) on cement concrete foundation 150 mm thick foundation 1:5:10 mix (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size), 15 mm thick cement plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back filling, complete. The wall shall be 230 mm thick with heavy duty ISI marked C.I. manhole covers.

#### **12.0 ORIFICE FLANGE**

Provide orifice flanges fabricated from 6 mm thick stainless steel plate to reduce pressure on individual hydrants to restrict the operating pressure to 3.5 kg/sqmt. The design of the orifice flanges shall be G.I./M.S.ven by the Contractor as per the location and pressure conditions of each hydrant/hose reel.

#### **13.0 FIRE BRIGADE INLET CONNECTION**

A fire brigade inlet connection with a non-return valve shall be provided to facilitate the fire brigade to pump water into the installation by the use of their own equipment. Four way or 150 mm dia connection to the system shall comprise of four instantaneous pattern 63 mm dia. male inlets shall be with caps and chains complete with 150 mm dia. sluice valves, non-return valve housed in a M.S. cabinet with glass fronted door. The cabinet shall be suitable for recess mounting.

Two way or 100 mm fire brigade inlet connection to the system shall comprise of two instantaneous pattern 63 mm dia. male inlets shall be with caps and chains complete with 100 mm dia sluice valve, non-return valve housed in a M.S. cabinet with glass fronted door. The cabinet shall be suitable for recess mounting.

#### **14.0 SYSTEM DRAINAGE**

The systems shall be provided with suitable drainage arrangements with G.I./MS piping of 50 mm dia. complete with all accessories, and provided with drain valve.

Air valves

Provide 25 mm i/d. screwed inlet single acting brass air valve on all high points in the system on top of air cushion tanks.

## **15.0 HYDRANT SYSTEM**

- 15.1 The hydrant system shall comprise of AC motor driven pump sets. Diesel pump, Jockey pump etc. with all required accessories including valves, appurtenances, instrumentation and controls etc. complete in all respects. The system shall cover the entire area from independent pipe work from the fire water pump set. The hydrant work shall remain pressurized through the proposed Jockey pump taking care of any leakages in the system pipelines and valve glands. All pumps / motors / enG.I./M.S.nes to be of makes approved by local Fire Authority.
- 15.2 The hydrant system shall be kept charged by pressurized water at approximately 7.5 Kg/cm<sup>2</sup> at all times. In the event of fire when any of the hydrant valves in the net work is opened, the resultant fall in header pressure should enable starting the Electric Motor driven fire water pumping set through pressure switches automatically. One Diesel EnG.I./M.S.ne / DG set driven pump shall be a stand-by pump serving hydrant system & sprinkler both. In case of failure of electricity or failure of Elec. Pump to start on demand, the stand-by DG set operated pump shall automatically take over. Apart from the automatic starting of the pump sets, provision shall be kept for manual starting also. However shifting down of the pump sets shall be manual.
- 15.3 The hydrant system in the yard shall be furnished with external hydrants consisting of landing valves (positioned approx. one meter above ground level) fitted G.I./M.S.(Heavy Duty) flanged single headed stand pipes installed on underground hydrant headers distributed 45 M apart approximately or as marked on the plan.

The entire system including all pumps, motors, diesel pump set and panels shall be of approved make by CPWD./NBC/NFPA/CFO./NBC/NFPA/CFO. / Local Fire Authority.

## **16.1 SPECIFICATION FOR PUMPS AND ANCILLARY EQUIPMENT**

### **16.2 SCOPE OF WORK**

- 16.2.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install electrically operated pumps for fire hydrant installations as required by the drawings and specified hereinafter or G.I./M.S.ven in the schedule of quantities.
- 16.2.2 Without restricting to generality of the foregoing the pumps and the ancillary equipment and shall include the following:
- a) Electrically operated pumps with motors base plate and accessories.
  - b) Pump suction and delivery headers, valves, air vessel and connections.
  - c) Pressure gauges / pressure switch.
  - d) Only single point 3 phase supply will be made available to the Contractor. From there, all provision viz. Electrical switchboard, wiring, cabling, cable tray, control panel, earthing, etc. shall be made.

### 16.1.3 GENERAL REQUIREMENT

- a) Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in concrete foundations.
- b) Pumps and motors shall be truly aligned with suitable instruments.
- c) All pump connections shall be standard flanged type with appropriate number of bolts.
- d) Manufacturer instructions regarding installation connections and commissioning shall be followed with respect to all pumps, switchgear and accessories.

### 16.1.4 FIRE AND JOCKEY PUMPS

- a) The main Fire hydrant & Sprinkler pumps shall be End Suction Back Pull Out / Split Casing type while Jockey pumps shall be of Centrifugal Monoblock Pump type having following specifications.
- b) Shut off head should not exceed 120% of rated head. Pump shall not develop less than 65% of rated head at 150% of rated capacity.

#### MATERIALS OF CONSTRUCTION

Part	Material
Casing	Cast Iron
Impeller	Bronze IS:318, Gr. LTB 2
Casing Wearing	SS
Shaft	AISI – 410 / Stainless Steel
Shaft Sleeve	S.S. 316
Stuffing Box	Gland Packed

- c) Pumps shall be provided with pressure gauge with isolation cock on the delivery side.
- d) In case of motor driven pump the motor rating should be adequate to drive the motor rating should be adequate to drive the pump at 150% of rated discharge.
- e) The pump and its prime mover (Electric motor or Diesel EnG.I./M.S.ne) shall comply with all the equipment of the Rules of the Traffic Advisory Committee.
- f) All pumps shall have positive suction & shall be provided with suction strainer of SS & CI bell mouth. In case of negative suction suitable priming arrangement shall be provided.
- g) In first phase only, all pumps shall be installed. Pump head shall be considering ultimate phase.

#### A) JOCKEY PUMP

Starting and stopping of Jockey Pump set shall be automatic at predetermined levels through pressure switch. However, arrangements for manual start and stop of the pump shall also be made. Jockey Pump shall take care of small leakages in the piping system and pumps cushion tanks.

## **B) ELECTRIC DRIVEN**

Electrically driven pumps shall be provided with totally enclosed fan cooled, foot mounted, squirrel cage induction motors suitable for fire pumps with IP-55 enclosure.

The motors should be rated not to draw more than 4.5 times the starting current.

Motors shall be atleast equivalent to the horse power required to drive the pump at 150% of its rated discharge.

The motors shall be wound for class-F insulation and windings shall be vacuum impregnated with heat and moisture resisting varnish, glass fiber insulated.

## **C) DIESEL ENG.I./M.S.NE (OPTIONAL IF ASKED BY LOCAL FIRE AUTHORITY)**

- i. Diesel eng.I./M.S.ne shall have suitable no. of cylinders with individual heat assemblies. The eng.I./M.S.ne shall be water cooled and shall include heat exchanger and connecting piping strainer, isolating pressure reducing valves, bye-pass line, exhaust pipe, silencer, day tank for fuel all interconnected piping etc., complete in all respects.
- ii. Eng.I./M.S.ne shall be direct injection type with low noise and exhaust omission levels,
- iii. The speed of eng.I./M.S.ne shall match the pump speed for direct drive.
- iv. The eng.I./M.S.ne shall be capable of being started without the use of the wicks, cartridge heater plugs or either at eng.I./M.S.ne room temperature of 4°C and shall take full load within 15 seconds from the receipt of the signal to start.
- v. The eng.I./M.S.ne shall effectively operate at 46°C ambient temperature at 150 meter above mean sea level.
- vi. Eng.I./M.S.ne shall be suitable for running on high speed diesel oil.
- vii. The system shall be provided with a control panel with push button starting arrangement also wired to operate the eng.I./M.S.ne on differential pressure gauge.
- viii. The entire system shall be mounted on a common structural base plate with anti-vibration mounting, Dunlop make, and flexible connections on the suction and delivery piping.
- ix. Contractor provide one fully mounted and supported Day Oil Tank fabricated from 6mm thick MS sheet electrically welded for 8 hours working load and having suitable capacity of oil. Provide level indicators – low level and full level in the Day Oil Tank on the control panel through float switches and an breather. Day Oil Tank shall also be provided with filling connection (Threaded) with cap, gauge glass indication and cocks, drain cock, inspection / cleaning cover with gasket and nuts / bolts. MS dyke to hold 150% of the Day Tank capacity to be built around the Day Tank.
- x. Contractor to provide one exhaust pipe with suitable muffler (residential type) to discharge the eng.I./M.S.ne gasses to outside in open air as per site conditions (Contractor to check the site).

- xi. Contractor to provide all accessories, fittings and fixtures necessary and required for a complete operating enG.I./M.S.ne set. The exhaust pipe shall be taken outside the building with minimum number of bends (approx. length 30 Meters) and shall be duly heat insulated with 50mm thick glass wool covered with 24 gauge aluminum cladding.

- xii. Contractor shall indicate special requirements, if any, for the ventilation of the Pump Room.

Noise & Vibration level of the pump driven by motor/enG.I./M.S.ne shall be within the acceptable limits of ISO 2372, IS 11727.

#### **16.1.5 BOOSTER PUMP**

A booster pump shall be provided at terrace to pressurize the wet riser system. The pump shall be centrifugal end suction / monoblock type.

#### **16.1.6 BASE PLATE**

Pumps and motors shall be mounted on a common structural base plate with anti vibration pads and installed as per manufacturer's instructions.

#### **16.1.7 VIBRATION ELIMINATORS**

Provide on all suction and delivery lines double-flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure G.I./M.S.ve in the relevant heat. Length of the test connector shall be as per manufacturer details.

### **17.0 CUBICLE TYPE SWITCH BOARD/L.T. PANEL, CABLES & EARTHING**

#### **17.1 Switchboards**

Cubicle type switchboards and components shall conform to the requirements of the latest revision including amendments of the following codes and standards.

IS:8623 Specification for factory built assemblies of switchgear and control gear for voltage upto and including 1000V AC / 1200V DC.

IS:4237 General requirements for switch-gear and control-gear for voltage not exceeding 1000- V.

IS:2147 Degree of protection provided by enclosure for low voltage switch-gear and control-gear.

IS:1018 Switch-gear and control-gear selection/installation and maintenance.

IS:6005 Code of Practice for phosphating of iron and steel.

IS:13947-1993/ Air circuit breaker / moulded case circuit breaker.

IEC 947 – 1989

IS:1248 Direct acting indicating analogue electrical measuring instruments and testing accessories.

IS:2705 Current transformers for metering and protection with classification burden ad Part - I, insulation.  
II & III 1964

Provide and install one switch board cubicle of approved dust and vermin proof type fabricated from 16 gauge M.S. sheet and finished with synthetic enamel paint of approved shade and shall have plastic identification for different motors. The cubicle shall

comprise of the following:-

- (a) Aluminum bus bar of rated capacity in a separate chamber with two additional share chambers.
- (b) Incoming main isolation switch fuse unit of required capacity HRC fuses.
- (c) Isolation switch fuse unit of required capacity HRC fuses, one for each motor.
- (d) Fully automatic auto transformer starters with push buttons one for each motor.
- (e) Fully automatic “STAR DELTA” starters with push buttons for jockey pumps.
- (f) Single phasing prevention for suitable rating for each motor.
- (g) Panel type ampere meters, one for each motor.
- (h) Panel type volt meter on incoming main with rotary selector switch to read voltage between phase to neutral and phase to phase.
- (i) Three neon phase indicating lamps on incoming main.
- (j) Two rotary switches for manual/ auto operations of fire and sprinkler pumps.



- (k) All interconnecting colour coded wiring from incoming main to switch gear, meters and accessories within the switchboard panel.

All switchgears and accessories shall be of approved make such as SIEMENS, ENGLISH ELECTRIC, LARSEN AND TOUBRO or equivalent Switchboard cubicles shall be floor-mounted type.

## 17.2 Cables

The Contractor shall provide all power and control cables from the motor control centre to various motors and control devices.

Cables should conform to IS: 1554 and carry BIS certification mark. Wiring cables should conform to IS: 694.

All power and wiring cables shall be aluminum conductors PVC insulated armoured and PVC sheathed of 1.1 KW grade.

All control cables shall have stranded conductors. The cables shall be supplied in drums as far as possible and bear the manufacturer's identification mark.

All cable joints shall be made in an approved manner as per accepted practice.

## 17.3 Earthing

There shall be two independent earthing stations at least 3 meters away from the pump room.

The earthing shall consist of an earth tape connected to an independent plate made of C.I. having a conductivity of not less than 100% international standard.

All electrical apparatus, cable boxes and sheath/ armour clamps shall be connected to the main bar by means of branch earth connections of appropriate size. All joints in the main bar and branch bar shall have the lapping surface properly tinned to prevent oxidation.

The joints shall be revetted and sweated.

Earth plates shall be buried in a pit 1.2 x 1.2 meter a minimum depth of 3 meter below the ground. The connections between the main bars shall be made by means of three 10 mm brass studs and fixed at 100 mm centres. The pit shall filled with coke breeze, rock salt and loose soil. A.G.I.Pipe of 20mm i/d. with perforation on the periphery shall be placed vertically over the plate to reach ground level for watering.

A brick masonry manhole 30 x 30 x 30 cm. size shall be provided to surround the pipe for inspection. A bolted removable link connecting main bar outside the pit portion leading to the plate shall be accommodated in this manhole for testing.

## 18.0 AIR CUSHION TANK

Every wet riser shall be provided with an air cushion tank at its top most point. The air cushion tank shall be provided with an automatic air release cock, 20 mm dia. drain pipe, drain valve and shut off valve.

Provide one air vessel fabricated from 12 mm M.S. plate with dished ends & suitable supporting legs. Each air vessel shall be provided with a 100 mm diameter flanged connection from pump, one 25 mm diameter drain with valve, one gunmetal water level gauge and 25 mm sockets for pressure switches. The vessel shall be 450 mm diameter x 2000 mm

high and tested to 28 kg / sqcm pressure.

The fire pumps shall operate on drop of 1 kg / sqcm pressure in the mains. The pump operating sequence shall be arranged in a manner to start the pumps automatically but should be stopped by starter push buttons only.

## **19.0 PRESSURE GAUGE**

All pressure gauges shall be dial type with Borden tube element of SS 316. The dial size shall be of 150 mm diameter and scale division shall be in metric units marked clearly in black on a white dial. The range

of pressure gauge shall be 0-10 kg.sq.cm or as specified in BOQ. The pressure gauges shall be complete with isolation cock, siphon tubing, etc.

## **20.0 PRESSURE SWITCHES**

20.1 The pressure switch shall be industrial type single pole double throw electric pressure switch designed for starting or stopping of equipment when the pressure in the system drops or exceeds pre set limits. It shall comprise of a single pole change over switch, below element assembly and differential spindle.

20.2 All pressure switches shall have ¼" BSP (F) inlet connection and screwed cable entry for fixing cable gland. All control cabling shall be provided.

## **21.0 SPRINKLER HEADS**

Sprinkler heads shall be provided at approximate spacing so as to cover 12 sq.mtr. per sprinkler head in case of ordinary hazard & 17 sq.mtr. in case of light hazard. The spacing shall however be in uniformity with the drawings and properly coordinated with electrical fixtures, ventilation ducts and grilles and other services along the ceiling. Sprinkler heads shall be gunmetal quartz bulb type with a temperature rating of 68°C. Sprinkler heads shall be of upright conventional type with fusible link for operation for basement. Other than basements for upper floors, pendent sprinklers are to be installed. Sprinkler head shall be approved by the under writers Laboratories (U.L.) or Fire Officers Committee (FOC). The finish shall be as specified in bill of quantities.

Contractor shall install cabinet (fabricated from 16 Gauge M. S. sheets with lockable glass shutters. Shelves for keeping spare sprinklers and spanner at locations approved by the EnG.I./M.S.neer-in-Charge and G.I./M.S.ven in the schedule of quantities. The contractor shall also G.I./M.S.ve required tools for removing and fixing of different types of sprinkler free of cost as directed by EnG.I./M.S.neer-in- Charge.

## **22.1 SPRINKLER SYSTEM**

**(CPVC-FIRE PRO- PVC PIPING-IF REQ.) CPVC PIPES & FITTINGS: -**

The pipes and fittings chemically known as Chlorinated Poly Vinyl Chloride [CPVC] shall

be produced in Copper Tube Size [CTS] from ½” to 2” with two different standard dimensional ratios – SDR 11 and 13.5. The fittings shall be produced as per SDR 11. All the CPVC pipes and fittings in SDR 11 and SDR 13.5 shall be made from the identical CPVC compound having the same physical properties. Pipes and fitting shall be produced as per SDR 11 & shall meet the requirement of ASTM D 2846 whereas the pipes produced with SDR 13.5 shall meet the requirement derived from ASTM F 442, specific to CPVC in Iron Pipe Size[IPS] dimension, which also shall be applied to CPVC pipes in Copper Tube Size[CTS] dimension.

- **CUTTING AND JOINTING AND INSTALLATION OF CPVC PIPES & FITTINGS:**

- i. **CUTTING:**

In order to make a proper and neat joint, the pipe length shall be measured accurately and make a small mark. Ensure that the pipe and fittings are size compatible. It shall be easily cut with a wheel type plastic pipe cutter or hacksaw blade. Cutting tubing as squarely as possible shall provide optimal bonding area within a joint.

- ii. **DEBURRING / BEVELING:**

Burrs and filings shall prevent proper contact between tube and fitting during assembly and should be removed from the outside and inside of the pipe. A pocket knife or file shall be used for this purpose. A slight bevel on the end of the tubing shall ease the entry of the tubing into the fitting socket.

- iii. **FITTING PREPARATION:**

Using a clean, dry rag, wipe dirt and moisture from the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 to 2/3 of the way into the fitting socket.

- iv. **SOLVENT CEMENTS APPLICATION:**

Use only CPVC cement or an all – purpose cement conforming to ASTM D 2846 or joint failure may result. When making a joint, apply a heavy, even coat of cement to the pipe end. Use the same applicator without additional cement to apply a thin coat inside the fitting socket. Too much cement can cause clogged water ways.

- v. **ASSEMBLY:**

Immediately insert the tubing into the fitting socket, rotate the tube ¼ to ½ turn while inserting. This motion will ensure an even distribution of cement within the joint. Properly align the fittings. Hold the assembly for approximately 10 seconds, allowing the joint to set-up.

- vi. **SET AND CURE TIMES:**

Solvent cement set and cure times are a function of pipe size, temperature and relative humidity. Curing time is shorter for drier environments, smaller sizes and higher temperatures. It requires 10 to 20 minutes for perfect joint.

- i. **CEMENTING:**

- Verify the cement is the same as the pipes and fittings being used.
- Check the temperature where the cementing will take place.
  - Cement takes longer time to set up in cold weather. Be sure to allow extra time for curing. Do not try to speed up the cure by artificial means – this could cause porosity and blisters in the cement film.
  - Solvents evaporate faster in warm weather. Work quickly to avoid the cement setting

up before the joint is assembled. Keep the cement as cool as possible. Try to stay out of direct sunlight.

- Keep the lid on cements, cleaner and primers when not in use. Evaporation of the solvent will affect the cement.
- Stir or shake cement before using.
- Use  $\frac{3}{4}$ " dauber on small diameter pipes, 1  $\frac{1}{2}$ " dauber up through 3" pipe, and a natural bristle brush, swab or roller  $\frac{1}{2}$  the pipe diameter on pipes 4" and up.
- Do not mix cleaner or primer with cement.
- Do not use thickened or lumpy cement. It should be like the consistency of syrup or honey.
- Do not handle joints immediately after assembly.
- Do not allow dauber to dry out.
- Maximum temperature allowable for CPVC pipe is 180o F.
- All colored cements, primers and cleaners will have a permanent stain. There is no known cleaning agent.
- Use according to the step outline in ASTM D – 2846, joining of pipe and fittings.

## • TESTING

After laying and jointing, the pipes and fittings shall be inspected under working condition of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost. Use of any compound or stop leak compound will not permit.

The pipes and fittings after they are laid shall be tested to hydraulic pressure of 1.5 times the working pressure or 7.5 Kg/Sq.cm whichever is more. The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw of taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped; the test pressure should be maintained without loss for at least two hours. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing.

## • MEASUREMENTS

The length above ground shall be measured in running meter correct to a cm for the finished work, which shall include G.I./M.S.pipe and G.I./M.S.fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, unions etc... Deductions for length of valves shall be made. Rate quoted shall be inclusive of all fittings, clamps, cutting holes chased and making good the same and all items mentioned in the specifications and Bill of Quantities.

## **22.2 GENERAL:**

To supply, install, testing and commissioning of sprinkler system as per drawing and Sprinkler heads spacing shall be in conformity with the drawings and properly coordinated in reflected ceiling with electrical fixtures, ventilation ducts and grills and other services along the ceiling.

Sprinkler heads shall be brass / gunmetal with quartz bulb with temperature rating of 68 degree celsius. Sprinkler heads shall be of type and quality approved by the local fire brigade authority/NFPA 13. The inlet shall be screwed. Sprinkler heads shall be pendent, recessed or special side type. All sprinklers shall conform to the specifications G.I./M.S.ven by CPWD./NBC/NFPA/CFO./NBC/NFPA/CFO., IS, NFPA, FOC, UL & FM.

## **22.3 PENDENT /UPRIGHT TYPE SPRINKLER HEAD**

Sprinkler heads shall be quartzite bulb type with bulb, valve assembly, yoke and the deflector. The sprinkler shall be of approved make and type with 15 mm nominal diameter outlets.

The bulb shall be made of corrosion free material strong enough to withstand any water pressure likely to occur in the system. The bulb shall be shatter when the temperature of the surrounding air reaches at 68 c. The nominal bore shall 15 mm diameter and colour of liquid shall be as per temperature rating.

## **22.4 CONCEALED TYPE / WITH ROSSETE SPRINKLER HEAD**

Adjustable concealed sprinklers shall be provided as specified in S.O.Q. in areas where an attractive appearance is primary concern. Concealed Sprinkler heads shall be infinitely adjustable for a full 15 mm so as to compensate for uneven ceiling heights & allow adjustment of the sprinkler cover at any timer. The sprinkler shall be of approved make and type with 15 mm nominal diameter outlets.

The bulb shall be made of corrosion free material strong enough to withstand any water pressure likely to occur in the system. The bulb shall be shatter when the temperature of the surrounding air reaches at 68 c.

The nominal bore shall 15 mm diameter and color of liquid shall be as per temperature rating.

## **22.5 INSATLLATION CONTROL VALVE & REALATED EQUIPMENTS FOR SPRINKLER STSTEM**

The sprinkler system shall have installation control valve (Flow switch with Isolation Valve and Drain arrangement) along with assemblies at entry of main header in each floor.

## **22.6 FLOW SWITCH**

Flow switch shall have a paddle made up of flexible material of the width to fit within the pipe bore. The terminal box shall be mounted over the paddle / pipe through a connecting socket. The switch shall be potential free in either NO or NC position as required. The switch shall be able to trip and make/ break con CPWD./NBC/NFPA/CFO./NBC/NFPA/CFO.t on the operation of a single sprinkler head. The terminal box shall have connections for wiring to the Fire alarm panel. The seat shall be of stainless steel. The flow switch shall have IP: 55 protections.

The flow switch shall work at a minimum flow rate of 100 LPM. Further, it shall have a

retard to compensate for line leakage or intermittent flows.

## **22.7 BUTTERFLY VALVE**

The Butterfly valve shall be suitable for waterworks and tested to minimum of 16 kg/sq cm Pressure. The valves shall fulfill the requirements of BIS(Indian Standard)BS: 5155 or AWWA C 504, API 609 and MSS-SP-67.

The body shall be of cast iron to IS: 210 in circular shape and of high strength to take the minimum water pressure of 10 kg/sq cm. The disc shall be heavy-duty cast iron with anti-Corrosive epoxy or nickel coating.

The valve seat shall be high grade elastomer or nitrile rubber. The valve in closed position shall have complete con CPWD./NBC/NFPA/CFO./NBC/NFPA/CFO.t between the seat and the disc throughout the perimeter. The elastomer rubber shall have a long life and shall not G.I./M.S.ve away on continuous applied water pressure. The shaft shall be of ENB grade carbon steel.

The valve shall be fitted between two flanges on either side of pipe flanges. The valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages.

The valve shall be supplied with manual gear operated opening/ closing system by lever.

## **22.8 DRAIN VALVE**

50 MM / or as specified in SOQ diameter MS/ G.I./M.S.pipe conforming to I.S.:1239 (heavy grade) with 50 mm diameter / or as specified in SOQ gunmetal full way valve shall be provided for drainage of any water in the system in low pockets.

## **22.9 SPRINKLER ALARM VALVE:**

Apart from above, Sprinkler alarm valve shall be provided with all accessories for wet sprinkler system to ensure positive water flow. It shall have flange connection & shall have brass body & steel trims. The valve shall conform to the specifications G.I./M.S.ven by NFPA/UL/LFA

## **23.0 TESTING OF THE HYDRANT SYSTEM:**

- 23.1 All air shall be trapped from the pipeline through hydrants & air valves. Each section of the pipe shall be slowly filled with the water & allow to stand the water for 2 hours minimum with the ends closed. No joints / connection shall be leaked within this duration. The hydraulic test pressure shall be 1.5 times the design pressure or 14.5 kg/cm<sup>2</sup> whichever is higher.
- 23.2 Flushing of underground connections: Underground mains and lead-in connections to system risers shall be flushed before connections made to piping in order remove foreign materials which may have entered the underground during the course of installation. For hydrant system the flushing operation shall be continued until water is clear.
- 23.3 Underground mains and lead-in connection shall be flushed at a flow rate of not less than 480 ltrs. per minute.

- 23.4 Provision shall be made for the disposal of water issuing from test outlets to avoid property damage.

23.5 Acceptance Test

At the time of taking over, the hydrant system shall fulfill the following acceptance tests:-

- 23.5.1 Starting up of the pressure suction (Jockey Pump) : The pressure switch shall be set at 6.5 kg/cm<sup>2</sup> at the lower limit and 7.5 kg/cm<sup>2</sup> at the upper limit. The system drain shall be opened to cause a drop in the pressure. The Jockey Pump shall start as soon as the pressure gauge needle falls down from 7.5 kg/cm<sup>2</sup>. The Jockey pump shall also stop automatically when the system has been pressurised again upto 7.5kg/cm<sup>2</sup>.
- 23.5.2 The main electrical pump shall be set to start when the pressure further drops from 6.5 kg/cm<sup>2</sup> & if it fails to start, the stand by pump will start. An external hydrant valve using a single length of hose and branch pipe shall be fully opened to cause a drop of pressure in the system. At first, the jockey pump shall start when the pressure drops from 7.5 kg. Further, drop in the pressure from 6.5 kg should be allowed to test automatic start-up of the electrical pump. The electrical pump shall continue to run atleast for 5 minutes and reG.I./M.S.ter rise in the pressure upto 6.5 kg the Jockey Pump shall be automatically start at this. The electrical pump shall be stopped manually by pressuring the stop button.
- 23.5.3 After having the system got fully charged at 7.5 kg/cm<sup>2</sup> the external hydrant valve using hose and branch pipe at (ii) above shall be opened. When the pressure has dropped from 6.5 kg/cm<sup>2</sup>, the electric main pump shall come into operation automatically. After the main pump has run for 5 minutes, the power supply in the pump house shall be switched off. The diesel pump shall automatically come into operation immediately.
- 23.5.4 All these tests mentioned above shall be repeated after one hour interval. The result of all the tests shall be identical again. After the system has satisfactorily withstood the above tests, it can be taken over from the contractor.

**24.0 START-UP/SYSTEM TESTING**

It will be the responsibility of the tenderer to cause interim/stage inspection by the Local Fire Authority LFA/ Chief Fire Officer C.F.O during execution of the work as and when so called for by the Employer / Consultant and shall carry out any rectification / modification as may be suggested by the Local Fire Authority (LFA), Chief Fire Officer (CFO).

Soon after the work is completed, the contractor shall inform the LFA/CFO in writing with a copy to the Consultant/Employer for getting the complete system including all sub system and instrumentation, control etc. thoroughly inspected and tested for satisfactory performance. After satisfactory completion of tests of the systems by the LFA / CFO, the contractor shall be required to submit as built drawings to the Consultant / EMPLOYER which have been so approved.

**25.0 COMMISSIONING OF SYSTEM**

- 25.1 Pressurised the fire hydrant system by running the main fire pump and after attai required pressure shut off the pump.
- 25.2 Open bye-pass valve and allow the pressure to drop in the system. Check that the jockey pumps cuts- in and cuts-out at the pre-set pressure. If necessary adjust the pressure switch

for the jockey pump. Close  
bye-pass valve.

- 25.3 Open bye-pass valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump should cut-in at the preset pressure and should not cut-out automatically on reaching the normal line pressure. The main fire pump should stop only by manual push button. However, the jockey pump should cut out as soon as the main pump starts.
- 25.4 Switch off the main fire pump and test check the diesel engine driven pump in the same manner as the electrically driven pump.
- 25.5 When the fire pumps have been checked for satisfactory working on automatic controls, open fire hydrant simultaneously and allow the hose pipe to discharge water into the fire tank to avoid wastage. The electrically driven pump should run continuously for eight hours so that its performance can be checked.
- 25.6 Diesel engine / DG set driven pump should also be checked in the same manner as engine driven in para above by running for 8 hours.
- 25.7 Check each landing valve, male and female couplings and branch pipes for compatibility with each other. Any fitting which is found to be incompatible and does not fit into the other properly, shall be replaced by the Contractor. Landing valves shall also be checked by opening and closing under pressure.
- 26.0 HANDING OVER**
- 26.1 All commissioning and testing shall be done by the Contractor to the complete satisfaction of the Engineer-in-Charge / Consultants, and the job handed over to the Client.
- 26.2 Contractor shall also hand over to the Client all maintenance and operation manuals and all items as per the terms of the contract.

#### TECHNICAL DATA SHEET

*(Technical information to be furnished in following format by Bidder)*

SR. NO.	SPECIFICATION	PARTICULARS		
1.0	FIRE PUMP(S)	HYDRANT	SPRINKLER	JOCKEY
1.1	Type(s)			
1.2	Make(s)			
1.3	<b>General Specifications:</b>			
1.3.1	Capacity (Lit/Sec)			
1.3.2	Head in (mtr.)			
1.3.3	Sizes of suction and delivery pipes in mm			



1.3.4	Pump Efficiency			
1.4	Material for Impeller			
1.5	Material for Pump Casing			
1.6	Material for Shaft			
<b>1.7</b>	<b>Electrical Motor</b>			
1.7.1	Type			
1.7.2	Make			
1.7.3	Speed in R.P.M			
1.7.4	H.P and Voltage of driving motor, type of enclosure and class of winding insulation, Motor full load current (Remote controlled starting arrangement, if any)			
1.7.5	Details of electric supply			
1.7.6	Type of Starter			
<b>1.8</b>	<b>Diesel engine (if asked)</b>			
1.8.1	Speed and Horse power of the engine driving pump(s)			
1.8.2	Method of starting the engine			
1.8.3	Fuel Consumption			
1.8.4	Details of batteries, Battery Charger and Diesel Engine control panel			
1.8.5	Make			
<b>2.0</b>	<b>HYDRANT MAINS</b>			
2.1	Material & Type of underground and / or overhead mains with method of joining			
2.2	To what pressure have the pipes been tested?			
2.3	No. & dia. Of wet riser			
<b>3.0</b>	<b>HYDRANT VALVES</b>			
3.1	Type and Make			
3.2	No. & type of Yard hydrants valve			
3.3	No. & type of floor hydrants			

<b>SR. NO.</b>	<b>SPECIFICATION</b>	<b>PARTICULARS</b>
<b>4.0</b>	<b>HOSE</b>	
4.1	Material and diameter	
4.2	Manufacturer's Name and Guarantee for bursting	
4.3	No. of length of 15m and 7.5m respectively	
4.4	At what pressure the hose has been tested by the	
4.5	Where is hose kept?	
4.6	No. of branch pipes and nozzles and their diameters	
<b>5.0</b>	<b>SPRINKLER</b>	

5.1	No. & type of isolation valves
5.2	Type, make and fusing temperature of the sprinkler heads used.

Note: Performance curve for pumps & catalogues for each above items shall be submitted

### LIST OF APPROVED MAKES

SR. NO.	ITEM	APPROVED MAKE
1	G.I. PIPES /M.S.	TATA / JINDAL / SWASTIK
2	G.I. /M.S. / FITTINGS	R BRAND / SANT-H / UNIK / K.S./JINDAL/JSI/
3	VALVES	KBL / IVC / LEADER / SANT / INTERVALVE / SARKAR/KARTAR
4	FIRE HYDRANTS	NEWAGE / SBJ / SUKAN/ WINCO / PRIYANKA
5	FIRE HOSE REEL	NEWAGE / SBJ / SUKAN/ WINCO / PRIYANKA
6	FIRE HOSE, COUPLING BRANCH PIPE, NOZZLES, FIRE BRIGADE INLET	NEWAGE / SBJ / SUKAN/
7	RRL HOSE	NEWAGE / SBJ / SUKAN/
8	CP HOSE	NEWAGE / SBJ / SUKAN/
9	PUMPS	KBL / M & P / GROUNDFOSS / KSB/
10	MOTOR	KEC / SIEMENS / CGL / ABB
11	DIESEL ENGINE	KOEL / GREAVES /GROUNDFOSS / KIRLOSKER
12	BATTERY	EXIDE / AMCO
13	BATTERY CHARGER	SERVILINK
14	PRESSURE SWITCHES	SWITZER / INFOSS
15	PRESSURE GAUGE	H GURU / FIEBG/BELL
16	FLOW SWITCHES	DANFOSS/FORBES MARSHALL/SWITZER
17	COATING & WRAPPING	IWL / RUSTEK/STP.
18	ELCTRIC METERS	A.E.I. / MECO
19	MCB / MCCBS	SIEMENS / L&T / SCHNEIDER/ABB
20	SWITCHGEAR / SFUs	L & T / SIEMENS
21	FRLS CABLES	GLOSTER /FINOLEX/ POLYCAB/ PARAMOUNT
22	FRLS WIRES	NATIONAL / FINOLEX / <del>POLYCAB/ PARAMOUNT</del>
23	SPRINKLERS	H.D. FIRE / TYCO / VIKING
24	FIRE EXTINGUISHERS	KANEX/ CEASE FIRE / MINIMAX/SAFEX
25	PAINTING	ASIAN / NEROLAC / BERGER
26	FIRE EXIT SIGNAGES	PROLITE/ AUTOGLOW/ NEWAGE/SBJ/ASHIRWAD

Note : (1) For any equivalent make, the contractor shall take approval from Client / Consultants

(1) The Client will have right to select or reject any make